

B.TECH. PROGRAM CURRICULUM – 2024
(Applicable for the batches admitted from A.Y 2024-25)
Version 3.0

**ELECTRONICS AND
COMMUNICATION ENGINEERING**

Version 1.0–Approved in the BoS meeting on 24-08-2024 & Academic Council meeting on 21-09-2024

Version 2.0–Approved in the BoS meeting on 17-05-2025 & Academic Council meeting on 14-06-2025

Version 3.0–Approved in the BoS meeting on 06-06-2026 & Academic Council meeting on 20-06-2026



ADITYA UNIVERSITY

Aditya Nagar, ADB Road, Surampalem - 533 437



Department of Electronics and Communication Engineering

Vision:

To be a recognized centre of excellence in Electronics and Communication Engineering through quality education, innovation, and research to meet societal and industrial needs.

Mission:

M1: Delivering a robust industry aligned curriculum that empowers students to achieve global excellence.

M2: Providing state-of-the-art infrastructure that fosters innovation, critical thinking, and interdisciplinary research.

M3: Inculcating technical and entrepreneurial skills to provide socially relevant and sustainable solutions.

Program Educational Objectives:

Graduates will

PEO1: Design and develop modern electronic and communication systems with professional ethics, environmental sustainability, and social responsibility.

PEO2: Pursue successful professional careers and higher studies by cultivating a learning mindset, engaging in innovative research, and embracing lifelong learning.

PEO3: Demonstrate effective communication, leadership, and adaptability to excel in diverse, multidisciplinary, and collaborative environments.

Program Specific Outcomes:

PSO 1: Design and implement sustainable and energy-efficient solutions in Communication and Signal Processing to address societal and industrial needs.

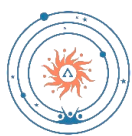
PSO 2: Apply advanced technologies in VLSI Design and Embedded Systems to develop innovative solutions and enhance professional competence.

PROGRAM OUTCOMES (PO's)

The 11 Program Outcomes are described as below.

After successful completion of the program, the graduates will be able to

- PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
- PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
- PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
- PO5 **Engineering tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
- PO6 **The Engineer and the world :** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
- PO7 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
- PO8 **Individual and collaborative teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
- PO9 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO10 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO11 **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Department Electronics and Communication Engineering****B. Tech (ECE) Program Curriculum -2024**
(Applicable for the Batches admitted from A.Y 2024-25)**UG Programs Offered**

- B. Tech in (Electronics and Communication Engineering)
- B. Tech in (Electronics and Communication Engineering) with
 - Minor degree in Civil Engineering
 - Minor degree in Electrical and Electronics Engineering
 - Minor degree in Mechanical Engineering
 - Minor degree in Computer Science and Engineering
 - Minor degree in Data Science
 - Minor degree in Artificial Intelligence and Machine Learning
 - Minor degree in Mining Engineering
 - Minor degree in Petroleum Technology
 - Minor degree in Agricultural Engineering
 - Minor degree in Entrepreneurship Development and Incubation
 - Minor Degree in Quantum Technologies
- Minor Streams offered in B.Tech (Electronics and Communication Engineering)
 - Minor Stream in VLSI
 - Minor Stream in Embedded Systems
 - Minor Stream in Signal Processing and Communication Technology
 - Minor Stream in Space Technology
 - Minor Stream in Technology for Digital Resilience Industry Integrated Program- L & T
 - Minor Stream in Smart Infrastructure (Electronics) Industry Integrated Program- L & T

Credit Division Category-wise

S.No	Broad Category of Courses	UGC	Credits
1	Major Core Courses (MCC)	80	80
2	Minor Stream Courses (MSC) Or University Open Elective Courses (UEC)	32	32
3	Multidisciplinary Courses (MDC)	9	9
4	Ability Enhancement Courses (AEC)	8	09
5	Skill Enhancement Courses (SEC)	9	10
6	Value Added Courses (VAC)	6-8	06
7	Summer Internships (SI)	2-4	04
8	Full Semester Internship (or) Project (PROJ)	12	10
9	Mandatory Courses (MC)		0
Total Credits to be earned for B.Tech Degree		160	160

Foundation Courses – FC

Intermediate-level Courses - IC

Advanced Courses - AC

Major Core Courses (MCC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MA001	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
241MA002	Differential Equations & Vector Calculus	FC	2	1		3	50	50	100	-
241MA007	Transform Calculus	FC	2	1		3	50	50	100	LAC, DEVC
241CH002	Applied Chemistry	FC	2		1	3	50	50	100	-
241PH002	Modern Physics	FC	2		1	3	50	50	100	-
241CS001	Programming for Problem Solving Using C	FC	2		2	4	50	50	100	-
241IT001	IT & AI Skills	FC			2	2	50	50	100	-
241ME001	Engineering Graphics	FC	1		2	3	50	50	100	-
241ME003	Engineering Workshop	FC			1	1	100	-	100	-
241EE001	Basic Electrical & Electronics Engineering	FC	2		2	4	50	50	100	-
241EC002	Network Analysis	FC	3	1		4	50	50	100	-
241EC001	Digital Electronics & Logic Design	FC	2		2	4	50	50	100	-
241EC003	Electronic Devices & Circuits	FC	2		2	4	50	50	100	BEEE
241EC004	Random Variables & Stochastic Processes	FC	3	1		4	50	50	100	-
241EC014	Signals & Systems	FC	2		2	4	50	50	100	-
241EC005	Electromagnetic Waves & Transmission Lines	IC	2	1		3	50	50	100	DEVC
241EC006	Analog Electronics	IC	2		2	4	50	50	100	EDC

241EC007	Integrated Circuits & Applications	IC	2		2	4	50	50	100	EDC
241EC008	Linear Control Systems	IC	2	1		3	50	50	100	S&S
241EC009	Analog & Digital Communications	IC	2		2	4	50	50	100	S&S
241EC010	Digital Signal Processing	IC	2		1	3	50	50	100	S&S
241EC011	VLSI Design	IC	2		1	3	50	50	100	EDC
241EC012	Microprocessors & Microcontrollers	AC	2		1	3	50	50	100	DELD
241EC013	Antenna & Microwave Engineering	AC	2		2	4	50	50	100	EMTL
Total			45	7	28	80				

Multi-Disciplinary Courses (MDC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CS003	Data Structures	FC	2		2	4	50	50	100	PPSC
241MB002	Engineering Economics	FC	3			3	50	50	100	-
241MB003	Management Science	FC	2			2	50	50	100	-
	Total		7		2	9				

Ability Enhancement Courses (AEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EN001	Essential Cognitive Skills for Engineers	FC			1	1	100	-	100	-
241EN002	Advanced Cognitive Skills for Engineers(or) Proficiency in Foreign Language Japanese / German /French/ Spanish	FC			1	1	100	-	100	-
241UC005										
241UC004										
241UC003										
241UC006										
241UC007	Design Thinking	FC			1	1	100	-	100	-
241UC008	Universal Human Values	FC	2			2	100	-	100	-
241UC009	Technical Paper Publication	AC			2	2	100	-	100	-
241EC096	Student Activity-Based Learning	AC				2				
Total			2		5	9				

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC021	PCB Design	FC			2	2	50	50	100	-
241EC094	Soft Computing Tools	IC			2	2	50	50	100	-
241CS072	Object Oriented Programming through JAVA	AC			2	2	50	50	100	-
241EC016	ECAD Tools	AC			2	2	50	50	100	VLSI
241EC017	Verification using Verilog & UVM	AC			2	2	50	50	100	VLSI
Total					10	10				

Value Added Courses (VAC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241UC010	Indian Cultural Heritage & Fine Arts	FC			1	1	100	-	100	-
241PE001	Sports & Yoga	FC			1	1	100	-	100	-
241CS004	Internet of Things	FC			1	1	100	-	100	-
241CS002	Data Analysis Using Python	IC			2	2	50	50	100	-
241UC011	Employability Skills-I	FC			3	0	100	-	100	-
241UC013	Employability Skills-II	FC			3	0	100	-	100	ES-I
241UC014	Employability Skills-III	IC			3	0	100	-	100	ES-II
241UC015	Employability Skills-IV	IC			3	0	100	-	100	ES-III
241UC016	Employability Skills-V	AC			3	1	100	-	100	ES-IV
Total					20	6				

Summer Internships (SI)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC018	Summer Internship-I	IC			2	2	100	-	100	-
241EC019	Summer Internship-II	AC			2	2	100	-	100	-
Total					4	4				

Full Semester Internship (PROJ)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC020	Full Semester Internship (or) Project	AC			10	10	50	50	100	-
Total					10	10				

Mandatory Courses (MC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241AC001	Environmental Science	FC	2			0	100	-	100	-
241AC002	Constitution of India	FC	2			0	100	-	100	-
241AC003	Research Methodology	FC	2			0	100	-	100	-
241AC004	Intellectual Property Rights & Patents	FC	2			0	100	-	100	-
241AC005	Indian Knowledge Systems (IKS)	FC	2			0	100	-	100	-
Total			10			0				

Minor Stream: VLSI

Course Code	Minor Stream Course	level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC086	Digital System Design through Verilog	IC	2		1	3	50	50	100	DELD
241EC026	Digital Design through system Verilog	AC	2		1	3	50	50	100	DDTV
241EC023	CMOS Digital IC Design	IC	3			3	50	50	100	DELD
241EC022	Design For Testability	IC	3			3	50	50	100	DDTV
241EC030	Testing & Verification of VLSI Circuits	IC	3			3	50	50	100	VLSI
241EC024	Analog VLSI Design	IC	3			3	50	50	100	VLSI
241EC027	FPGAs & ASIC Design	AC	3			3	50	50	100	DDTV
241EC028	Low Power VLSI Design	AC	3			3	50	50	100	VLSI
241EC029	SoC Design	AC	3			3	50	50	100	MPMC
241EC025	CMOS Mixed signal IC Design	AC	2		1	3	50	50	100	CDIC, AVLSI
241EC031	VLSI Physical Design	AC	2			2	50	50	100	LPVLSI
	Total		29		3	32				

Minor Stream: Embedded Systems

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC037	Sensors & Actuators	FC	3			3	50	50	100	-
241EC040	Embedded C	IC	3			3	50	50	100	-
241EC036	Hardware interfacing & Networking	IC	3			3	50	50	100	-
241EC038	Microcontrollers for Embedded Systems	IC	3			3	50	50	100	MPMC
241EC032	Embedded Real Time Systems	AC	3			3	50	50	100	-
241EC042	Wireless LANs & PANs	IC	3			3	50	50	100	-
241EC039	System Programming	AC	3			3	50	50	100	-
241EC034	Embedded System Design	AC	2		1	3	50	50	100	-
241EC041	Real Time operating System using QNX	AC	0	0	2	2	50	50	100	RTOS
241EC033	Machine Learning for Embedded Systems	AC	3			3	50	50	100	-
241EC035	Hardware & Software Co-Design	AC	3			3	50	50	100	-
	Total		29		3	32				

Minor Stream: Signal Processing and Communication Technology

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC045	Fundamentals of Speech Processing	IC	2		1	3	50	50	100	S&S
241EC046	Information Theory & Coding Techniques	IC	2		1	3	50	50	100	-
241EC044	Digital Signal Processors & Architectures	IC	3			3	50	50	100	DSP
241EC043	Digital Image Processing	IC	2		1	3	50	50	100	S&S
241EC049	Radar Engineering	IC	3			3	50	50	100	ADCM
241EC051	Soft Computing Techniques	AC	3			3	50	50	100	-
241EC047	Optical Communications	AC	3			3	50	50	100	ADCM
241EC050	Satellite Communications	AC	3			3	50	50	100	ADCM
241EC048	Pattern Recognition	AC	2			2	50	50	100	DIP
241EC052	Wireless Communications	AC	3			3	50	50	100	ADCM
241EC053	Wireless Sensor Networks	AC	3			3	50	50	100	IOT
Total			29		3	32				

Minor Stream: Space Technology

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC054	Introduction to Space Laws	IC	3			3	50	50	100	-
241EC055	Aircraft Communication Systems	IC	3			3	50	50	100	-
241EC057	Aircraft Navigation Systems	IC	3			3	50	50	100	-
241EC062	Missile & Space Vehicle Guidance & Control	IC	2			2	50	50	100	-
241EC060	Flight Control Systems	IC	3			3	50	50	100	-
241EC058	Avionics Embedded Systems	IC	3			3	50	50	100	-
241EC059	Avionics Network Technology	AC	3			3	50	50	100	-
241EC064	Unmanned Aircraft Systems	AC	3			3	50	50	100	-
241EC056	Aerospace Electromagnetic Compatibility	AC	3			3	50	50	100	-
241EC061	Global Navigation Satellite Systems & Applications	AC	3			3	50	50	100	SC
241EC063	Remote Sensing & Digital Image Processing of Satellite Data	AC	3			3	50	50	100	DIP
Total			32			32				

Minor Stream: Technology for Digital Resilience
Industry Integrated Program- L & T

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC066	Software Defined Radio	IC	3	1		4	50	50	100	-
241EC067	Introduction to Internet of Things	IC	2		1	3	50	50	100	-
241EC068	Cloud based Internet of Things	IC	2		2	4	50	50	100	IIoT
241EC069	Cyber Defence & Information Security	IC	3			3	50	50	100	-
241EC070	Industrial Applications of Microcontrollers - A Practice based approach	IC	3			3	50	50	100	-
241EC065	Applied Industrial IoT	IC	3			3	50	50	100	-
241EC071	Data Engineering, Analytics & Security in Industries	AC	3			3	50	50	100	-
241EC072	Cloud Adoption & Management Techniques	AC	3			3	50	50	100	-
241EC073	Artificial Intelligence & Edge Computing	AC	3			3	50	50	100	-
241EC074	Modern Wireless Communications	AC	3			3	50	50	100	-
Total			28	1	3	32				

#Syllabus for the industry partner courses will be released in the department as and when Required.

Minor Stream: Smart Infrastructure (Electronics)
Industry Integrated Program- L & T

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC075	Digital Data Communications	IC	3		1	4	50	50	100	-
241EC076	Introduction to Machine Learning	IC	3		1	4	50	50	100	-
241EC077	Sensors & Transducers	IC	3			3	50	50	100	-
241EC078	Cyber Physical Systems for Industrial Applications	IC	3			3	50	50	100	-
241EC065	Applied Industrial IoT	IC	3			3	50	50	100	-
241EC079	Drone Technology and its Transformative Applications- A Practitioner's Perspective	IC	3			3	50	50	100	-
241EC073	Artificial Intelligence and Edge Computing	AC	3			3	50	50	100	-
241EC080	5G Technology for Smarter & Secure Connectivity	AC	3			3	50	50	100	-
241EC074	Modern Wireless Communications	AC	3			3	50	50	100	-
241EC081	Chip based VLSI Design for Industrial Applications	AC	3			3	50	50	100	-
Total			30		2	32				

#Syllabus for the industry partner courses will be released in the department as and when Required.

UNIVERSITY OPEN ELECTIVE COURSES

AI & ML

Course Code	Course Name	Level	L	T	P	C	CE	SE	Total	Offered to Programs	Pre-requisite
241AI002	Artificial Intelligence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241AI005	Machine Learning	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI027	AI & Data Science	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI028	AI in Healthcare	IC	2		1	3	50	50	100	CE,EEE, ME, ECE,CSE, IT, AIML,CSE (DS) PT,Min.E	DAP
241AI011	Deep Learning	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI010	Natural Language Processing	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI009	Reinforcement Learning	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI029	AI in Agriculture	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
241AI030	Robotics & AI	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
241AI031	AI in Finance & Economics	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
Total			19		13	32					

Production Excellence											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241ME081	Fundamentals of Production Excellence	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
241ME082	Six Sigma for Production Excellence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME083	Quality Excellence in Production	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME084	Digital Transformation for Production Excellence	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME085	Agile Production Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME086	Process Excellence & Optimization	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME087	Risk Management in Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME088	Ethical & Social Responsibility in Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME089	Data-Driven Decision Making for Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
241ME058	Industry 5.0 for Engineers	AC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE

241ME090	Cost Excellence in Production	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
Total			23		9	32					

Supply Chain Management											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241MB017	Introduction to Supply Chain Management	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
241MB018	Logistics & Distribution Management	FC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB019	Supply Chain Project Management	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB020	Supply Chain Innovation & Trends	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB021	Supply Chain Analytics	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB022	Demand Planning & Forecasting	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB023	Supply Chain Risk Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM

241MB024	Inventory Management & Control	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB025	E-Commerce & Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB026	Operations Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB027	Supply Chain Ethics & Corporate Social Responsibility (CSR)	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
Total			32			32					

Sustainability											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241CE074	Introduction to Sustainable Development	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
241CE079	Natural Disaster Management & Mitigation	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE081	Waste Water Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE082	Integrated Solid Waste Management for a Smart City	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE083	Watershed Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-

241EE033	Energy Audit, Conservation & Management	IC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EE006	Electric Power Generation, Transmission & Distribution Systems	AC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241CE075	Sustainable Agriculture & Food Systems	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE076	Sustainable Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE077	Sustainable Production Excellence	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE078	AI in Environmental Science and Sustainability	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
Total			32			32					

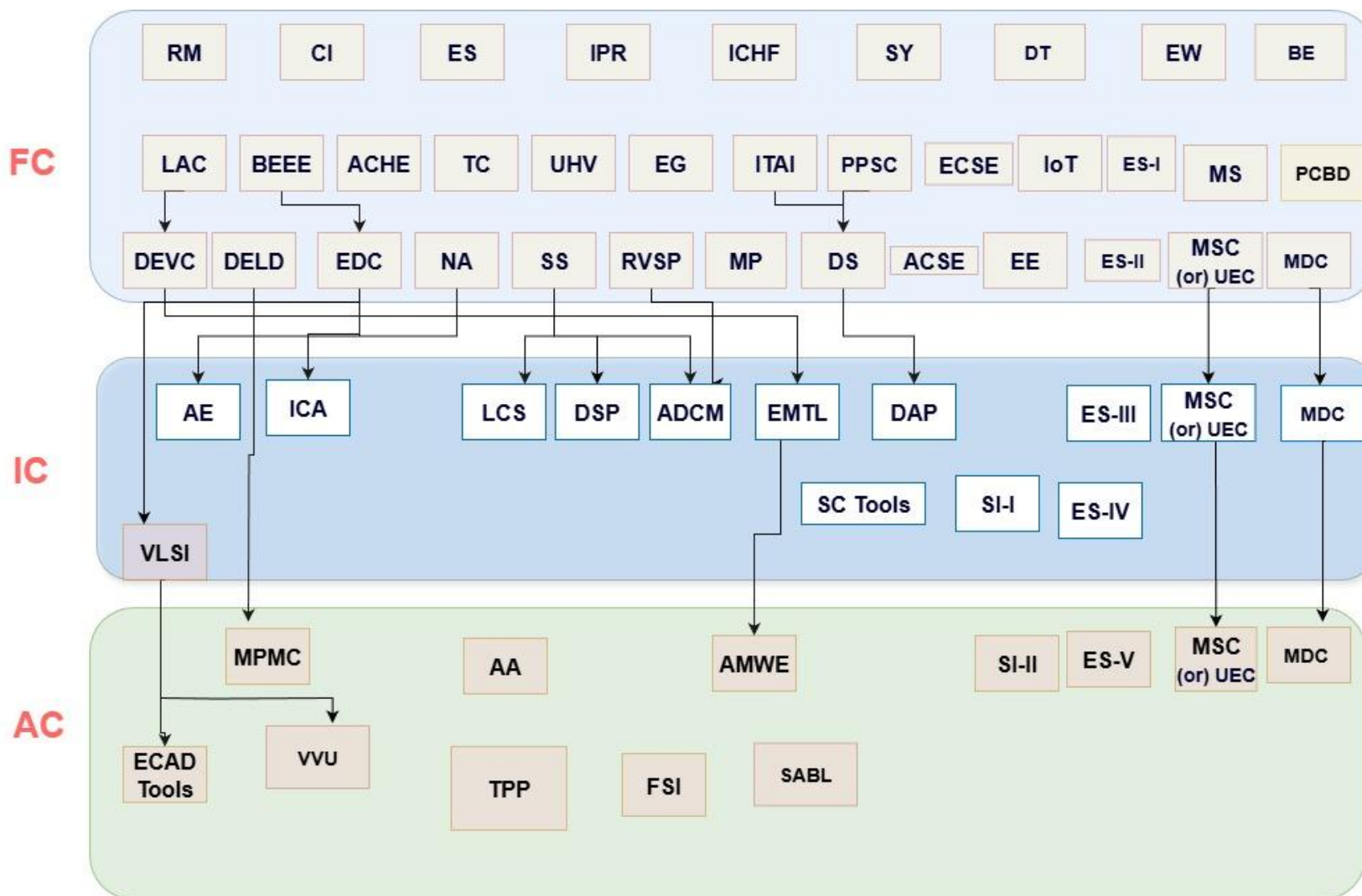
Security											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241CS032	Cybersecurity Essentials	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT035	Security in Software Development	FC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS028	Ethical Hacking	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS069	Cloud Security	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT036	Security & Compliance in Business	IC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT037	Cryptography & Data Security	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT038	Security Awareness & Social Engineering	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT039	Cybersecurity Policy & Strategy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT040	Security in Emerging Technologies	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS030	Information Security Analysis & Audit	AC	2			2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT041	Financial Information Security & Privacy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
Total			25		07	32					

Others											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241CE080	Remote Sensing & GIS Applications	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EE036	Electric Energy Storage Systems	FC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EE043	Electrical safety	IC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EE054	Hybrid & Electric Vehicles	IC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241ME073	Organizational Behaviour	FC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME036	Sustainable Energy Systems	FC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME037	Solar Energy Systems	FC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME060	Composite Materials	IC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	SSP/MP
241EC082	Communication Systems	FC	3			3	50	50	100	CE,EEE,ME,CSE ,IT, AIML, CSE(DS) PT,Min.E	-
241EC083	Electronic Measurements & Instrumentation	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EC084	Introduction to Embedded Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-

241EC085	Fundamentals of Image Processing	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
241EC077	Sensors and Transducers	IC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
241CS003	Data Structures	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241CS065	Computer Organization	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS013	Operating Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT005	Database Management Systems	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241IT007	Agile Software Engineering	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241CS007	Computer Networks	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT006	Java Programming	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241CS068	Fundamentals of RedHat Enterprise Linux	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS067	AWS Cloud Foundations	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS066	AWS Cloud Development	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS070	Continuous integration & delivery using DevOps	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT024	Fundamentals of Salesforce Administration	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT034	Advanced Salesforce Administration	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT023	Principles of Pega Systems	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT026	Pega System Architecture & Design	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241MB004	Entrepreneurship Development & Incubation	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-

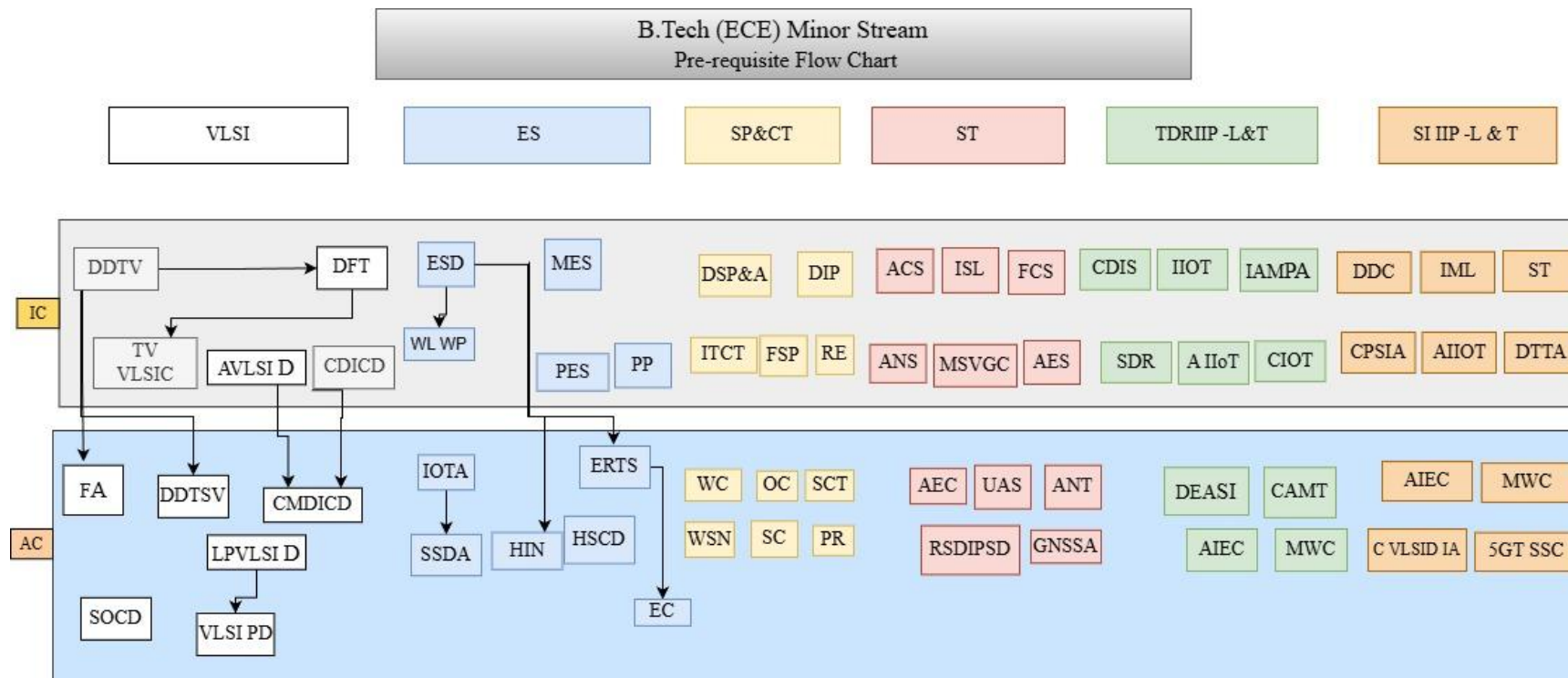
241MB005	Business Ethics & Corporate Governance	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241MB006	Entrepreneurship Development & Business Management	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EC029	SoC Design	AC	3			3	50	50	100	CE, EEE, ME, CSE, IT, AIML, CSE (DS), PT, Min.E.	MPMC
241CS023	Cloud Computing	FC	2		2	4	50	50	100	CE, EEE, ME, ECE, PT, Min.E.	-

B.Tech (ECE) Program Curriculum Pre-requisite Flowchart



FOUNDATION COURSES		INTERMEDIATE-LEVEL COURSES		ADVANCED COURSES	
LAC	Linear Algebra & Calculus	EMTL	Electromagnetic Waves & Transmission Lines	MPM C	Microprocessors & Microcontrollers
DEVC	Differential Equations & Vector Calculus	AE	Analog Electronics	AMW E	Antenna & Microwave Engineering
TC	Transform Calculus	ICA	Integrated Circuits & Applications	DIP	Digital Image Processing
ACHE	Applied Chemistry	LCS	Linear Control Systems	OOPS	Object Oriented Programming through JAVA
MP	Modern Physics	ADC M	Analog & Digital Communications	ECAD	ECAD Tools
PPSC	Programming for Problem Solving Using C	DSP	Digital Signal Processing	VVU	Verification using Verilog & UVM
ITAI	IT & AI Skills	DAP	Data Analysis Using Python	SI-II	Summer Internship-II
PCBD	PCB Design	VLSI	VLSI	TPP	Technical Paper Publication
EG	Engineering Graphics	SC Tools	Soft Computing Tools	FSI	Full Semester Internship
EW	Engineering Workshop	SI-I	Summer Internship-I	ES-V	Employability Skills-V
BEEE	Basic Electrical & Electronics Engineering	ES-III	Employability Skills-III		
NA	Network Analysis	ES-IV	Employability Skills-IV		
DELD	Digital Electronics & Logic Design				
EDC	Electronic Devices & Circuits				
RVSP	Random Variables & Stochastic Processes				
SS	Signals & Systems				
ECSE	Essential Cognitive Skills for Engineers				
ACSE	Advanced Cognitive Skills for Engineers (or) Proficiency in Foreign Language (Japanese/German /French/Spanish)				
DT	Design Thinking				
UHV	Universal Human Values				
ICHF	Indian Cultural Heritage & fine arts				
SY	Sports & Yoga				
IOT	Internet of Things				
EE	Engineering Economics				
MS	Management Science				
DS	Data Structures				
ES	Environmental Science				

COI	Constitution of India
RM	Research Methodology
IPR	Intellectual Property Rights & Patents
ES-I	Employability Skills-I
ES-II	Employability Skills-II
BE	Indian Knowledge Systems



INTERMEDIATE - LEVEL COURSES

ADVANCED COURSES

VLSI	DDTV	Digital System Design Through Verilog	CMICD	CMOS Mixed Signal IC Design
	DFT	Design for Testability	LVLSI	Low Power VLSI Design
	CDIC	CMOS Digital IC Design	FA	FPGAs & ASIC Design
	D			
	TVVL	Testing & Verification of VLSI Circuits	SoCD	SoC design
Embedded Systems-ES	SI			
	AVLS	Analog VLSI Design	DDTSV	Digital System Design Through System Verilog
	I		VLSIPD	VLSI Physical System Design
	MES	Microcontrollers for Embedded Systems	ERTS	Embedded & Real Time Systems
	ESD	Embedded System Design	HSCD	Hardware & Software Codesign
Signal Processing and Communication Technology-ST&CT	PES	Programming Languages for Embedded System	SSDAS	Smart Sensors & Devices for Agriculture
	WLW	Wireless LAN's & PAN's	HIN	Hardware interfacing & Networking
	PP	Parallel Processing	EC	Embedded Computing
			IOTA	Internet of Things & its Applications.
	FSP	Fundamentals of Speech Processing	SCT	Soft Computing Techniques
Space Technology-ST	ITCT	Information Theory & Coding Techniques	OC	Optical Communications
	DSPA	Digital Signal Processors & Architectures	SC	Satellite Communications
	RE	Radar Engineering	WC	Wireless Communications
	DIP	Digital Image Processing	WSN	Wireless Sensor Networks
	ISL	Introduction to Space Laws	PR	Pattern Recognition
Technology for Digital Resilience Industry Integrated Program- L & T-TDRIIP-L&T	ACS	Aircraft Communication Systems	ANS	Avionics Technology
	ANS	Aircraft Navigation Systems	GNSSA	Global Navigation Satellite Systems & Applications
	MSV	Missile & Space Vehicle Guidance and Control	UAS	Unmanned Aircraft System
	GC		AEC	Aerospace Electromagnetic Compatibility
	FCS	Flight Control System	RSDIPSD	Remote Sensing & Digital Image Processing of Satellite Data
	AEC	Avionics Embedded System		
	CDIS	Cyber Defence & Information Security	DEASI	Data Engineering, Analytics & Security in Industries
	IAMP	Industrial Applications of Microcontrollers - A Practice based approach	CAMT	Cloud Adoption & Management Techniques
	A			
	AIIoT	Applied Industrial IoT	AIEC	Artificial Intelligence & Edge Computing
	SDR	Software Defined Radio	IIoT	Introduction to Internet of things

Smart Infrastructure (Electronics) Industry Integrated Program- L & T	CBIoT	Cloud Based IoT	MWC	Modern Wireless communication
	CPSIA	Cyber Physical Systems for Industrial Applications	5GTSSC	5G Technology for Smarter & Secure Connectivity
		Drone Technology and its		
	DTTA	Transformative Applications -A Practitioner's Perspective	CVLSIIA	Chip based VLSI Design for Industrial Applications
	DDC	Digital Data Communication		
	IML	Introduction to Machine Learning		
	S&T	Sensors & Transducers		

Suggestive Semester-wise Curriculum

I SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241MA001	Linear Algebra & Calculus	MCC	FC	2	1		3	3
241PH002	Modern Physics	MCC	FC	2		1	3	4
241CS001	Programming for Problem Solving Using C	MCC	FC	2		2	4	6
241EE001	Basic Electrical & Electronics Engineering	MCC	FC	2		2	4	6
241IT001	IT & AI Skills	MCC	FC			2	2	4
241EN001	Essential Cognitive Skills for Engineers	AEC	FC			1	1	2
241UC008	Universal Human Values	AEC	FC	2			2	2
241PE001	Sports & Yoga	VAC	FC			1	1	2
	Total			10	1	9	20	29

II SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241MA002	Differential Equations & Vector Calculus	MCC	FC	2	1		3	3
241CH002	Applied Chemistry	MCC	FC	2		1	3	4
241ME001	Engineering Graphics	MCC	FC	1		2	3	5
241EC002	Network Analysis	MCC	FC	3	1		4	4
241ME003	Engineering Workshop	MCC	FC			1	1	2
241CS003	Data Structures	MDC	FC	2		2	4	6
241EN002	Advanced Cognitive Skills for Engineers(or) Proficiency in Foreign Language Japanese / German /French/ Spanish	AEC	FC			1	1	2
241UC005								
241UC004								
241UC003								
241UC006								
241UC007	Design Thinking	AEC	FC			1	1	2
241UC010	Indian Cultural Heritage & Fine Arts	VAC	FC			1	1	2
241UC011	Employability Skills-I	VAC	FC			3	0	3
241AC001	Environmental Science	MC	FC	2			0	2
	Total			12	2	12	21	35

III SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241MA007	Transform Calculus	MCC	FC	2	1		3	3
241EC001	Digital Electronics & Logic Design	MCC	FC	2		2	4	6
241EC003	Electronic Devices & Circuits	MCC	FC	2		2	4	6
241EC014	Signals & Systems	MCC	FC	2		2	4	6
241MB002	Engineering Economics	MDC	FC	3			3	3
241EC021	PCB Design	SEC	FC			2	2	4
241CS004	Internet of Things	VAC	FC			1	1	2
241UC013	Employability Skills-II	VAC	FC			3	0	3
241AC002	Constitution of India	MC	FC	2			0	2
	Total			13	1	12	21	35

IV SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241EC004	Random Variables & Stochastic Processes	MCC	FC	3	1		4	4
241EC006	Analog Electronics	MCC	IC	2		2	4	6
241EC008	Linear Control Systems	MCC	IC	2	1		3	3
	Minor Stream Course-1or University Open Elective Course -1	MSC or UEC	FC	2		1	3	4
241MB003	Management Science	MDC	FC	2			2	2
241EC094	Soft Computing Tools	SEC	IC			2	2	4
241CS002	Data Analysis Using Python	VAC	IC			2	2	4
241UC014	Employability Skills-III	VAC	IC			3	0	3
241AC003	Research Methodology	MC	FC	2			0	2
	Total			13	2	10	20	32

V SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241EC005	Electromagnetic Waves & Transmission Lines	MCC	IC	2	1		3	3
241EC009	Analog & Digital Communications	MCC	IC	2		2	4	6
241EC007	Integrated Circuits & Applications	MCC	IC	2		2	4	6
241EC011	VLSI Design	MCC	IC	2		1	3	4
	Minor Stream Course -2 or University Open Elective Course -2	MSC or UEC	IC	3			3	3
241CS072	Object Oriented Programming through JAVA	SEC	AC			2	2	4
241UC015	Employability Skills-IV	VAC	IC			3	0	3
241EC018	Summer Internship-I	SI	IC			2	2	4
241AC004	Intellectual Property Rights & Patents	MC	FC	2			0	2
	Total			13	1	12	21	35

VI SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241EC010	Digital Signal Processing	MCC	IC	2		1	3	4
241EC012	Microprocessors & Microcontrollers	MCC	AC	2		1	3	4
241EC013	Antenna & Microwave Engineering	MCC	AC	2		2	4	6
	Minor Stream Course-3 or University Open Elective Course -3	MSC or UEC	IC	2		1	3	4
	Minor Stream Course -4 or University Open Elective Course -4	MSC or UEC	IC	3			3	3
	Minor Stream Course -5 or University Open Elective Course -5	MSC or UEC	AC	3			3	3
241EC016	ECAD Tools	SEC	AC			2	2	4
241AC005	Indian Knowledge Systems (IKS)	MC	FC	2				2
	Total			16		7	21	30

VII SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
	Minor Stream Course -6 or University Open Elective Course -6	MSC (or) UEC	IC	3			3	3
	Minor Stream Course -7 or University Open Elective Course -7	MSC (or) UEC	IC	3			3	3
	Minor Stream Course -8 or University Open Elective Course -8	MSC (or) UEC	AC	3			3	3
	Minor Stream Courses -9 or University Open Elective Course -9	MSC (or) UEC	AC	3			3	3
	Minor Stream Course -10 or University Open Elective Course -10	MSC (or) UEC	AC	3			3	3
	Minor Stream Course -11 or University Open Elective Course -11	MSC (or) UEC	AC	2			2	2
241EC017	Verification using Verilog & UVM	SEC	AC			2	2	4
241EC019	Summer Internship-II	SI	IC			2	2	4
	Total			17		4	21	25

VIII SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
241UC009	Technical Paper Publication	AEC	AC			2	2	4
241UC016	Employability Skills-V	VAC	AC			3	1	3
241EC096	Student Activity-Based Learning	VAC	AC				2	
241EC020	Full Semester Internship (or) Project	PROJ	AC			10	10	20
	Total					15	15	27

Total Credits:160

*** To acquire a minor degree, a student has to earn 20 credits in addition to the 160 credits**
Minor Degree in Electronics and Communication Engineering
(Offered to other branches students):

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-Requisite
241EC087	Fundamentals of Communications	FC	2		1	3	50	50	100	-
241EC088	Fundamentals of Signal Processing	FC	2		1	3	50	50	100	-
241EC089	Analog & Digital Circuits	IC	2			2	50	50	100	BEEE
241EC042	Wireless LAN's & PAN's	IC	3			3	50	50	100	-
241EC090	Linear & Digital IC Applications (or) Sensors & Actuators	IC	3			3	50	50	100	ADC
241EC091										
241EC092	Embedded Microcontrollers (or) Digital System Design	IC	2		1	3	50	50	100	ADC, PPSC
241EC093										
241EC067	Introduction to Internet of things (or) Modern Wireless Communications	AC	2		1	3	50	50	100	EM, WLAN's & PAN's
241EC074			3			3	50	50	100	FC
Total			16		4	20				

Minor Degree in Civil Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CE025	Repair & Rehabilitation of Structures	FC	3			3	50	50	100	-
241CE043	Building Planning & Computer-Aided Drawing	FC			2	2	50	50	100	-
241CE027	Green Buildings	FC	3			3	50	50	100	-
241CE040	Fundamentals of Soil Behaviour	FC	3			3	50	50	100	-
241CE054	Railway Engineering(or) Docks & Harbour Engineering	FC	3			3	50	50	100	-
241CE047										
241CE036	Environmental Impact & Risk Management(or) Environmental Management	IC	3			3	50	50	100	-
241CE037										
241CE056	Urban Transportation Planning(or) Intelligent Transportation Systems	IC	3			3	50	50	100	-
241CE049										
Total			18		2	20				

Minor Degree in Electrical and Electronics Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EE055	Operation & Control of Electric machines	FC	2			2	50	50	100	BEEE
241EE056	Fundamentals of Power Electronics	FC	2			2	50	50	100	BEEE
241EE013	Electrical Measurements & Instrumentation	FC	2		2	4	50	50	100	ENA-1/BEEE
241EE006	Electric Power Generation and Distribution Systems	IC	3			3	50	50	100	ENA-1/BEEE
241EE034	Alternative Energy Sources (or)	IC	3			3	50	50	100	EPGDS / BEEE/ ISM
241EE027	Utilization of Electrical Energy									
241EE037	Hybrid Electric Vehicles (or)	AC	3			3	50	50	100	FPE/ OCEM
241EE035	Special Electric machines									
241EE043	Electrical Safety (or)	AC	3			3	50	50	100	EPGDS /PSA
241EE030	Methods & Algorithms for Intelligent Control									
	Total		18		2	20				

Minor Degree in Mechanical Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241ME074	Basic Mechanical Engineering	FC	2			2	50	50	100	-
241ME004	Engineering Thermodynamics	IC	2	1		3	50	50	100	SSP/MP
241ME077	Introduction to Automobile Engineering (or)	IC	3			3	50	50	100	SSP/MP
241ME078	Mechanics of Solids									
241ME012	Heat Power Engineering (or)	IC	2	1		3	50	50	100	ETD
241ME040	Refrigeration & Air Conditioning									
241ME075	Production Technology	IC	3			3	50	50	100	EW
241ME076	Metallurgy & Material Science	IC	3			3	50	50	100	SSP/MP
241ME079	Theory of Machines (or)	AC	3			3	50	50	100	SSP/MP
241ME080	Advanced Engineering Metrology									
	Total		18	2		20				

Minor Degree in Computer Science and Engineering

Course Code	Course Title	Level	L	T	P	C	CIE	SE E	Total	Pre-requisite
241CS013	Operating Systems	IC	2		1	3	50	50	100	-
241CS007	Computer Networks	IC	2		1	3	50	50	100	-
241IT007	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
241AI003	Data Mining	IC	2		1	3	50	50	100	-
241CS008	Object Oriented Programming through C++ (or) Java Programming	IC	2		2	4	50	50	100	PPSC
241IT006										
241CS016	Introduction to MERN Stack	IC			2	2	-	100	100	JP
241CS030	Development (or) Information Security Analysis & Audit	IC	2			2	50	50	100	-
241CS018	Advanced MERN Stack	AC			2	2	-	100	100	IMSD
241IT012	Development(or) Flutter Fundamentals	AC			2	2	50	50	100	-
Total			12		8	20				

Minor Degree in Data Science

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241IT007	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
241CS034	Fundamentals of Data Science	IC	2		1	3	50	50	100	-
241CS012	NoSQL Databases	IC	2			2	50	50	100	-
241AI003	Data Mining	IC	2		1	3	50	50	100	-
241CS037	Health Care Data Analytics (or)	IC	2		1	3	50	50	100	-
241CS036	Business Intelligence & Analytics									PPSC
241AI004	Big Data Analytics (or)	AC	2		1	3	50	50	100	DM
241AI036	Data Visualization Techniques									DAP
241CS041	Social Network Analysis (or)	AC	2		1	3	50	50	100	-
241CS040	Social Networks & Semantic Web									
	Total		14		6	20				

Minor Degree in Artificial Intelligence and Machine Learning

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241AI002	Artificial Intelligence	IC	2		1	3	50	50	100	-
241AI005	Machine Learning	IC	2		2	4	50	50	100	DAP
241AI015	AI Chatbots	IC	2			2	50	50	100	AI
241AI014	Soft Computing (or) Fundamentals of Data Science	IC	2		1	3	50	50	100	AI
241CS034			2		1	3	50	50	100	-
241AI037	Natural Language Processing and Text Analytics (or) Data Visualization Techniques	AC	2		1	3	50	50	100	DAP
241AI036										
241AI016	Prompt Engineering and GenAI (or) Social Network Analysis	AC	2		1	3	50	50	100	ML
241CS041										
241AI017	Federated Machine Learning	AC	2			2	50	50	100	ML
TOTAL			14		6	20				

Minor Degree in Petroleum Technology

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241PT027	Introduction to Petroleum Engineering	FC	2			2	50	50	100	-
241PT035	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
241PT047	Fundamentals of Geology & Reservoir Engineering	IC	3			3	50	50	100	-
241PT048	Fundamentals of Drilling & Production Engineering (or) Unconventional Hydrocarbon Resources	IC	3			3	50	50	100	-
241PT016										
241PT049	Natural Gas Hydrates (or) Fundamentals of Liquefied Natural Gas	AC	3			3	50	50	100	-
241PT005										
241PT050	Artificial Lift Techniques (or) Enhanced Oil Recovery	AC	3			3	50	50	100	-
241PT003										
241PT012	Petroleum Refinery Engineering	AC	3			3	50	50	100	-
Total			20			20				

Minor Degree in Mining Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MN003	Development of Mineral Deposits	FC	3			3	50	50	100	-
241MN041	Green Mining	FC	3			3	50	50	100	-
241MN006	Surface Mining	IC	3			3	50	50	100	DMD
241MN024	Drilling & Blasting	IC	3			3	50	50	100	DMD
241MN007	Underground Coal Mining Technology	IC	3			3	50	50	100	DMD
241MN008	(or) Underground Metal Mining Technology									
241MN014	Mine Legislation & General Safety (or)	AC	3			3	50	50	100	UCMT / UMMT
241MN028	Environmental Pollution & Control									
241MN045	Industrial Safety Practices (or)	AC	2			2	50	50	100	-
241MN046	Ground Control									
Total			20			20				

Minor Degree in Agricultural Engineering

Agricultural Engineering							Marks			Pre-requisite
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE082	Fundamentals of Renewable Energy Sources	FC	3			3	50	50	100	-
241AE083	Post-harvest Engineering of Cereal Crops	FC	3			3	50	50	100	-
241AE084	Ground Water Hydrology	FC	3			3	50	50	100	-
241AE085	Micro Irrigation Systems	IC	2			2	50	50	100	-
241AE086	Surface Water Hydrology (OR)	IC	3			3	50	50	100	GWH
241AE087	Land & Water Management Engineering									
241AE088	Agricultural Process Engineering & Food Quality (OR)	AC	3			3	50	50	100	PHECC
241AE089	Post-harvest Engineering Horticultural Produce									
241AE090	Agricultural & Machinery Equipment (or)	AC	3	0	0	3	50	50	100	FRES
241AE091	Design of Bio-energy systems									
	Total		20			20				

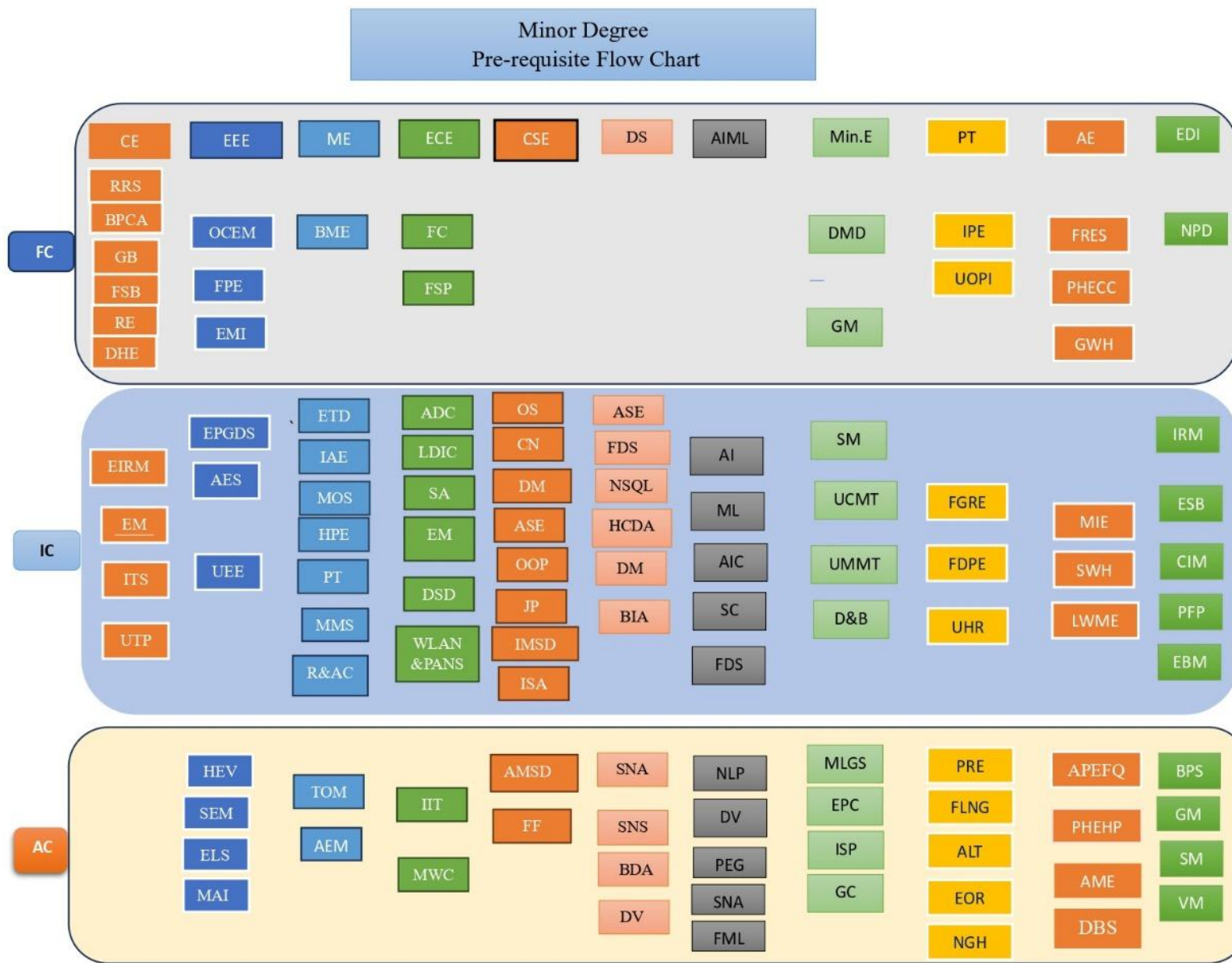
Minor Degree in Entrepreneurship Development & Incubation

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MB007	New Product Development	FC	3			3	50	50	100	-
241MB008	Entrepreneurship & Small Business Management	IC	2			2	50	50	100	-
241MB009	Insurance & Risk Management	IC	3			3	50	50	100	-
241MB010	Change & Innovations Management	IC	3			3	50	50	100	-
241MB011	Personal Financial Planning (or)	IC	3			3	50	50	100	-
241MB012	E-Business management									
241MB013	Business Policy & Strategic Management (or)	AC	3			3	50	50	100	-
241MB014	Green Marketing									
241MB015	Startup Management (or)	AC	3			3	50	50	100	-
241MB016	Venture Management									
Total			20			20				

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	241EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	241EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	241EC099	Basic Programming Lab (or)	1	0	2	3	V
	241EC100	Basic Laboratory Course for Quantum Technologies					
4	241EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII

Any One course from the below							
5	241EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	241EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	241EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	241EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	241EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	241EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	241EC108	Quantum Optics	3	0	0	3	VII
12	241EC109	Quantum Cybersecurity	3	0	0	3	VII
13	241EC110	Quantum Machine Learning	3	0	0	3	VII
Total			18	0	0	18	



Dept.	FOUNDATION COURSE		INTERMEDIATE- LEVEL COURSE		ADVANCED COURSE	
CE	RRS	Repair & Rehabilitation of Structures	EIRM	Environmental Impact & Risk Management		
	BPCA	Building Planning & Computer-Aided Drawing	EM	Environmental Management		
	GB	Green Building	UTP	Urban Transportation Planning		
	FSB	Fundamental of Soil Behaviour	ITS	Intelligent Transportation Systems		
	RE	Railway Engineering				
	DHE	Docks & Harbour Engineering				
EEE	OCEM	Operation control of Electric Machines	AES	Alternative Energy Sources	MAI	Methods & Algorithms for Intelligent Control
	FPE	Fundamentals of Power Electronics	EPGDS	Electric Power Generation & Distribution Systems	HEV	Hybrid Electric Vehicles
	EMI	Electrical Measurements & Instrumentation	UEE	Utilization of Electrical Energy	SEM	Special Electric Machines
	BME	Basic Mechanical Engineering	ETD	Engineering Thermodynamics	ELS	Electrical Safety
ME			IAE	Introduction to Automobile Engineering	TOM	Theory of Machines
			MOS	Mechanics of Solids	AEM	Advanced Engineering Metrology
			HPE	Heat Power Engineering		
			PT	Production Technology		
			MMS	Metallurgy & Material Science		
			R&AC	Refrigeration & Air Conditioning		
ECE	FC	Fundamentals of Communications	ADC	Analog & Digital Circuits	IIT	Introduction to Internet of things
			LDIC	Linear & Digital IC Applications		
			SA	Sensors & Actuators		
	FSP	Fundamentals of Signal Processing	EM	Embedded Microcontrollers	MWC	Modern Wireless Communications
CSE			DSD	Digital System Design		
			WLAN & PAN	Wireless LANS & PANS		
			SE	Software Engineering	AMSD	Advanced MERN Stack Development
			OOP	Object Oriented Programming through C++	FF	Flutter Fundamentals
			OS	Operating Systems		
			CN	Computer Networks		
DS			JP	Java Programming		
			IMSD	Introduction to MERN Stack Development		
			ISA	Information Security Analysis and Audit		
			DM	Data Mining	SNA	Social Network Analysis
			DM	Data Mining	DV	Data Visualization
			FDS	Fundamentals of Data Science	BDA	Big Data Analytics
			SE	Software Engineering		

AIML			NSQL	NoSQL Databases		SNSW	Social Networks and Semantic Web
			BIA	Business Intelligence & Analytics			
			HCDA	Health Care Data Analysis			
			ML	Machine Learning		DV	Data Visualization
			AI	Artificial Intelligence		PEG	Prompt Engineering and GenAI
			AI C	AI Chatbot		SNA	Social Network Analysis
			FDS	Fundamentals of Data Science		FML	Federated Machine Learning
			SC	Soft Computing		NLP	Natural Language Processing
						MLGS	Mine Legislation and General Safety
						EPC	Environmental Pollution & Control
Min.E	DMD	Development of Mineral Deposits	SM	Surface Mining			
	GM	Green Mining	UCMT	Underground Coal Mining Technology		ISP	Industrial Safety Practices
			UMMT	Underground Metal Mining Technology		GC	Ground Control
			DB	Drilling & Blasting		PRE	Petroleum Refinery Engineering
PT	IPE	Introduction to Petroleum Engineering	FGRE	Fundamentals of Geology and Reservoir Engineering		FLNG	Fundamentals of Liquefied Natural Gas
	UOPI	Unit operations in Petroleum Industry	FDPE	Fundamentals of Drilling and Production Engineering		NGH	Natural Gas Hydrates
			UHR	Unconventional Hydrocarbon Resources		ALT	Artificial Lift Techniques
						EOR	Enhanced Oil Recovery
Ag.E	GWH	Ground Water Hydrology	LWME	Land and Water Management		DBS	Design of Bio-Energy Systems
	PHEC C	Post-harvest Engineering of Cereal Crops	SWH	Surface Water Hydrology		PHEHP	Post-Harvest Engineering for Horticultural Produce
			MIE	Micro Irrigation Systems		AME	Agricultural Machinery and Equipment
						APEFQ	Agriculture Process Engineering and Food Quality
EDC	FRES	Fundamentals of Renewable Energy Sources					
	NPD	New Product Development	ESB	Entrepreneurship and Small Business Management		BPS	Business Policy & Strategic Management
			CIM	Change & Innovations Management		GM	Green Marketing
			PFP	Personal Financial Planning		SM	Startup Management
			EBM	E-Business Management		VM	Venture Management
			IRM	Insurance and Risk Management			

Major Core Courses (MCC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MA001	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
241MA002	Differential Equations & Vector Calculus	FC	2	1		3	50	50	100	-
241MA007	Transform Calculus	FC	2	1		3	50	50	100	LAC, DEVC
241CH002	Applied Chemistry	FC	2		1	3	50	50	100	-
241PH002	Modern Physics	FC	2		1	3	50	50	100	-
241CS001	Programming for Problem Solving Using C	FC	2		2	4	50	50	100	-
241IT001	IT & AI Skills	FC			2	2	50	50	100	-
241ME001	Engineering Graphics	FC	1		2	3	50	50	100	-
241ME003	Engineering Workshop	FC			1	1	100	-	100	-
241EE001	Basic Electrical & Electronics Engineering	FC	2		2	4	50	50	100	-
241EC002	Network Analysis	FC	3	1		4	50	50	100	-
241EC001	Digital Electronics & Logic Design	FC	2		2	4	50	50	100	-
241EC003	Electronic Devices & Circuits	FC	2		2	4	50	50	100	BEEE
241EC004	Random Variables & Stochastic Processes	FC	3	1		4	50	50	100	-
241EC014	Signals & Systems	FC	2		2	4	50	50	100	-
241EC005	Electromagnetic Waves &	IC	2	1		3	50	50	100	DEVC

	Transmission Lines									
241EC006	Analog Electronics	IC	2		2	4	50	50	100	EDC
241EC007	Integrated Circuits & Applications	IC	2		2	4	50	50	100	EDC
241EC008	Linear Control Systems	IC	2	1		3	50	50	100	S&S
241EC009	Analog & Digital Communications	IC	2		2	4	50	50	100	S&S
241EC010	Digital Signal Processing	IC	2		1	3	50	50	100	S&S
241EC011	VLSI Design	IC	2		1	3	50	50	100	EDC
241EC012	Microprocessors & Microcontrollers	AC	2		1	3	50	50	100	DELD
241EC013	Antenna & Microwave Engineering	AC	2		2	4	50	50	100	EMTL
Total			45	7	28	80				

Linear Algebra & Calculus

(Common to CE,EEE,ME,ECE,CSE,IT,AIML,CSE(DS),PT&Min.E)

Course Code: 241MA001

L	T	P	C
2	1	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Solve the system of Linear equations.
- CO2:** Calculate Eigen values and Eigen vectors.
- CO3:** Apply differential calculus for one and several variable functions.
- CO4:** Calculate the Maximum value and Minimum value of a function of several variables.
- CO5:** Compute areas and volumes using multiple integrals.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

System of linear Equations: Vector Space, Linear Independence, Rank of a matrix by echelon form, normal form, Inverse of Non-singular matrices by Gauss-Jordan method, Solutions of Linear Systems: Existence, Uniqueness, Solving the system by Gauss elimination method.

Practice(Using any computational tool)

1. Variables, arithmetic operations, elementary mathematical functions.
2. Defining row vector, column vector, Arithmetic operations on matrices
3. finding transpose of a matrix, inverse of a matrix, determinant of a matrix
4. rank of a matrix, , solving system of linear equations.

UNIT – II

Eigenvalues, Eigenvectors : Eigenvalues and properties(without proof), Eigenvectors, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), Quadratic forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation, Nature of Quadratic forms.

Practice(Using any computational tool):

Computing eigen values and eigen vectors, matrix diagonalization.

UNIT – III

One Variable Calculus:Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

Several Variable Calculus: Limit, Continuity, partial derivatives and their geometrical interpretation.

Practice(Using any computational tool):Basics of plotting,Plot graphs of single variable functions

UNIT – IV

Functions of several variables:Total differential and differentiability, derivatives of composite and implicit functions, derivatives of higher order and their commutativity,Euler's theorem on homogeneous functions , Taylor's and Maclaurin's expansion of functions of two variables. Jacobians, maxima and minima, constrained maxima/minima problems using Lagrange's method of multipliers.

Practice(Using any computational tool): Plot graphs of various multi variable functions

UNIT – V

Multiple Integrals: Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Practice(Using any computational tool):Plotting the region of Integration

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021, ISBN: 978-8184875607.
2. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 5th Edition, 2018, ISBN: 978-1292174341.

Reference Books:

1. Advanced Engineering Mathematics, Michael Greenberg, , Pearson publishers, 9th Edition, ISBN: 9788177585469.
2. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications, Third Edition, 2023, ISBN: 9788121938907.

Web Links:

1. <https://archive.nptel.ac.in/courses/111/104/111104137/>
2. <https://archive.nptel.ac.in/courses/111/107/111107108/>
3. <https://www.khanacademy.org/math/linear-algebra/>
4. <https://www.khanacademy.org/math/multivariable-calculus>

Differential Equations & Vector Calculus
(Common to CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT&Min.E)

	L	T	P	C
Course Code:241MA002	2	1	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Solve the linear differential equations of first order and apply in various engineering problems.
- CO2:** Solve the linear differential equations of higher order and apply in various engineering problems.
- CO3:** Solve the linear partial differential equations
- CO4:** Calculate the gradient, divergence and curl.
- CO5:** Compute work done, flux using vector integration

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Ordinary Differential Equations of First Order and First Degree:

Solution of first order linear differential equations, exact differential equations and equations reducible to exact differential equations, Orthogonal Trajectories, Modelling of RL- circuit.

Practice(Using any computational tool): Solving the first order initial value problems using **odesolver** and plot the solution curves.

UNIT – II

Linear Differential Equations of Higher Order:

Solution of linear differential equations with constant coefficients, method of variation of parameters, solution of simultaneous linear differential equations.

Equations reducible to Linear differential equations with constant coefficients: Cauchy's homogeneous Linear Equations, Legendre's Linear Equations. Study of oscillations arising in LCR circuit (free oscillations and forced oscillations).

Practice(Using any computational tool): Solving the second order initial value problems using **odesolver** and plot the solution curves

UNIT – III

Partial Differential Equations:

Solution of linear PDE of first order by Lagrange's method, solution of homogeneous linear PDE of higher order with constant coefficients.

UNIT – IV

Vector Differentiation:

Gradient of a scalar field, finding angle between two surfaces, directional derivative.

Divergence and solenoidal fields. Curl and irrotational fields, Finding Scalar Potential.

Practice(Using any computational tool): Plotting of surfaces, 3D-plots, plotting vector fields

UNIT – V

Vector Integration:

Line integrals, work done by a force, conservative force field, surface integral, flux, volume integral. Green's theorem, Stoke's theorem and Gauss divergence theorem.

Text Books:

1. Advanced Engineering Mathematics, E. Kreyszig, John Willey & Sons, 10th Edition, 2018, ISBN 978-0470458365.
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44th Edition 2021, ISBN 978-9383214204.

Reference Books:

1. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6th Edition. ISBN 978-1284105902.
2. Higher Engineering Mathematics, B.V. Ramana, McGraw-Hill Education, 11th Edition, ISBN 978-9339216016.

Web Links:

1. <https://www.classcentral.com/course/differential-equations-engineers-13258>
2. <https://archive.nptel.ac.in/courses/111/106/111106100/>
3. <https://www.khanacademy.org/math/differential-equations>
4. <https://archive.nptel.ac.in/courses/111/101/111101153/>
5. <https://archive.nptel.ac.in/courses/111/105/111105122/>

Transform Calculus

Course Code: 241MA007

L	T	P	C
2	1	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Calculate the Fourier series of a given function and examine the convergence of the series.
- CO2:** Calculate Laplace transform of standard functions and examine the properties of Laplace transform.
- CO3:** Apply Laplace transform to solve Initial value problems.
- CO4:** Calculate the Fourier transform for certain functions.
- CO5:** Compute Z- transform of various functions and apply to solve difference equations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Fourier Series: Fourier series of periodic function, Half-range series, Change of interval and Fourier series in complex form, Parseval's formula and R.M.S Value.

Practice(Using any computational tool):Generating Fourier Series of functions .

UNIT – II

Laplace Transforms: Laplace transforms of standard functions, Shifting theorems, Change of scale property, Multiplication with t, Division by t, Transforms of derivatives and integrals, Unit step function, Dirac delta function, Periodic function, Evaluating improper integrals of the type $\int_0^{\infty} f(t) dt$ using Laplace Transforms.

Practice(Using any computational tool):Find Laplace transform of elementary functions.

UNIT – III

Inverse Laplace Transforms : Inverse Laplace transforms of functions, First shifting theorem, Convolution theorem (without proof), Method of partial fractions, Second shifting theorem, Solving initial value problems and integro-differential equations using Laplace transforms.

UNIT – IV

Fourier Transforms: Fourier integral theorem (without proof), Fourier sine and cosine integral, Fourier Transform, Properties, Fourier sine and cosine transforms and Finite Fourier transforms.

UNIT – V

Z-Transforms: Definition of Z-transform, Properties, Damping rule, Shifting rule, Initial and final value theorems, Inverse Z-transform, Convolution theorem (without proof), Solution of Difference equation by using Z-transforms.

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021· ISBN978-8184875607.
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021).ISBN 978-9383214204.

Reference Books:

1. A text book of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2016.ISBN 978-8131808320.
2. Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN 9788121938907.

Web Links:

1. <https://nptel.ac.in/courses/117105134/13>
2. <https://nptel.ac.in/courses/108106075/23>
3. <https://tutorial.math.lamar.edu/Classes/DE/LaplaceTransforms.aspx>
4. <https://archive.nptel.ac.in/courses/111/106/111106111/>

Applied Chemistry
(Common to EEE, ECE, CSE, IT, CSE(DS) &AIML)

	L	T	P	C
Course Code: 241CH002	2	0	1	3

Course Outcomes:

At the end of the course, the students will be able to:

- CO1:** Interpret the essence of polymers and explore engineering applications.
- CO2:** Exemplify the principles and applications of electrochemical cells.
- CO3:** Summarize the preliminaries of Computational Chemistry and its applications.
- CO4:** Infer the preliminaries of Nano, smart materials and their applications.
- CO5:** Apply the knowledge of water treatment and E-waste management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3		1			1		1	1		
CO2	3							1	1		
CO3	2							1	1		
CO4	2					1		1	1		
CO5	3					2		1	1		

UNIT-I

Polymer Chemistry:

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, with specific examples and methods of polymerization (Suspension polymerization and Emulsion Polymerization) Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - PTFE and Bakelite.

Polymer composites: Composites as structural material; Synthesis and applications of Kevlar and Carbon Fibers.

Conducting polymers: Polyacetylene- Mechanism of conduction – applications (polymers in sensors, Self-Cleaning windows), Biodegradable polymers - Introduction, Polyglycolic acid - synthesis, degradation and uses.

Practice:

- Preparation of a polymer (Bakelite).
- Determination of molecular weight of polymer using Ostwald's viscometer.

UNIT- II

Electrochemistry and Applications:

Electrochemical cell, Nernst equation, cell potential calculations and numerical problems, Electrochemical sensors: potentiometric sensors with examples, amperometry sensors with examples.

Primary cells – Zinc-air battery, Secondary cells –Ni-Cd and, Lead-Acid battery, lithium-ion batteries- working of the batteries including cell reactions; Fuel cells, hydrogen-oxygen, Methanol-Oxygen fuel cell– working of the cells. Polymer Electrolyte Membrane Fuel cells (PEMFC)

Electrochemical sensors – potentiometric sensors with examples, amperometric sensors with example (Glucose Electrochemical sensor)

Practice:

1. Conductometric titration of strong acid vs strong base.
2. Potentiometric titration of red-ox.
3. P^H -metric titration of Acid-Base.
4. Determination of Glucose by Electrochemical Sensor.

UNIT- III

Computational Chemistry

Computational Quantum Chemistry and its applications, Prediction of Molecular Properties using Computational Chemistry, Molecular Modelling and Structure - molecular Modelling today: overview of problems, tools, and solution analysis. Techniques for Conformational Sampling-Monte Carlo, global Optimization etc.

Practice:

1. Molecular docking to predict the interaction energy between molecules.

UNIT-IV

Nano and Smart Materials

Introduction to nanomaterials and general applications, basic chemical methods of preparation (top down and bottom-up approach) - Sol-gel method. Applications of Carbon nano tubes and Fullerenes, Graphene (water treatment and drug delivery). Characterisation of nano materials by SEM and TEM (only Principle). Smart materials and their engineering applications. Shape memory materials- Poly L-Lactic acid. Thermo response materials – Poly acryl amides, Poly vinyl Amides

Practice:

1. Preparation of nano particles by Green synthesis.
2. Characterization of nanoparticles (SEM & TEM).

UNIT- V

Water Treatment & E-Waste Management

Water treatment: Introduction, hardness of water, types, determination of hardness by EDTA method, disadvantages of hard water, removal of hardness by Zeolite and ion exchange method, Desalination of water – reverse osmosis and Electrodialysis.

E-Waste: Introduction, sources of e-waste, Composition, Characteristics, and Need of e-waste management. Toxic materials used in manufacturing electronic and electrical products; Recycling: Recycling of Li-Ion batteries. Extraction of copper from E-waste.

Practice:

1. Determination of Hardness of a ground water sample.
2. Determination of Chloride content in given water sample.
3. Estimation of dissolved oxygen in given water sample.

Text Books:

1. Engineering Chemistry, Prasanta Rath, S. Aruna Kumari, CENGAGE Learning, ISBN 978-93-5350-651-3, ISBN 93-5350-651-4.
2. Engineering Chemistry Fundamentals and Applications, Shikha Agarwal, Cambridge, 2nd Edition, ISBN 978-1-108-72444-9.

Reference Books:

1. Engineering Chemistry, Uppal M.M, Jain and Jain, Khanna Publishers, 35th Edition.
2. A Textbook of Engineering Chemistry, Dr.S.S.Dara, Dr.S.S.Umare, S.Chand Publication, 2022, ISBN 978-817-409-2625.
3. Molecular Modelling Principles and applications, Andrew R. Leach, Prentice Hall, II Edition, ISBN 978-935-501-2585.

Web Links:

1. <https://archive.nptel.ac.in/courses/104/106/104106096/>
2. <https://archive.nptel.ac.in/courses/104/105/104105124/>
3. <https://archive.nptel.ac.in/courses/104/106/104106137/>
4. <https://nptel.ac.in/courses/118102003>

Modern Physics
(Common to EEE, ECE, CSE, IT, AIML & CSE (DS))

	L	T	P	C
Course Code: 241PH002	2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Apply the principles of interference and diffraction to design and enhance the resolving power of grating.
- CO2:** Familiarize the concepts of LASER's and Optical fibers with applications.
- CO3:** Explain the fundamental concepts of Quantum behavior of matter.
- CO4:** Differentiate various electron theories to understand the properties of solids.
- CO5:** Explain the basic concepts of Semiconductors and identify the type of semiconductors using Hall effect.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1						1	1		
CO2	2	1						1	1		
CO3	2	1						1	1		
CO4	2	1						1	1		
CO5	2	1						1	1		

UNIT-I

Wave Optics

Interference: Introduction - Principle of Superposition - Interference of light- Conditions for sustained Interference- Interference in thin films (reflected geometry) – Colours in thin films – Newton's Rings (reflected geometry) – Determination of wavelength and refractive index – Applications.

Diffraction: Introduction – Fresnel and Fraunhofer Diffraction - Diffraction due to Single slit (quantitative), Double slit (qualitative) - N-Slits Intensity distribution curves (qualitative) – Grating spectrum–Rayleigh's criterion - Resolving powers of grating (qualitative) - Applications.

Practice:

1. Determination of Radius of curvature of a plano-convex lens using Newton's Rings.
2. Measurement of Width or thickness of a thin wire by forming interference fringes.
3. Determination of Wavelength of light source using Diffraction grating by normal

incidence method.

4. Resolving power of grating.
5. Determination of wavelength of light by using prism.

UNIT –II

Lasers & Optical Fibers

Lasers: Introduction - Characteristics of Lasers – Spontaneous and Stimulated emission of radiation – population inversion- Einstein's coefficients – Relation - significance - Pumping Mechanisms - Ruby laser – Helium-Neon laser - Applications.

Optical Fibers:

Introduction- Principle of propagation in Optical Fiber, Angle of acceptance, Expression for Numerical Aperture and condition for propagation – Classification of Optical fibers - Applications.

Practice:

1. Determination of Wavelength of He-Ne laser source by using diffraction grating.

UNIT –III

Quantum Mechanics

Introduction – Matter waves – de Broglie's hypothesis – Davisson and Germer Experiment - Heisenberg's Uncertainty Principle – interpretation of wave function – Schrödinger Time dependent and Time Independent wave equations– Particle in a potential box.

UNIT –IV

Free electron Theory

Free Electron Theory: Introduction–Classical free electron theory (merits and demerits only) -Quantum Free electron theory – Electrical conductivity- Fermi energy state–Fermi Dirac distribution function - Temperature dependence – Density of states.

Band theory of solids: Bloch Theorem – Origin of energy bands in crystalline solids – classification of crystalline solids.

Practice:

1. Study the variation of magnetic field along the axis of a circular coil carrying current by using Stewart and Gee's apparatus.
2. Determination of Frequency of electrically maintained tuning fork by Melde's apparatus.

UNIT –V

Semiconductor Physics

Introduction – Intrinsic semiconductors – density of charge carriers – Electrical conductivity –Fermi level - extrinsic semiconductors - P-type & N-type semiconductors-Density of charge

carriers (Qualitative) - Dependence of Fermi energy on carrier concentration and temperature–
Hall effect-Hall coefficient - Applications of Hall effect–Drift and Diffusion currents -
Einstein’s equation – Working of PN junction diode – Zener diode

Practice:

1. Determination of V-I characteristics and Breakdown voltage of a Zener diode.
2. Determination of Energy band gap of a semiconductor by using P-N junction diode.
3. Study the relation between Temperature and resistance and finding the constants A & B of a thermistor.
4. Determine the resistivity of a semiconductor by four probe method.

Text books:

1. Engineering Physics by M N Avadhanulu & T.V.S. Arun Murthy, S Chand & Company Ltd, 1st Edition 2024, ISBN: 978-93-5870-932-3.
2. Engineering Physics by Satyendra Sharma and Jyotshna Sharma, Pearson publications, ISBN: 978-81-3151-178-7.

Reference Books:

1. Concepts of Modern Physics by Authur Beiser, Shobhit Mahajan and S Rai Choudhary, McGraw Hill, ISBN: 9789351341857.
2. Engineering Physics by M.R. Srinivasan, New Age international publishers, ISBN: 978-1848290501.
3. Optics by Ajoy Ghatak, McGraw Hill Education, 6th Edition, ISBN: 978-9390113590.

Web Links:

1. <http://nptel.ac.in/courses/122107035/11>
2. <http://nptel.ac.in/courses/115102023/->
3. <https://phet.colorado.edu/en/simulations/category/physics>
4. <http://physicsgecg.blogspot.in/p/reading-materials.html>

Programming for Problem Solving using C
(Common to CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT&Min.E)

	L	T	P	C
Course Code: 241CS001	2	0	2	4

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Demonstrate basics of computer, algorithm and flow chart for problem solving.
- CO2:** Make use of an appropriate control structures to solve given problems.
- CO3:** Solve complex problems using arrays and strings.
- CO4:** Develop modular programming using functions and dynamics memory allocations using pointers.
- CO5:** Demonstrate file handling using file operations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2	1	3			2			1
CO2	2	3	2	1	3			2			1
CO3	2	3	2	1	3		1	2			1
CO4	2	3	2	1	3		1	2			1
CO5	2	3	2	1	3		1	2			1

UNIT – I

Introduction to Programming and Problem Solving

Introduction to Programming Languages, Basics of a Computer Program- Algorithms, Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms. flowcharts (Using Dia Tool), pseudo code.

Structure of C Program Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, operators, keywords, identifiers, Type Conversion, and Casting.

Practice:

1.
 - a. Basic linux environment and its editors like Vi,Vim & Emacs etc.
 - b. Exposure to turbo C, gcc
 - c. Explore to hacker rank or any other Online coding platform and compiler environment.
 - d. “Hello world” in C
 - e. Objective: Learn about the syntax of reading from stdin and writing to stdout.
<https://www.hackerrank.com/challenges/hello-world-c/problem?isFullScreen=true>

Write a simple program to read int, float, char and string using scanf() and display using printf() in all the above given platforms.

2. Basics and Operators
 - a. Sum and Difference of 2 numbers
Objective: Learn int and float data types.
<https://www.hackerrank.com/challenges/sum-numbers-c/problem?isFullScreen=true>
 - b. Playing with Characters
Objective: Learn how to take a character, a string and a sentence as input in C.
<https://www.hackerrank.com/challenges/playing-with-characters/problem?isFullScreen=true>
 - c. Bitwise Operators
Objective: Learn how to work with bits (0,1) and bitwise operators.
<https://www.hackerrank.com/challenges/bitwise-operators-in-c/problem?isFullScreen=true>
 - d. Conversion of Fahrenheit to Celsius and vice versa.
 - e. Distance travelled by an object.
 - f. Calculate Simple interest and compound interest.
3. Operators and Expressions, Variables and Type conversions
 - a. Evaluate the following expressions
 - i. $a/b*c-b+a*d/3$
 - ii. $j = (i++) + (++i)$
 - b. Square root of a given number.
 - c. Find the area of circle, square, rectangle and triangle.
 - d. Find the maximum of three numbers using conditional operator.
 - e. Take marks of 5 subjects in integers, find the total in integer and average in float.

UNIT – II

Control Structures

Simple sequential programs Conditional Statements (if, if-else, else if ladder, switch), Loops (for, nested for loop, while, do-while) break and continue, goto statement

Practice:

1. Conditional Statements
 1. Objective: Understand if and else Conditional statements in C.
<https://www.hackerrank.com/challenges/conditional-statements-in-c/problem?isFullScreen=true>
 2. Roots of a Quadratic Equation.
 3. Generate electricity bill.
 4. Simulate a calculator using switch case.
 5. Find the given year is a leap year or not.
2. Loops
 - a. Objective: Learn the usage of the for loop in C.
<https://www.hackerrank.com/challenges/for-loop-in-c/problem?isFullScreen=true>
 - b. Sum of the digits of a 5-digit number.

Objective: Learn the usage of while loop and usage of operators - % and /.

<https://www.hackerrank.com/challenges/sum-of-digits-of-a-five-digit-number/problem?isFullScreen=true>

- c. Given number is a prime or not. (Also Prime numbers between a given range.)
- d. Armstrong Number or not.
- e. Palindrome or not.
- f. Objective: Print a pattern of numbers using Loops.
<https://www.hackerrank.com/challenges/printing-pattern-2/problem?isFullScreen=true>
- g. Construct a Pyramid pattern.

UNIT – III

Arrays indexing, Accessing programs with array of integers, two dimensional arrays, Introduction to Strings, string handling functions.

Sorting techniques: bubble sort, selection sort.

Searching Techniques: linear, Binary search.

Practice:

1. Arrays
 - a. Objective: Print the sum and free the memory where the array is stored.
<https://www.hackerrank.com/challenges/1d-arrays-in-c/problem?isFullScreen=true>
 - b. Objective: Working with indices in array
<https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true>
 - c. Search an element in array (Linear Search)
 - d. Find min and max elements in array
 - e. Insert an element into array
 - f. Eliminate duplicate elements from array
 - g. Sorting of elements in an array using Bubble sort
2. Arrays
 - a. Sum of two 2-D arrays
 - b. Multiplication of two 2-D arrays
 - c. Transpose of a Matrix
 - d. Trace of a Matrix
 - e. Lower Triangular Matrix
3. Hacker Rank
 - a. Objective: print each word of the sentence in a new line.
<https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true>
 - b. Count number of alphabets (lowercase, uppercase, consonants, vowels) and digits
Lowercase to Uppercase, Uppercase to Lowercase, Toggle case, Sentential case
 - c. Objective: Digit Frequency Objective: find the frequency of each digit in the given string.
<https://www.hackerrank.com/challenges/frequency-of-digits-1/problem?isFullScreen=true>
 - d. Find string length, concatenate 2 strings, reverse a string using built-in and without built-in string functions.

UNIT – IV

Functions: Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, arrays as parameters, Scope and Lifetime of Variables, storage class, recursion, functions & pointers, functions and arrays.

Practice:

Functions in C

1. Objective: Learn simple usage of functions.
<https://www.hackerrank.com/challenges/functions-in-c/problem?isFullScreen=true>
2. Objective: Fibonacci Numbers using recursive function.
<https://www.hackerrank.com/challenges/ctci-fibonacci-numbers/problem>
3. Objective: N^{th} factorial using recursion.
<https://www.hackerrank.com/contests/ccc-veltech-practice-set-ende/challenges/factorial-using-recursion-1>
4. Objective: Find the super digit of the integer.
<https://www.hackerrank.com/challenges/recursive-digit-sum/problem>
5. Implement LCM
6. Objective: Calculate the Nth term of series.
<https://www.hackerrank.com/challenges/recursion-in-c/problem?isFullScreen=true>

UNIT – V

Introduction to Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, modifying parameters inside functions using pointers, Command line Arguments, Dynamic memory allocation, Null Pointer, generic pointer, dangling pointer.

File Handling: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

Practice:

1. Pointers
 - a. Objective: learn to implement the basic functionalities of pointers in C.
<https://www.hackerrank.com/challenges/pointer-in-c/problem?isFullScreen=true>
 - b. Objective: Learn using Pointers with Arrays and Functions
<https://www.hackerrank.com/challenges/students-marks-sum/problem?isFullScreen=true>
 - c. Objective: sort a given array of strings into lexicographically increasing order or into an order in which the string with the lowest length appears first.
<https://www.hackerrank.com/challenges/sorting-array-of-strings/problem?isFullScreen=true>
 - d. Find the sum of a 1D array using malloc()
 - e. Swap two numbers using functions and pointers - call by value and reference.
 - f. Objective: Dynamic Handling requests by a Librarian to place the books in the shelves. <https://www.hackerrank.com/challenges/dynamic-array-in-c/problem?isFullScreen=true>
2. File handling concepts
 - a) Write text into and read text from a file.
 - b) Write text into and read text from a binary file using fread() and fwrite().

- c) Copy the contents of one file to another file.
- d) Merge two files into the third file using command-line arguments
- e) Find no. of lines, words and characters in a file.

Additional Practice:

1. Variadic functions in C
Objective: Understanding variable number of arguments
<https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true>
2. Small Triangles, Large Triangles
Objective: Print sorted by their areas
<https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true>
3. Permutations of Strings
Objective: print all strings permutations in strict lexicographical order
<https://www.hackerrank.com/challenges/permutations-of-strings/problem?isFullScreen=true>

Text Books:

1. Programming in C, Rema Theraja, Oxford, 2nd Edition. ISBN 93-5497-9.
2. The C Programming Language, Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall. ISBN: 9780131103627.

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education. ISBN: 9352604172.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill. ISBN: 0071367993.
3. Let Us C Yashwanth, Kanetkar, Eighth edition, BPB Publications. ISBN:1934015253.
Programming in C A-Practical Approach Ajay Mittal. Pearson Education. ISBN: 9788131729342.
4. R G Dromey How to Solve It by Computer (Prentice-Hall International Series in Computer Science, ISBN: 978-0134340012.

Web Links:

- 1 <https://www.hackerrank.com/>
- 2 https://onlinecourses.nptel.ac.in/noc22_cs40/preview
- 3 <https://archive.nptel.ac.in/courses/106/104/106104128/>

IT & AI Skills

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 241IT001

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Utilize Excel and Power BI for data analysis, visualization, and reporting.
- CO2:** Apply various data analysis techniques in Excel and Power BI to extract meaningful insights from datasets
- CO3:** Create clear and compelling visualizations using Excel and Power BI to communicate data-driven insights.
- CO4:** Develop data models in Power BI to organize and analyze data efficiently.
- CO5:** Design interactive dashboards in Power BI to facilitate data exploration and decision-making.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			2				1	1	1
CO2	2	3			2				1	1	2
CO3	2	2			2				1	1	2
CO4	1	2	1		2				1	1	2
CO5	1	2	1		2				1	1	2

Practice:

1. Introduction to Excel

- a. Overview of Excel and its capabilities for data analysis
- b. Basics of Excel: Navigating the interface, entering data, formatting cells
- c. Introduction to functions and formulas: SUM, AVERAGE, IF, VLOOKUP, etc.
- d. Importing data into Excel from different sources: CSV, text files.

2. Data Analysis with Excel

- a. Data manipulation techniques: Sorting, filtering, and grouping data
- b. Advanced functions and formulas: INDEX/MATCH, SUMIFS, COUNTIFS, etc.
- c. Data visualization with Excel: Creating charts and graphs
- d. Using PivotTables for data summarization and analysis

3. Advanced Excel Features

- a. Introduction to Excel tables and structured references
- b. Working with named ranges and dynamic ranges
- c. Excel data validation techniques

4. Introduction to Power BI

- a. Overview of Power BI and its advantages over Excel for large datasets
- b. Installing Power BI Desktop
- c. Understanding the Power BI interface: Navigation, ribbons, and panes
- d. Importing data into Power BI Desktop from various sources

5. Data Preparation in Power BI

- a. Introduction to Power Query for data transformation
- b. Cleaning, shaping, and filtering data in Power Query Editor

6. Data Preparation in Power BI

- a. Combining data from different sources
- b. Loading data into Power BI model.

7. Data Modeling in Power BI

- a. Understanding relationships between tables
- b. Creating calculated columns and measures using DAX

8. Data Modeling in Power BI

- a. Introduction to DAX functions: CALCULATE, FILTER, RELATED, etc.
- b. Working with date and time functions in DAX

9. Visualization Basics in Power BI

- a. Creating basic visualizations: Bar charts, line charts, pie charts, etc.
- b. Customizing visualizations: Formatting, titles, legends, etc.

10. Visualization Basics in Power BI

- a. Using slicers and filters to interact with visualizations
- b. Adding drill-down capabilities to visualizations

11. Advanced Visualizations and Dashboards in Power BI

- a. Exploring advanced visualizations: TreeMap, Waterfall chart, KPIs, etc.
- b. Creating custom visuals from the marketplace

12. Advanced Visualizations and Dashboards in Power BI

- a. Designing effective dashboards: Layout, arrangement, and organization
- b. Adding interactivity with bookmarks and drill-through

Additional Practice:

- 1. Basic Data Analysis:** Import a dataset into Excel and perform basic data analysis tasks such as sorting, filtering, and creating simple charts to visualize the data.
- 2. Expense Tracker:** Create a spreadsheet to track your expenses. You can have columns for date, item description, category, and amount. Use formulas to calculate totals and analyze your spending habits.
- 3. Data modeling and extracting statistics from dataset:** Connecting Power BI to local data files and cloud servers (COVID19 dataset will be imported into the Power BI for visualization).

Text Books:

- 1.** Learn Power BI - Second Edition: A comprehensive, step-by-step guide for beginners to learn real-world business intelligence 2nd Edition, ISBN: 9781801811958.
- 2.** Power BI Beginner: Zero to Hero in Power BI Desktop by Philip Seamark, ISBN 1691641227.

Reference Books:

1. Power BI Quick Start Guide: Build dashboards and visualizations to make your data come to life by Devin Knight and Siddharth Mehta.
2. Learn Power BI: A Beginner's Guide to Analyzing Data and Creating Reports with Power BI by Murilo Miranda.

Web Links:

1. <https://learn.microsoft.com/en-us/power-bi/>
2. <https://support.microsoft.com/en-us/excel>
3. <https://cce.sydney.edu.au/course/MSE1>
4. <https://cce.sydney.edu.au/course/PBBA>

Engineering Graphics
(CCE,EEE,ME,ECE,CSE,IT,AI ML,CSE(DS),PT&Min.E)

Course Code: 241ME001

L	T	P	C
1	0	2	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply the principles of engineering drawing to construct Engineering curves.
- CO2:** Construct projections of points and lines.
- CO3:** Demonstrate visualization skills of projections of planes.
- CO4:** Demonstrate visualization skills of projections of solids and development of surfaces.
- CO5:** Construct isometric and orthographic views of simple solids.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1		2			1	1		
CO2	3	2	1		2			1	1		
CO3	3	2	1		2			1	1		
CO4	3	2	1		2			1	1		
CO5	3	2	1		2			1	1		

Practice:

1. Introduction to Engineering Graphics

Introduction to AutoCAD, Dimensioning, elements of dimensioning, system of dimensioning, and Conventions in Drawing.

2. Construction of Cycloids and Involute

- a) Construction of Cycloid, Epicycloid and Hypocycloid
- b) Involute of a pentagon and circle

3. Introduction to Orthographic Projection

- a) Principles of Projection
- b) Orthographic Projection – Four Quadrants.
- c) First angle & Third angle Projection with examples, reference plane, importance of reference lines or Plane.
- d) Projections of a point situated in any one of the four quadrants.

4. Projection of straight lines-I:

- a) Projections of straight lines parallel to both reference planes.

- b) Projections of straight lines perpendicular to one reference plane and parallel to other reference plane
- c) Projections of straight line parallel to one plane & inclined to another plane

5. Projection of straight lines-II:

- a) Projections of straight line inclined to both reference planes

6. Projection of planes:

- a) Regular planes perpendicular to both reference planes, Parallel to one reference plane and inclined to the other reference plane
Ex: Rectangle, Pentagon, Hexagon and Rhombus

7. Projection of planes

- a) Projections of Planes inclined to both reference planes Ex: Rectangle, Pentagon, Hexagon and Rhombus.

8. Projection of solids

- a) Axis Perpendicular to H.P and Axis Perpendicular to V.P
Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone
- b) Axis Parallel to H.P and V.P
Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

9. Projection of solids

- a) Projection of Solids with axis inclined to one reference plane and parallel to another plane
Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

10. Development of Surfaces

- a) Development of Prisms and Cylinder simple cases

11. Development of Surfaces

- a) Development of Pyramids and Cone simple cases

12. Conversion of Isometric views to Orthographic views

- a) Practice figure - 1
- b) Practice figure – 2

Additional Practice:

1. Conversion of Isometric views to Orthographic views

- a) Practice figure - 3
- b) Practice figure – 4

2. Conversion of Orthographic views to Isometric views

- a) Practice figure - 1
- b) Practice figure - 2

Text Books:

1. Engineering Drawing, N. D. Bhatt, Charotar Publishing House, 54th Edition, 2024, ISBN : 9789385039706.
2. Engineering Drawing and Graphics , Venugopal, New Age Publications, 2nd Edition, 2019, ISBN: 9788122415452.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2021, ISBN: 978-9385983177.
2. Computer Aided Engineering Graphics, T. Jeyapoovan, Vikas Publishing house, New Delhi, 1st Edition, 2023, ISBN : 9789356743199.

Web Links:

1. <https://nptel.ac.in/courses/112103019/>
2. <https://academy.autodesk.com/authenticated-home-user>
3. <https://www.sciencedirect.com/book/9780080108391/engineering-drawing-from-thebeginning>

Engineering Workshop

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code: 241ME003	0	0	1	1
Course Outcome:				

At the end of the course, student will be able to:

- CO1:** Prepare various wooden joints.
- CO2:** Demonstrate various sheet metal models.
- CO3:** Develop the basic knowledge of house wiring.
- CO4:** Develop the basic knowledge of plumbing.
- CO5:** Practice various welded joints.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1				1	1	2	1		1
CO2	1	1				1	1	2	1		1
CO3	2	2				1	1	2	1		1
CO4	1	2				1	1	2	1		1
CO5	2	2				1	1	2	1		1

Practice:

- To make a T-Lap joint from the given wooden workpieces.
- To make a dovetail lap joint from the given wooden workpieces.
- To make a taper tray using the given sheet metal.
- To make a funnel using the given sheet metal.
- To make a square tin using the given sheet metal.
- To connect three bulbs by using series and parallel connections.
- To give connection to a bulb by using staircase wiring.
- To prepare wiring for a tube light with switch control.
- To prepare a PVC pipe joint by using the given circuit1.
- To prepare a PVC pipe joint by using the given circuit2.
- To make a butt joint using the given M.S pieces by arc welding.
- To make a lap joint using given M.S pieces by arc welding

Additional Practice:

- To make a crosslap joint from the given wooden workpieces.
- To make an open scoop using the given sheet metal.
- To make a T-joint using given M.S pieces by arc welding.

Text Books:

1. Work shop Manual, P.Kannaiah & K.L.Narayana/ SciTech Publishers, 2nd Edition, ISBN: 978-8183711302.
2. Elements of Workshop Technology, VolII by S.K. Hajra Choudhury, S.K. Hajra. Choudhury & Nirjhar Roy, Media Promoters and Publishers Pvt Limited, 14th Edition, ISBN: 8185099146.

Reference Books:

1. Workshop Technology, Part 1, W.A.J. Chapman, 5th Edition, ISBN 9780415503020.
2. Engineering Practices Lab Manual, T. Jeyapoovan & M. Saravanapandian, Vikas Publishing House Pvt Limited, 4th Edition, ISBN: 8125929037.
3. Engineering Practices Laboratory Manual, Ramesh Babu.V., VRB Publishers Private Limited, Chennai, Revised Edition, 2019-20, ISBN: 978-81-935993-8.

Web Links:

1. <https://bharatskills.gov.in>
2. <https://www.gopracticals.com/basic-engineering/workshop/>

Basic Electrical & Electronics Engineering
(Common to CE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code: 241EE001	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO 1:** Analyze the concepts associated to AC and DC circuits.
- CO 2:** Explain the operating principles of motors, generators and measuring instruments.
- CO 3:** Analyze the Different Energy Resources and Equipment Safety Measures.
- CO 4:** Explain the concept and the applications of semiconductor Diodes.
- CO 5:** Analyze the Basic Electronic Circuits and interpret numeric information in different code formats.

Mapping of course outcomes with program outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	1		1				2	2	
CO2	2	3	1						2	2	
CO3	3	2	1						2	2	
CO4	3	2	1						2	2	
CO5	3	2	1						2	2	

Mapping of course outcomes with program Specific Outcomes:

CO\PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	1	
CO4	1	
CO5	1	

UNIT-I

DC and AC Circuits:

DC circuits: Ohm's and Kirchhoff's laws, analysis of series, parallel and series-parallel circuits excited by independent voltage sources for R, L, C parameters, current division, voltage division

AC circuits: Generation of sinusoidal voltage, frequency of generated voltage, average value, RMS value, form, and peak factors. Real power, reactive power, apparent power, and Power factor.

Practice:

1. Verification of Ohm's Law.
2. Verification of KCL and KVL.
3. Verification of KCL, KVL and ohm's law using simulation.

UNIT-II

Machines and Measuring Instruments: Principles and operation of DC machines, Transformers – Synchronous Machines - three Phase and single phase induction motors - Moving coil and moving iron instruments, Wheatstone bridge and Megger.

Practice:

1. To study Magnetisation Characteristics of DC shunt generator.
2. Measurement of Power and Power factor using Single-phase wattmeter.
3. Measurement of Resistance using Wheat stone bridge.
4. Measurement of Earth Resistance using Megger.

UNIT-III**Energy Resources, Electricity Bill & Safety Measures**

Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Thermal, Solar & Wind power generation. Calculation of electricity bill for domestic appliances. Working principle of Fuse and Miniature circuit breaker (MCB). Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Practice:

1. Calculation of Electrical Energy for Domestic Premises.

UNIT-IV**Semiconductor Devices**

Intrinsic semiconductors, Extrinsic semiconductors, P type and N type, P-N junction characteristics of P N Junction Diode, Zener Effect, Zener Diode and its Characteristics. working of simple Zener Voltage Regulator and Amplifier. Bipolar Junction Transistor - CB, CE, CC Configurations and Characteristics.

Practice:

1. Sketch the V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias.
2. Sketch the V-I characteristics of Zener Diode and its application as voltage Regulator.
3. Plot Input & Output characteristics of BJT in CE and CB configurations.
4. Obtain Frequency response of CE amplifier.

UNIT-V**Basic Electronic Circuits**

Block diagram description of a dc power supply, working of a half and full wave, bridge rectifier, filters.

Digital Electronics

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Truth Tables and Functionality of Logic Gates – NOT,

OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adders.

Practice:

1. Implementation of half wave and full wave rectifiers.
2. Design Half Adder and Full Adder circuits.
3. Verification of truth table for Logic gates using ICs.

Text Books:

1. Basic Electrical and Electronics Engineering, Salivahanan, S, Tata McGraw Hill Education (India) Private Limited, New Delhi, ISBN: 9789389691801.
2. Principles of Electrical Engineering, V. K. Mehta, R. Mehta, S. Chand & Company Ltd., New Delhi, ISBN-13: 9788121930888.
3. Digital Fundamentals, Thomas Floyd, Prentice Hall, 10th Edition, ISBN: 9780132737968.

Reference Books:

1. Electronic Devices & Circuit Theory, Robert L. Boylestad and Louis Nashelsky, Pearson, 11th Edition, ISBN: 9780135026496.
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, ISBN: 9788177000207.

Web Links:

1. <https://nptel.ac.in/courses/108/101/108101091/> (NPTEL Video by Dr. Mahesh B. Patil from IIT Bombay)
2. <https://nptel.ac.in/courses/117/106/117106108/> (NPTEL Video by Prof. Nagendra Krishnapura from IIT Madras)

Network Analysis

Course Code: 241EC002

L	T	P	C
3	1	0	4

Course Outcomes:

At the end of the course student will be able to:

- CO1:** Apply mesh and nodal analysis to DC and AC circuits.
- CO2:** Analyze the circuit using network theorems.
- CO3:** Analyze transient behaviour of RL, RC and RLC circuits with DC excitation.
- CO4:** Outline the characteristics of resonant circuits.
- CO5:** Model a two port network in terms of Z, Y, h & T parameters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2								1
CO2	3	2	2								1
CO3	2	3	2								1
CO4	3	2	2								1
CO5	2	3	2								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	1	
CO4	2	
CO5		2

UNIT – I

D.C.Circuits: Types of circuit elements, Types of Sources and Source Transformation, Mesh analysis and Nodal analysis, problem solving with resistances only including dependent sources also, principle of Duality with examples.

Steady State Analysis of A.C Circuits: Impedance concept, phase angle and phasor notation for series R-L, R-C, and R-L-C circuits, mesh and nodal analysis, Star-Delta conversion, problem solving.

UNIT – II

Network Theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem, Reciprocity theorem, Tellegen's theorem.

UNIT – III

Transient Analysis: Introduction, Initial & Final conditions for basic passive elements, Transient response of Source free series RL and RC circuits, Transient response of series RL and RC circuits for DC excitation, Transient response of series RLC circuits for DC excitation.

UNIT – IV

Resonance: Introduction, Series resonance -Impedance, Resonant frequency, Quality factor, Bandwidth, Parallel resonance-Condition for maximum impedance, Current, Bandwidth, and General case resistance present in both branches.

UNIT – V

Two-Port Networks: Introduction to two port networks, Z-parameters, Y-parameters, ABCD-parameters, h-parameters, Reciprocity and Symmetry in two port network, Relationship between Parameters, Interconnection of two port networks.

Text Books:

1. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven M. Durbin, 9th Edition, 2020, ISBN: 978-9390185139.
2. Joseph Edminister and Mahmood Nahvi, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, 7th Edition, ISBN: 978-1260011968.

Reference Books:

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, revised 3rd Edition, 2019, ISBN: 978-9353433123.
2. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N. O. Sadiku, McGraw-Hill Education, 7th Edition, 2022, ISBN: 978-9355320162.

Web Links:

1. <https://www.falstad.com>
2. <https://ocw.mit.edu/high-school/physics/exam-prep/electric-circuits/>
3. www.allaboutcircuits.com
4. <https://nptel.ac.in/courses/117106108/> Prof. Gajendranath Chowdary /IIT Madras.
5. <https://asnm-iitkgp.vlabs.ac.in/List%20of%20experiments.html>

Digital Electronics & Logic Design

(Common to EEE & ECE)

Course Code: 241EC001

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Interpret number representation in different code formats and the functionality of Logic Gates.
- CO2:** Perform logic minimization using suitable techniques.
- CO3:** Design various combinational logic circuits for required specifications.
- CO4:** Implement logic functions using PLDs.
- CO5:** Design different sequential logic circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2						2	1		1
CO2	2	2						2	1		1
CO3	2	2	3	1				2	1		1
CO4	2	2	3	1				2	1		1
CO5	2	2	3	1				2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		3
CO4		3
CO5		3

UNIT – I

Number Systems: Representation of numbers of different radix, conversion from one radix to another radix, $r-1$'s complement and r 's complement of signed numbers, problem solving. Binary Codes: 4bit codes, 2421, 8421. Error detection & correction codes, (parity checking, even parity, odd parity), Review of logic gates.

Practice:

1. Functional verification of logic gates.
2. Develop basic logic gates using universal gates.

UNIT – II

Boolean Algebra & Minimization Techniques: Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using

Boolean theorems, minimization of switching functions using K-Map up to 5 variables, tabular minimization.

Practice:

1. Verification of De-Morgan's laws.
2. Design a logic circuit for a given Boolean expression.

UNIT – III

Combinational logic circuits: Review of adders, half subtractor, full subtractor, ripple carry adder, carry look-ahead adder circuit, 4-bit binary adder/subtractor circuit, BCD adder, Decoders, encoders, multiplexers, de-multiplexers, comparators and code converters, realization of Boolean functions using decoders & multiplexers.

Practice:

1. Design Full adder circuit and verify its truth table.
2. Design a combinational logic circuit for 8 to 1 MUX.
3. Verification of functional table of 3-to-8-line Decoder/De-multiplexer.
4. Design BCD to Seven Segment Display Decoder.

UNIT – IV

Programmable Logic Devices: Introduction to PLDs: PROM, PAL, PLA-Basics structures, realization of Boolean function with PLDs, programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, realization of Boolean functions using PROM, PAL, PLA.

UNIT – V

Sequential Circuits: Latches and flip flops, truth tables and excitation tables, flipflop with reset and clear, Conversion of flip-flops. Design of registers - shift register, bi-directional shift register, universal shift register, Design of ripple counters, design of synchronous counters, Johnson counter, ring counter.

Practice:

1. Verify the truth tables of Basic Flip-flops.
2. Design an 8-bit right shift register using D Flip-flop and verify the truth table.

Additional Practice:

1. Design an Experimental model to demonstrate the operation of 74154 De-Multiplexer. using LEDs for outputs
2. Design BCD Adder Circuit and Test the Same using Relevant IC.
3. Verify the operation of 4-bit Universal Shift Register for different Modes of operation.

Text Books:

1. Switching and Finite Automata Theory, ZviKohavi& Niraj K.Jha, 3rdEdition, ISBN: 978-0521857482.
2. Digital Design, Morris Mano, Pearson, 3rd Edition, ISBN: 978-8178085555.

Reference Books:

1. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 5thEdition, 2022, ISBN: 978-9355321770.
2. Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers, ISBN: 978-0534378042.

Web Links:

1. <http://nptel.ac.in/courses/117/106/117106086/> (By Prof. Goutam Saha, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur)
2. www.nptelvideos.in/2012/12/digital-circuits-and-systems.html(By Prof. Santanu Chattopadhyay, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
3. <https://www.smartzworld.com/notes/switching-theory-and-logic-design-stld/>.

Electronic Devices & Circuits

	L	T	P	C
Course Code: 241EC003	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Interpret the characteristics of semiconductor diodes.
- CO2:** Compare the characteristics of rectifiers with and without filters.
- CO3:** Explain the characteristics of BJT and FET in different configurations.
- CO4:** Apply biasing methods for stabilization of BJT and FET amplifiers.
- CO5:** Construct a small signal low frequency equivalent model of BJT and FET.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2						2	1		1
CO2	3	2		1				2	1		1
CO3	3	2						2	1		1
CO4	2	2		2				2	1		1
CO5	2	3	1	2				2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		3
CO2		3
CO3		2
CO4		2
CO5		2

UNIT – I

Junction Diode Characteristics: Introduction to semiconductors, energy band structure of open circuited PN junction, forward and reverse bias of PN junction, current components in PN junction diode, drift and diffusion currents, law of junction, diode current equation, temperature dependence of V-I characteristics, Breakdown mechanisms, diffusion and transition capacitances.

Special Semiconductor Devices: LED, Photo diode, Tunnel Diode, Varactor Diode and UJT.

Practice:

- V-I characteristics of LED
- Draw the V-I characteristics of UJT and Identify the negative resistance region.

UNIT – II

Diode applications: Types of rectifiers and their operation, input and output waveforms, derivations of parameters of rectifiers. Filters: Inductor filter, Capacitor filter, L-section filter, π -section filter, multiple L-section and multiple π - section filters, clipper and clamper circuits.

Practice:

1. Non Linear wave shaping – Series Clippers.
2. Non Linear wave shaping – Clampers.

UNIT – III

Transistor Characteristics: BJT: Construction and operation of a transistor, transistor current components, transistor current equation, transistor as a switch and amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, transistor parameters, relation between α and β , comparison of BJT transistor configurations. FET: Construction, operation, characteristics and parameters of JFET, depletion and enhancement mode MOSFETs, comparison between JFET and MOSFET.

Practice:

1. Transistor as a switch.
2. Determine h-parameters of CE Configuration from Input and Output Characteristics.
3. Obtain the Drain and Transfer Characteristics of FET-CS Configuration also find μ , g_m and r_d .

UNIT – IV

Transistor Biasing and Thermal Stabilization: Need for biasing, load line analysis, basic stability and stability factors (S , S' , S''), BJT biasing methods, fixed bias, collector to base bias, self-bias, Stabilization against variations in V_{BE} , I_{c0} and β , Bias compensation, FET voltage divider biasing method.

Practice:

1. Transistor biasing- Design of self-bias circuit

UNIT – V

Small Signal Analysis of Transistor Amplifiers at Low Frequency: Transistor as a two-port network, Transistor hybrid model, determination of h-parameters, generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis.

FET: Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers.

Practice:

1. Obtain the frequency response of CC amplifier using BJT.
2. Obtain the frequency response of CS Amplifier using FET.

Additional Practice:

1. Implementation of half wave and full wave rectifiers with π filter.
2. Determine the Q point of given voltage divider bias circuit.
3. Non Linear wave shaping – Shunt Clippers with reference voltage.
4. Non Linear wave shaping – Double ended Clipping with reference voltage.

Text Books:

1. Electronic Devices and Circuits, J. Millman, Christos C. Halkias, Satyabrata Jit, Tata McGraw Hill, 4th Edition, ISBN: 978-9339219543.
2. Electronic Devices and Circuits, David A. Bell, Oxford University Press, 5th Edition, 2018, ISBN: 978-0195693409 .

Reference Books:

1. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 10th Edition, 2020, ISBN: 9788131727003.
2. Electronic Devices and Circuits, GK Mithal, Khanna Publishers, 23rd Edition, ISBN: 978-8174091772.
3. Electronic Circuits, D. A. Neamen, Tata McGraw Hill Education, ISBN: 978-0070634336 .

Web Links:

1. https://www.electronics-tutorials.ws/diode/diode_2.html
2. <http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html>
3. <http://nptel.ac.in/courses/117103063/11> by Dr. Chitrlekha Mahanta, IIT Guwahati
4. <https://nptel.ac.in/courses/122106025/> by Prof. T. S. Natarajan, IIT Madras.
5. <https://www.circuitlab.com/editor/#?id=6syafk>
6. <https://www.falstad.com/circuit/circuitjs.html>

Random Variables & Stochastic Processes

Course Code: 241EC004

L	T	P	C
3	1	0	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the properties of random variables
- CO2:** Infer the characteristics of multiple random variables.
- CO3:** Interpret the characteristics of random process in time domain.
- CO4:** Interpret the characteristics of random process in frequency domain.
- CO5:** Summarize the types and characteristics of Noise

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	2									1
CO3	3	2									1
CO4	3	2									1
CO5	2	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Single Random Variable: Definition, Discrete and Continuous Random variables, Distribution and density function of random variable and their properties, Expected value of Function of random variable, Moments, Mean and Variance and their properties, Binomial, Poisson, Uniform, Exponential, Gaussian distributions, Transformation of random variable.

UNIT – II

Multiple Random Variables: Joint Distribution and density function of multiple random variables, Joint Moments, Marginal and conditional distributions, Covariance, Correlation, Sum of independent random variables, Central limit theorem, statistic independence of random variables.

UNIT – III

Random Processes-Temporal characteristics: Random process – Definition, Types of Random process, First-Order, Second-order, Strict Sense Stationary random process, Wide sense stationary and Ergodic processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions, Random Signal Response of Linear Systems: Linear Time Invariant System, System Response – Convolution, Mean and Mean-squared Value of System Response.

UNIT – IV

Random Processes – Spectral Characteristics: The Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function.

UNIT – V

Noise Sources: Definitions, Resistive/Thermal Noise Source, Arbitrary Noise Sources, Effective Noise Temperature, Noise equivalent bandwidth, Average Noise Figures, Spectral characteristic of system response for Noise, Narrow Band Noise, Quadrature representation of Narrow Band Noise & its properties.

Text Books:

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH Publications, 4th Edition, ISBN:978-0-07-047428-4.
2. Probability-Random Variables and Stochastic Processes, Athanasios Papoulis and S. Unnikrishna, PHI Publications, 4th Edition, ISBN:978-0070486584.

Reference Books:

1. Probability Theory and Stochastic Processes, Y. Mallikarjuna Reddy, Universities Press (India) Pvt. Ltd., 4th Edition, ISBN:9788173718878.
2. Probability and Random Processes with Applications to Signal Processing, Henry Stark and John W. Woods, Pearson Education, International Edition, ISBN:9780131784574.

Web Links:

1. <http://nptel.ac.in/courses/117105085/> - by Prof.M.Chakraborty, IIT Khargpur
2. <https://ocw.mit.edu/courses/18-445-introduction-to-stochastic-processes-spring-2015/> - Offered by MIT

Signals & Systems

Course Code: 241EC014

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Analyze signal classifications and Fourier series representations of periodic signals.
- CO2:** Analyze the spectral characteristics of signals using Fourier analysis.
- CO3:** Apply Laplace and Z-transform techniques on signals.
- CO4:** Utilize the concept of convolution and sampling theorem in signal processing.
- CO5:** Analyze the response of continuous time LTI system.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			3			1	1		1
CO2	2	3			2			1	1		1
CO3	3	2			2			1	1		1
CO4	2	3			2			1	1		1
CO5	2	2			2			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Signals: Definitions of a signal , Classification of signals, Elementary signals, Basic operations on signals.

Fourier Series: Representation of Fourier series for continuous time periodic signals, Trigonometric and Exponential Fourier series, Symmetry conditions , Dirichlet's conditions, Properties of Fourier series, Complex Fourier spectrum.

Practice :

1. Generation of various signals such as unit impulse, unit step, ramp, exponential and sinewave.
2. Perform Operations on signals such as Addition, Multiplication, Scaling, Shifting, and Folding.
3. Perform Fourier synthesis of square wave.

UNIT – II

Fourier Transform: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signals, Fourier transform of standard signals, Fourier transform of periodic signals, Properties of Fourier transforms

Practice:

1. Calculate the Fourier Transform and Inverse Fourier Transform of a given continuous time signal.

UNIT – III

Laplace Transform: Bilateral and unilateral Laplace Transforms, Region of convergence and its properties, Constraints on ROC for various classes of continuous time signals, Properties of Laplace Transform, Inverse Laplace Transform.

Z-Transform: Concept of Z- Transform of a Discrete Sequence, Region of convergence in Z-Transform, Constraints on ROC for various classes of discrete time signals, Properties of Z-Transform, Inverse Z-Transform.

Practice:

1. Obtain Laplace Transform and inverse Laplace Transform of a given continuous time signal.
2. Calculate the Z-Transform and Inverse Z-Transform of a given discrete time signal.

UNIT – IV

Convolution of Signals: Convolution and its properties, Graphical representation of convolution, Convolution of signals through transforms.

Sampling: Introduction to Sampling, Sampling theorem, Nyquist rate, Nyquist duration, Types of Sampling, Reconstruction of signal from its samples, Effect of under sampling,

Practice:

1. Perform convolution of given continuous time signals.
2. Generate oversampled, Nyquist and undersampled discrete time signals for the given Analog signal

UNIT – V

Signal Transmission Through LTI Systems: Definitions of a system, Classification of Systems, Transfer function of a LTI system, Impulse response and step response of LTI systems, Distortion less transmission through a system, Ideal LPF, HPF, BPF and BSF characteristics, Signal bandwidth, System bandwidth.

Practice:

1. Obtain Impulse and step response of given LTI system.

Additional Practice:

1. Finding the even and odd parts, real and imaginary parts of signal.
2. Analyze the effect of increasing the number of terms in the Fourier series on the Gibbs phenomenon.
3. Verification of linearity and time invariance properties of a given system.

Text Books:

1. Signals & Systems by Simon Haykin and Van Veen, Wiley, 2nd Edition, ISBN: 978-8126512652.
2. Signals and Systems by A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2nd Edition, Reprint, ISBN: 978-7560509709.

Reference Books:

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, ISBN:978-8178000169.
2. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, Reprint, ISBN: 978-0070702219.
3. Signals and Systems – A. Anand Kumar, PHI, 3rd Edition, 2022, ISBN: 978-8120348400.
4. Signals & Systems by Tarun Kumar Rawat, Oxford Publication, 1st Edition, ISBN: 978-0198066798.
5. Signals & Stochastic Processes by [Y Mallikarjuna Reddy and Giri Babu Kande](#), The Orient Blackswan Publication, 1st Edition, ISBN: 978-9386235312.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ec28/preview
2. <http://acl.digimat.in/nptel/courses/video/108106163/L16.html>
3. <https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011/pages/lecture-notes/>

Electromagnetic Waves & Transmission Lines

	L	T	P	C
Course Code: 241EC005	2	1	0	3

Course Outcomes:

At the end of the course student will be able to:

- CO1:** Interpret the properties of electric fields and magnetic fields.
- CO2:** Infer the Maxwell's equations for electric fields and magnetic fields.
- CO3:** Analyze the characteristics of uniform plane waves.
- CO4:** Interpret the fundamentals of transmission lines.
- CO5:** Apply impedance matching techniques for the transmission lines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	1									
CO5	2	2									

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Electrostatics: Review of Co-ordinate Systems and Vector Calculus, Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss Law and Applications, Electric Potential, Maxwell's Two Equations for Electrostatic Fields, Convection and Conduction Currents, Dielectric Constant, Continuity Equation, Capacitance, Energy Density in Electrostatic Fields.

UNIT – II

Magnetostatics: Biot-Savart Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Two Equations for Magneto static Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Inductance, Magnetic Energy.

Maxwell's Equations(Time Varying Fields): Faraday's Law and Transformer emf, Inconsistency of Ampere's Law and Displacement Current Density, Maxwell's Equations in Differential, Integral, Final Forms and Word Statements.

UNIT – III

EM Wave Characteristics-I: Uniform Plane Waves – Definition, Wave equations for Conducting and Perfect Dielectric media, Wave propagation in Lossy dielectrics, Lossless dielectrics and Free space, Wave propagation in good conductors, Skin depth, Polarization & Types.

EM Wave Characteristics-II: Reflection and Refraction of Plane Waves – Normal and Oblique Incidences for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total internal reflection, Surface Impedance, Poynting Vector and Poynting Theorem.

UNIT – IV

Transmission lines-I: Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line, Lossless lines, Distortion less lines.

UNIT – V

Transmission lines-II: SC and OC Lines, Reflection Coefficient, VSWR, Impedance Transformations of $\lambda/4$, $\lambda/2$, $\lambda/8$ Lines, Smith Chart-Construction and Applications, Quarter wave transformer, Stub Matching-single & double.

Text Books:

1. Principles of Electromagnetics, Matthew N.O. Sadiku, and S.V. Kulkarni, Oxford University Press, 6th Edition, ISBN: 978-0199461851.
2. Electromagnetic Waves and Radiating Systems, E.C. Jordan and K.G. Balmain, PHI, 2nd Edition, ISBN: 978-9332551770.

Reference Books:

1. Engineering Electromagnetics, William H. Hayt, John A. Buck, Jaleel M. Akhtar, TMH, 9th Edition, 2020, ISBN: 978-9353169725.
2. Transmission Lines and Networks, Umesh Sinha and Satya Prakashan, Technical India Publications, 2nd Edition, ISBN: 8176841889.
3. Electromagnetic Waves and Transmission Lines, Y Mallikarjuna Reddy, Universities Press, 1st Edition, ISBN: 978-8173719776 .

Web Links:

1. <https://nptel.ac.in/courses/108106157> NPTEL Course on “Transmission lines and Electromagnetic Waves”, IIT Madras, Dr. Ananth Krishnan.
2. <https://www.damtp.cam.ac.uk/user/tong/em.html> Lectures on “Electromagnetism”, by David Tong, University of Cambridge, London.
3. <https://nptel.ac.in/courses/117103065> NPTEL Course on “Electromagnetic fields”, IIT Guwahati, Dr. Ratnajit Bhattacharjee.

Analog Electronics

Course Code: 241EC006

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Build the high frequency transistor amplifier circuits.
- CO2:** Analyze the frequency response of multi stage circuits.
- CO3:** Summarize the performance metrics of feedback amplifiers.
- CO4:** Construct low and high frequency oscillators for given specifications.
- CO5:** Analyze the performance of power and tuned amplifiers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1					2	1		1
CO2	3	2						2	1		1
CO3	3	2						2	1		1
CO4	3	2	1					2	1		1
CO5	3	2						2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	1	
CO4	1	
CO5	1	

UNIT – I

Small Signal Analysis of Transistor Amplifiers at High Frequency: Two-Port network Approach, The transistor pi Model, Hybrid- π common emitter transistor model, Hybrid π conductance, Hybrid π -capacitances, validity of hybrid π model, CE short circuit current gain, current gain with resistive load, cut-off frequencies.

FET: Analysis of common Source and common drain Amplifier circuits at high frequencies.

Practice :

1. Introduction to OrCAD Software.

UNIT – II

Multistage Amplifiers: Classification of amplifiers, methods of coupling, analysis of CE amplifier, two stage RC coupled amplifier, cascode amplifier, High input resistance circuits: Darlington pair amplifier, Boot-strap emitter follower.

Practice:

1. Construct a two stage RC coupled amplifier to obtain frequency response, voltage Gain and Bandwidth. (OrCAD Software).
2. Construct a two stage RC coupled amplifier to obtain frequency response, voltage gain and bandwidth.

UNIT – III

Feedback Amplifiers: Feedback concept, types of feedback, classification of amplifiers, feedback topologies, Characteristics of negative feedback amplifiers, Generalized analysis of feedback amplifiers, Performance comparison of feedback amplifiers, Method of analysis of voltage and current series feedback amplifiers.

Practice:

1. Construct voltage series feedback amplifier to obtain frequency response, voltage gain and bandwidth. (OrCAD Software).
2. Construct voltage series feedback amplifier to obtain frequency response, voltage gain and bandwidth.

UNIT – IV

Oscillators: Oscillator principle, condition for oscillations, types of oscillators, RC-phase shift and Wein bridge oscillators with BJT and FET and their analysis, Generalized analysis of LC Oscillators, Hartley and Colpitt's oscillators with BJT and FET and their analysis, Frequency and amplitude stability of oscillators.

Practice:

1. Construct a RC phase shift oscillator using BJT to generate a sinusoidal signal.(OrCAD Software)
2. Construct a RC phase shift oscillator using BJT to generate a sinusoidal signal.

UNIT – V

Power Amplifiers: Classification of amplifiers, Class A power Amplifiers and their analysis, Harmonic Distortions, Class B Push-pull amplifiers and their analysis, Complementary symmetry push pull amplifier, Class AB power amplifier, Class-C power amplifier, Class-D power amplifier.

Tuned Amplifiers: Introduction, Q-Factor, single tuned amplifier, double tuned amplifiers, staggered tuned amplifiers.

Practice:

1. Construct a class-A power amplifier to obtain power efficiency. (OrCAD Software)
2. Construct a class-A power amplifier to obtain Q-point and power efficiency using Hardware.

3. Construct a single tuned amplifier to obtain frequency response, voltage gain and bandwidth. (OrCAD Software)
4. Construct a single tuned amplifier to obtain frequency response, voltage gain and bandwidth.

Additional Practice:

1. Construct three stage RC coupled amplifier and compare with two stage RC coupled amplifiers.
2. Construct Darlington pair amplifier to obtain frequency response, voltage gain and bandwidth.
3. Construct a Colpitt's oscillator using BJT to generate a sinusoidal signal.

Text Books:

1. Electronic Devices and Circuits , Jacob Millman & Christos. C. Halkias, Satyabrata Jit, Tata McGraw Hill, 4th Edition, ISBN: 9789352601080.
2. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 10th Edition, 2020, ISBN: 9788131727003_U.

Reference Books:

1. Electronic Devices & Circuits, David A. Bell, Prentice Hall of India/Pearson Education, 5th Edition, 2018, ISBN: 019569340X.
2. Electronic Devices and Circuits, Anil Kumar Maini, Varsha Agrawal, John Wiley & Sons, ISBN: 9788126578085.
3. Electronic Circuit Analysis and Design, Donald A. Neaman, McGrawHill, ISBN: 9780072409574.

Web Links:

1. http://onlinecourses.nptel.ac.in/noc21_ee89/preview by Prof. Shouribrata Chatterjee, IIT, Delhi.
2. <http://nptel.ac.in/courses/108/102/108102095> by Prof. S.C.Dutta Roy, IIT, Delhi.
3. <http://www.iitg.ac.in/apvajpeyi/ph218.html>
4. <http://nptel.ac.in/courses/108/102/108102095> by Prof. S.C.Dutta Roy, IIT, Delhi.

Integrated Circuits & Applications

	L	T	P	C
Course Code: 241EC007	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Construct Op-Amps using the differential amplifier and related circuitry.
- CO2:** Illustrate the parameters related to measurement of Op-Amp characteristics.
- CO3:** Construct the circuits for linear and non-linear applications using Op-Amp.
- CO4:** Build the data conversion circuits and construct the circuits for filtering applications using Op-Amp.
- CO5:** Analyse 555 Timer circuits and Phase Locked Loops.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	1									1
CO3	3	2	1								1
CO4	3	2	1								1
CO5	3	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction to Integrated Circuits: Integrated Circuits: Basic Concepts, Package Types, Temperature ranges and it's Power supplies. Differential Amplifier- DC and AC analysis of differential amplifier configurations, Cascaded Differential Amplifier Stages and Level translator.

UNIT – II

Characteristics of Op-Amps: Block Diagram, Pin diagram and Equivalent Circuit of an Op-Amp, Ideal and practical characteristics of an Op-Amp, DC and AC characteristics, Op-Amp Configurations: Inverting, Non-inverting and Difference amplifiers.

Practice:

1. Construct basic Applications of Op-Amp – Adder, and Subtractor Circuits.

UNIT – III

Linear and Non-Linear Applications of Op- Amps: Linear Applications - Integrator and Differentiator, Instrumentation amplifier, AC amplifier, Non-Linear Applications- Comparators, Schmitt trigger, Waveform Generators: Sine wave generator - RC phase shift oscillator, Free-running Oscillator, One-shot Multivibrators, Triangular wave and Sawtooth wave generators, Logarithmic Amplifiers, Precision rectifiers.

Practice:

1. Design Integrator and Differentiator Circuits using Op-Amp 741.
2. Construct Waveform Generator using single Op-Amp with variable duty cycle.
3. Design Schmitt Trigger Circuits using Single OP-Amp with Reference voltage.
4. Design a Function Generator using Op-Amp 741.

UNIT – IV

D-A and A-D Converters: Introduction, Basic DAC techniques: Weighted Resistor DAC, R-2R and Inverted R-2R ladder DAC, Basic ADC techniques: Parallel Comparator type, Successive Approximation type and Dual Slope ADC. Active Filters: Introduction, Butter worth filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and All pass filter.

Practice:

1. Design an Active Filters 1 – LPF, HPF (First order) using Op-Amp 741.
2. Design an Active Filters 2 – BPF and Band Reject (First order) filters using Op-Amp 741.

UNIT – V

Timers & Phase Locked Loops: Introduction to IC 555 timer, Functional diagram, Monostable and Astable operations and applications, PLL - Introduction, Block schematic, Principles and Description of individual blocks, IC 565 PLL and its Applications, IC 566 VCO Internal Diagram and Applications.

Practice:

1. Construct Astable multivibrator using IC 555 Timer.
2. Construct Mono stable multivibrator using IC 555 Timer.
3. Evaluate Capture range and Lock range using PLL IC565

Additional Practice:

1. Design a 4-bit R-2R Ladder network with Op-Amp Buffer and Measure the output waveform for various input combinations.
2. Design and Construct DC Power Supply using three terminal Voltage Regulators 78XX and 79XX
3. Construct Precision half-wave rectifier and full-wave rectifier using Op-Amp 741.

Cornerstone Projects:**1. Automatic Street Light Controller**

Description: This project uses an LDR and IC 741 as a comparator to detect ambient light. The comparator switches ON street lights automatically during low-light conditions.

Expected Outcome: Automatic switching of street lights based on day/night conditions, reducing power consumption.

2. Water Level Indicator and Alarm

Description: This project uses IC 741 is configured as a comparator to monitor different water levels using conductive probes. A buzzer sounds when the tank becomes full.

Expected Outcome: Accurate water level indication with overflow prevention.

3. Rain Detection Alarm

Description: This project uses Rain sensor output is compared using IC 741. When rain is detected, a buzzer or LED is activated.

Expected Outcome:

Instant rain indication for agricultural and domestic applications.

4. Traffic Light Controller

Description: This project uses one IC 555 timers to generate sequential timing signals for Red, Yellow, and Green LEDs.

Expected Outcome: Automatic traffic signal operation with fixed timing sequence.

5. Automatic Door Bell Timer

Description: This project uses IC 555 in monostable mode generates a fixed-duration output pulse whenever the push button is pressed.

Expected Outcome: Produces a uniform doorbell ringing duration regardless of button press time.

6. Smart Street Light Automation

Description: This project uses an LDR and an IR motion sensor with IC 741 configured as a comparator to detect ambient light and the presence of vehicles or pedestrians. The street light automatically switches ON during night-time and can operate at full brightness only when motion is detected, thereby reducing energy consumption.

Expected Outcome: Automatic and energy-efficient street lighting with intelligent brightness control for smart city applications.

7. Rain Detection and Automatic Window Controller

Description: This project uses a rain sensor with IC 741 as a comparator to detect rainfall, while an IC 555 timer controls the operation of a motor that automatically closes windows or sunroofs when rain is detected.

Expected Outcome: Automatic protection of indoor spaces and equipment from rain, suitable for smart homes, greenhouses, and automobiles.

8. Automatic Fire Detection and Alarm System

Description: This project uses a flame sensor and an LM35 temperature sensor with IC 741 configured as a comparator to detect fire or excessive temperature. An IC 555 timer generates an alarm signal through a buzzer and LED to provide an early warning.

Expected Outcome: Reliable fire detection with immediate audio-visual alerts for homes, laboratories and industrial environments.

9. Smart Intravenous (IV) Drip Monitoring System

Description: This project uses an IR sensor or load cell with IC 741 for signal conditioning and comparison to monitor IV fluid level and drip rate. When the IV bottle is nearly empty or the drip rate becomes abnormal, an alarm is generated to notify healthcare personnel.

Expected Outcome: Continuous monitoring of IV infusion with timely alerts, improving patient safety and reducing manual supervision in hospitals.

10. Smart Patient Health Monitoring System

Description: This project uses **IC 741 operational amplifiers** for amplification, filtering, and signal conditioning of body temperature and heart rate sensor signals. An **ESP32/NodeMCU** processes the conditioned signals and uploads the patient's vital parameters to an IoT cloud platform for real-time monitoring. An alarm is triggered if any parameter exceeds the preset threshold.

Expected Outcome: Real-time monitoring of patient vital signs with remote access and instant alerts during abnormal conditions, improving patient safety and reducing the need for continuous manual supervision.

11. IoT-Based Smart Water Quality Monitoring System

Description: This project uses **IC 741 operational amplifiers** for amplification, signal conditioning, and comparison of analog outputs from **pH, turbidity, and temperature sensors**. The conditioned signals are processed by an **ESP32/NodeMCU** and transmitted to an IoT cloud platform for real-time monitoring. An alarm is generated when any water quality parameter exceeds the predefined safe limits.

Expected Outcome: Continuous real-time monitoring of water quality parameters with remote access and instant alerts for unsafe conditions, enabling timely corrective actions and ensuring safe water for domestic, agricultural, and industrial applications.

12. IoT-Based ECG & Heart Rate Monitoring System

Description: This project uses **IC 741 operational amplifiers** for amplification, filtering, and signal conditioning of ECG and heart rate signals. The conditioned signals are processed by an **ESP32/NodeMCU** and transmitted to an IoT cloud platform for real-time monitoring. An alarm is generated if the ECG waveform or heart rate deviates from the preset normal range.

Expected Outcome: Continuous real-time monitoring of ECG and heart rate with remote access and instant alerts during abnormal cardiac conditions, enabling timely medical intervention and improving patient care in hospitals and home healthcare environments.

13. IoT-Based Smart Industrial Gas Leakage Detection System

Description: This project uses **IC 741 operational amplifiers** for signal conditioning and comparison of the analog output from an **MQ-2/MQ-135 gas sensor**. The conditioned signal is processed by an **ESP32/NodeMCU** and transmitted to an IoT cloud platform for real-time monitoring. When the gas concentration exceeds a preset threshold, the system activates an alarm and sends instant notifications to authorized personnel.

Expected Outcome: Continuous real-time monitoring of industrial gas leakage with remote access and immediate alerts during hazardous conditions, improving workplace safety, preventing accidents, and enabling timely corrective action.

Note:

- The cornerstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The evaluation of the Cornerstone Project shall be based on the project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository (if applicable).

Text Books:

1. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, Pearson Education, 4th Edition, ISBN: 978-9332549913.
2. Linear Integrated Circuits, D. Roy Chowdhury and Shail B. Jain, New Age International Ltd, 4th Edition, 2021, ISBN: 9788122472127.

Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits, Sergio Franco, McGraw Hill, 4th Edition, ISBN: 978-9352601943.
2. Op-Amps and Linear Integrated Circuits: Concepts and Applications, James M Fiore, Cengage Learning India Ltd, 1st Edition, ISBN: 978-8131512340.

Web Links:

1. <http://nptel.ac.in/courses/117108038/Prof.Gunashekar M.K/IISc Bangalore>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-3-circuits/op-amps>
3. <http://www.creativeworld9.com/2011/02/learn-linear-ic-applications>

Linear Control Systems

Course Code: 241EC008

L	T	P	C
2	1	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Develop the overall transfer function using block diagram algebra and signal flow graphs.
- CO2:** Identify time response specifications, error constants of second order systems.
- CO3:** Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- CO4:** Analyze the stability of LTI systems using frequency response methods.
- CO5:** Develop state models for physical systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3								1
CO2	2	3	1								1
CO3	2	3	2								1
CO4	2	3	2								1
CO5	2	2	3								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Mathematical Modeling of Control Systems: Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula. Transfer Function of DC Servo motor.

UNIT – II

Time Response Analysis: Standard test signals, Time response of first and second order systems, Time domain specifications, Steady state errors and error constants, Effects of proportional derivative, proportional integral systems.

UNIT – III

Stability and Root locus Technique: The concept of stability, Routh's stability criterion, limitations of Routh's stability, Root locus concept, construction of root loci.

UNIT – IV

Frequency Response Analysis: Introduction to Frequency domain specifications-Bode diagrams- transferfunction from the Bode Diagram-Phase margin and Gain margin stability Analysis from Bode Plots, Polar Plots,Nyquist Stability criterion, Lag, Lead, Lag-Lead compensators.

UNIT – V

State Space Analysis of LTI Systems: Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and its Properties – Concepts of Controllability and Observability.

Text Books:

1. Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 7th Edition, 2021, ISBN: 978-8195175581.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall of India, 7th Edition, ISBN: 978-8120309685.

Reference Books:

1. Control Systems principles and design, M.Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition, ISBN: 978-0071333269.
2. Control Systems, Manik Dhanesh N, Cengage publications, 4th Edition, ISBN: 978-8131518120.
3. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India, 5th Edition, ISBN: 978-9332550162.

Web Links:

1. <https://www.electrical4u.com/state-space-analysis-of-control-system>
2. <https://nptel.ac.in/courses/107/106/107106081> by Dr.Ramkrishna Pasumarthu

Analog & Digital Communications

Course Code: 241EC009

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Interpret the modulation and demodulation techniques of AM.
- CO2:** Explain the concepts of Angle modulation and demodulation.
- CO3:** Interpret the transmitter and receiver sections.
- CO4:** Infer Pulse analog modulation and demodulation Techniques.
- CO5:** Inspect the characteristics of Pulse Digital Modulation Techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2						2	1		1
CO2	3	2						2	1		1
CO3	3	2						2	1		1
CO4	3	2						2	1		1
CO5	3	2						2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Amplitude Modulation: Need for modulation, Amplitude Modulation - Time and frequency domain description, single tone modulation, power relations in AM waves, Switching modulator, Envelope detector, DSBSC modulation - time and frequency domain description, Balanced Modulator, Coherent detection, COSTAS Loop, SSB modulation - time and frequency domain description, frequency discrimination, Demodulation of SSB Waves, Vestigial Side Band modulation and Demodulation.

Practice:

1. Generate amplitude modulated signal, determine the percentage modulation and demodulate the modulated signal using envelope detector.
2. Generate AM-DSBSC modulated signal and demodulate the modulated signal.

UNIT – II

Angle Modulation: Basic concepts of Phase Modulation, Frequency Modulation: Single tone Frequency modulation, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave - Generation of FM Signal- Armstrong Method, Direct method- Reactance Modulator, Detection of FM Signal: Balanced slope detector, Phase locked loop, Comparison of FM and AM, Concept of Pre-emphasis and de-emphasis.

Practice:

1. Generate frequency modulated signal, determine the modulation index and bandwidth, also demodulate the frequency modulated signal.
2. Plot the frequency response of pre-emphasis and de-emphasis circuits.

UNIT – III

Transmitters and Receivers: Classification of Transmitters, AM Transmitters, FM Transmitters Receivers: Radio Receiver - Receiver Types - Tuned radio frequency receiver, Superheterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, Image frequency, AGC, Amplitude limiting, FM Receiver, Comparison of AM and FM Receivers.

Practice:

1. Verify the characteristics of mixer.
2. Experimentally study the characteristics of a given AGC circuit.

UNIT – IV

Pulse Modulation: Types of Pulse modulation- Generation and Reconstruction of PAM, PWM and PPM.

Pulse Code Modulation: PCM Generation and Reconstruction, Non- Uniform Quantization and Companding, DPCM, DM and Adaptive DM, Noise in PCM and DM.

Practice:

1. Analyze the process of pulse amplitude modulation and demodulation.
2. Analyze the process of pulse position modulation and demodulation.

UNIT – V

Digital Modulation Techniques: ASK, FSK, BPSK and QPSK Modulators and Detectors, Differential PSK, QAM, Baseband Signal Receiver, Optimum Receiver, Calculation of Probability of Error.

Practice:

1. Observe the process of Frequency Shift Keying Modulation and Demodulation.
2. Verify the process of Phase Shift Keying Modulation and Demodulation.

Additional Practice:

1. Verify the characteristics of receiver.
2. Verify the process of Differential Pulse Code Modulation and Demodulation.

Text Books:

1. Modern digital and analog communication systems by B.P.Lathi, Zhi Ding, Oxford, 4th Edition, ISBN: 978-0199476282.
2. Introduction to Analog and Digital Communications by Simon Haykin, Wiley, 2nd Edition, ISBN: 978-0-471-43222-7.
3. Analog and Digital Communication – K. Sam Shanmugam, Wiley, 2018, ISBN: 9788126509140.

Reference Books:

1. Principles of Communication Systems - Herbert Taub, Donald L Schilling, Goutam Saha, McGraw-Hill, 4th Edition, ISBN: 978-1259029851.
2. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, Pearson, 5th Edition, 30 August 2019, ISBN: 978-0130494924.

Web Links:

1. <https://archive.nptel.ac.in/courses/117/105/117105143/>
2. https://onlinecourses.nptel.ac.in/noc21_ee74/preview
3. <https://archive.nptel.ac.in/courses/108/102/108102096/>
4. <https://archive.nptel.ac.in/courses/117/101/117101051/>

Digital Signal Processing

Course Code: 241EC010

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize discrete time signals and systems in time and frequency domain.
- CO2:** Compute the DFT using FFT algorithms.
- CO3:** Design IIR filters using different techniques.
- CO4:** Design FIR filters using different techniques.
- CO5:** Extend the concept of single-rate signal processing to multi-rate signal processing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		1	2			2	2		1
CO2	3	2		1	2			2	2		1
CO3	3	2	3	1	2			2	2		1
CO4	3	2	3	1	2			2	2		1
CO5	3	2		1	2			2	2		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction: Introduction to Digital Signal Processing: Discrete-time signals & sequences, Classification of discrete-time systems, stability and causality of LTI systems. Discrete-time Fourier Transform (DTFT), Frequency domain representation of discrete-time signals and systems. Linear Convolution, System function.

Practice:

1. Generation of basic signals (impulse, step, ramp, exponential, sine square, triangle).
2. Perform addition of two or more sinusoidal signals with different frequencies.

UNIT – II

Discrete Fourier Series & Fourier Transforms: Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT)-Radix-2 decimation-in-time and decimation-in-frequency FFT Algorithms, Inverse FFT, Linear Convolution using Circular Convolution.

Practice:

1. Calculate the Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT) of a given discrete signal.
2. Perform circular and linear convolution using DFT.

UNIT – III

Design of IIR Digital Filters & Realizations: Analog filter approximations- Butterworth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Direct form -I, Direct form -II, Cascade form and Parallel form realization of IIR systems.

Practice:

1. Obtain frequency response of IIR Low Pass Butterworth filters.
2. Obtain frequency response of IIR Low Pass Chebyshev filters.

UNIT – IV

Design of FIR Digital Filters & Realizations: Characteristics of FIR Digital Filters, Frequency response, Design of FIR Digital Filters using Window technique, Comparison of IIR & FIR filters, Direct form, Cascade form and Parallel form realization of FIR systems.

Practice:

1. Obtain frequency response of FIR Low Pass filter using Rectangular Window.
2. Obtain frequency response of FIR Low Pass filter using Hamming Window.

UNIT – V

Multirate Digital Signal Processing: Introduction, Decimation, Interpolation Sampling rate conversion, Implementation of Sampling rate converters, Applications: Sub-band Coding of Speech Signals, Implementation of Digital Filter Banks, Trans-multiplexers.

Practice:

1. Perform decimation and interpolation on signals.
2. Perform Sampling rate conversion on signals.

Cornerstone Projects:

1. Noise Cancellation System for Real-Time Audio Signals

- Concept: Adaptive filtering (LMS / NLMS)
- Working:
 - Capture noisy voice
 - Remove background noise in real time
- Output: Clean audio through speaker
- Applications: Call centres, hearing aids

2. Real-Time FFT Spectrum Analyzer

- Concept: FFT
- Working:
 - Capture signal
 - Display frequency spectrum live (GUI/LCD)
- Output: Peaks showing dominant frequencies
- Applications: Communication, audio analysis

3. Real-Time ECG Signal Monitoring & Filtering

- Concept: FIR/IIR filtering
- Working:
 - Capture ECG signals
 - Remove noise (baseline wander, powerline)
- Output: Clean ECG waveform on display
- Applications: Healthcare monitoring

4. Smart Audio Equalizer System

- Concept: Digital filters (FIR/IIR)
- Working:
 - Adjust bass, treble in real time
- Output: Modified audio output
- Applications: Music systems

5. Vehicle Engine Fault Detection using Vibration Signals

- Concept: FFT + Frequency analysis
- Working:
 - Capture vibration signals
 - Detect abnormal frequencies
- Output: Fault alert
- Applications: Automotive diagnostics

6. Real-Time Digital Communication Receiver

- Concept: Modulation/Demodulation (ASK/FSK/PSK)
- Working:
 - Receive signal
 - Demodulate in real time
- Output: Recovered message
- Applications: Wireless communication

7. Real Time Number Plate Detection System

- Concept: DSP in images
- Working:
 - Capture live image/video
 - Apply filtering (edge detection, smoothing)
- Output: Processed image/video
- Applications: Surveillance, vision systems

8. Real-Time Sampling Rate Converter (Audio)

- Concept: Multirate DSP
- Working:
 - Change sampling rate of live audio
- Output: Resampled audio
- Applications: Audio streaming

9. Real-Time Convolution/Reverb Audio Processor

- Concept: Convolution (FFT-based)
- Working:
 - Apply echo/reverb effects
- Output: Enhanced audio
- Applications: Music production

10. Noise Removal System for EEG Signal

- Concept: Adaptive filtering
- Working:
 - Capture brain signals
 - Remove noise/artifacts
- Output: Clean EEG signals
- Applications: Neurotech, BCI

11. Real-Time Spectrum Sensing for Cognitive Radio

- Concept: FFT + Energy detection
- Working:
 - Detect free frequency bands

- Output: Spectrum usage graph
- Applications: 5G, wireless systems

12. Speech Recognition Preprocessing System

- Concept: DSP + Feature extraction (MFCC)
- Working:
 - Extract features from speech
- Output: Feature vectors
- Applications: AI assistants

All the projects should be implemented using hardware like Raspberry Pi, DSP Boards, Arduino etc

Note:

- The cornerstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The evaluation of the Cornerstone Project shall be based on the project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository (if applicable).

Text Books:

1. Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris G. Manolakis, Pearson Education/PHI, ISBN: 978-9332535893.
2. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, 1st Edition, ISBN: 978-0198081937.

Reference Books:

1. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI, ISBN: 978-0131988422.
2. Multirate Systems and Filter Banks, P.P.Vaidyanathan, Pearson, 1st Edition, ISBN: 978-0136057185.

Web Links:

1. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing by Prof. S.C. Dutta Roy, IIT Delhi)
2. [https://nptel.ac.in/courses/117/102/117102060/\(Digital Signal Processing - Video course, Coordinator BY Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi\).](https://nptel.ac.in/courses/117/102/117102060/(Digital%20Signal%20Processing%20-%20Video%20course,%20Coordinator%20BY%20Prof.%20S.C.%20Dutta%20Roy%20Department%20of%20Electrical%20Engineering%20IIT%20Delhi).)
3. <http://www.dspguide.com/pdfbook.htm>
4. <http://vlabs.iitkgp.ernet.in/dsp/>

VLSI Design

Course Code: 241EC011

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Students will be able to:

- CO1:** Outline the fundamental concepts related to MOS and Bi-CMOS Circuits fabrication.
- CO2:** Analyze the electrical properties of MOS and Bi-CMOS Circuits.
- CO3:** Make use of design rules for developing stick and layout diagrams.
- CO4:** Infer the physical circuit parameters in terms of scaling.
- CO5:** Interpret the issues related to subsystem design.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									1
CO2	3	2									1
CO3	3	2									1
CO4	3	2	1								1
CO5	3	2	1								1

Mapping of Course Outcomes with Program-Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction: Introduction to IC Technology, MOS and related VLSI Technology, Basic MOS Transistors, Enhancement and Depletion modes of transistor action, IC production process, MOS and CMOS Fabrication processes, BiCMOS Technology, Comparison between CMOS and Bipolar technologies.

Practice:

1. Digital circuit Simulation overview.
2. Digital circuits simulation and functional response verification of basic gates.
3. V-I Characteristics of nMOSFET & pMOSFET.

UNIT – II

Basic Electrical Properties Of MOS and Bi-CMOS Circuits: I_{ds} versus V_{ds} Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance, and Figure of Merit. The Pass transistor, NMOS Inverter, Pull-up to Pull-down Ratio for NMOS inverter driven by another NMOS inverter. Alternative forms of pull-up include the CMOS Inverter, MOS transistor circuit model, Bi-CMOS Inverter, Latch-up in CMOS circuits. Realization of gates using NMOS, PMOS, and CMOS technologies.

Practice:

1. Digital circuits simulation and functional response verification of combinational circuits.
2. Realization of schematics and functional response verification of complex gates.

UNIT – III

MOS and Bi-CMOS Circuit Design Processes: MOS Layers, Stick Diagrams, Design Rules and Layout, General Observations on the Design rules, $2\mu\text{m}$ Double Metal, Double Poly, CMOS/BiCMOS rules, $1.2\mu\text{m}$ Double Metal, Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter, Symbolic Diagrams-Translation to Mask Form

Practice:

1. Layout extraction of basic gates.
2. Layout Extraction of combinational circuits.

UNIT – IV

Basic Circuit Concepts: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, The Delay Unit, Inverter Delays, Propagation Delays, Wiring Capacitances, Fan-in and fan-out characteristics, Choice of layers, Transistor switches,

Practice:

1. Performing DRC for basic gates and combinational circuits.
2. Performing LVS/Netlist extraction for logic gates.

UNIT – V

Scaling of MOS Circuits: Scaling models, Scaling factors for device parameters, Limits due to sub-threshold currents, current density limits on logic levels, and supply voltage due to noise. Subsystem Design: Architectural issues, switch logic, Gate logic, examples of structured design, clocked sequential circuits, system considerations, general considerations of subsystem design processes, and an illustration of design processes.

Practice:

1. Performing LVS/Netlist extraction for complex gates and combinational circuits.
2. PEX estimation for the given logic circuits.

Additional Practice:

1. Layout design for specific constraints (delay, power dissipation).
2. DRC/LVS/PEX verification of the Multiplexer.
3. DRC/LVS/PEX verification of given SOP ($Z = (AB + C)D$)'.

Software Tools Used:

1. Cadence Virtuoso - Schematic & Layout Design.
2. Cadence Spectre - Circuit Simulation.
3. Cadence ViVA - Waveform Analysis.
4. Cadence Assura (or Pegasus) - DRC, LVS, PEX.

Practice:

1. Introduction to Cadence Environment (1 Week).
 - a. Introduction to VLSI design flow.
 - b. Overview of Cadence Virtuoso interface.
 - c. Library creation, schematic entry.
 - d. Basic Linux commands for Cadence.
2. MOS Device Simulation (1 Week).
 - a. Simulation of nMOS and pMOS characteristics using Cadence Spectre.
 - b. I_{ds} - V_{ds} and I_{ds} - V_{gs} plots.
 - c. Waveform visualization using Cadence ViVA.
3. CMOS Circuit Design (2 Weeks).
 - a. CMOS inverter design using Cadence Virtuoso.
 - b. Design of NAND, NOR gates.
 - c. Transient and DC analysis using Spectre.
4. Combinational Circuit Design (2 Weeks).
 - a. Design of complex CMOS gates.
 - b. Multiplexer and SOP realization.
 - c. Functional verification using Spectre + ViVA.
5. Layout Design (2 Weeks).
 - a. Stick diagram to layout conversion.
 - b. Layout design using Cadence Virtuoso.
 - c. Layout of inverter, NAND, and NOR gates.
6. Physical Verification (2 Weeks).
 - a. DRC (Design Rule Check) using Cadence Assura.
 - b. LVS (Layout vs Schematic) verification.
 - c. PEX (Parasitic Extraction).
7. Performance Analysis (1 Week).
 - a. Delay and propagation analysis.
 - b. Power estimation using Spectre.
 - c. Fan-in and fan-out effects.

Mini Tasks:

1. CMOS inverter sizing (pull-up/pull-down ratio).
2. Stick diagram to layout conversion.
3. Delay calculation using simulation.
4. Parasitic capacitance impact analysis.

Cornerstone Projects:**1. CMOS Half Adder Design**

Description: Design and implement a CMOS half adder using basic logic gates in the Cadence environment. Perform schematic design, simulate the circuit, generate layout, and verify using DRC, LVS, and PEX. Compare its performance with a full adder.

Expected Outcome: A fully functional CMOS half adder with verified layout and correct output waveforms, along with analysis of delay and power consumption.

2. CMOS Full Adder Design (Multiple Styles)

Description: Design and implement a CMOS full adder using different logic styles such as conventional CMOS and transmission gate logic. Perform schematic design, simulation, layout generation, and verification using DRC, LVS, and PEX. Compare the designs based on power, delay, and area.

Expected Outcome: A verified CMOS full adder layout with comparative analysis showing trade-offs between different design styles in terms of performance metrics.

3. 4-bit Ripple Carry Adder

Description: Design and implement a 4-bit ripple carry adder by cascading full adders. Perform schematic design, simulate the circuit, generate layout, and analyze propagation delay due to the carry chain.

Expected Outcome: A working 4-bit adder with verified layout and demonstrated understanding of delay propagation in cascaded arithmetic circuits.

4. Multiplexer Design (2:1, 4:1, 8:1)

Description: Design and implement multiplexers of different sizes using CMOS logic. Perform schematic design, simulation, layout generation, and verification. Analyze fan-in and fan-out effects on performance.

Expected Outcome: A functional multiplexer design with verified layout and analysis of scalability, delay, and switching behavior.

5. SR Latch and D Flip-Flop Design

Description: Design and implement SR latch and D flip-flop circuits using CMOS logic. Perform schematic design, simulate sequential behavior, generate layout, and verify using DRC and LVS.

Expected Outcome: A correctly functioning sequential circuit with verified layout and timing behavior observed through simulation.

6. Ring Oscillator Design

Description: Design a ring oscillator using an odd number of CMOS inverters. Perform schematic design, simulate oscillations, generate layout, and analyze oscillation frequency and delay.

Expected Outcome: A working ring oscillator with measurable frequency and a validated relationship between delay and oscillation frequency.

7. CMOS Comparator Design

Description: Design and implement a CMOS comparator circuit. Perform schematic design, simulate comparison operation, generate layout, and verify using DRC and LVS.

Expected Outcome: A functional comparator circuit capable of distinguishing input levels with proper switching characteristics.

8. Clock Buffer / Driver Design

Description: Design a CMOS buffer/driver circuit capable of driving large capacitive loads. Perform schematic design, simulate performance, generate layout, and analyze fan-out effects.

Expected Outcome: A buffer circuit with improved driving capability and reduced delay, validated through simulation and layout verification.

9. Low Power CMOS Inverter Design

Description: Design a CMOS inverter optimized for low power consumption by adjusting transistor sizing. Perform simulation, layout, and analysis of static and dynamic power.

Expected Outcome: A power-optimized inverter design with measurable reduction in power consumption and acceptable delay performance.

10. Carry Look-Ahead Adder Design

Description: Design and implement a carry look-ahead adder to improve speed over ripple carry architecture. Perform schematic design, simulation, layout, and timing analysis.

Expected Outcome: A high-speed adder with reduced propagation delay compared to the ripple carry adder, validated through simulation.

11. Power vs Delay Trade-off Study

Description: Design a CMOS circuit with different transistor sizing configurations. Perform simulations to study the trade-off between power consumption and delay.

Expected Outcome: A comparative analysis demonstrating the relationship between power and delay, supported by simulation results.

12. Parasitic-Aware Design (PEX Based)

Description: Design a CMOS circuit and perform both pre-layout and post-layout simulations. Analyze the effect of parasitic elements extracted using PEX.

Expected Outcome: A clear comparison showing the impact of parasitics on circuit performance, including delay degradation.

13. Area-Optimized Layout Design

Description: Design a compact layout for a given CMOS circuit using techniques like shared diffusion and optimal placement.

Expected Outcome: A minimized area layout with correct functionality and adherence to design rules.

14. Design Rule Violation Study

Description: Create a layout with intentional design rule violations and correct them using the DRC tool.

Expected Outcome: A corrected layout demonstrating understanding of design rules and their importance in fabrication.

15. LVS Debugging Project

Description: Design a circuit with mismatches between schematic and layout, then identify and fix errors using LVS.

Expected Outcome: A verified layout matching the schematic, demonstrating debugging capability.

16. Custom Standard Cell Design

Description: Design basic standard cells like inverter, NAND, NOR with fixed height and optimized layout.

Expected Outcome: A set of standard cells suitable for digital design with a consistent layout structure.

17. Mini Standard Cell Library Creation

Description: Create a small library of standard cells and characterize them for delay and power.

Expected Outcome: A basic standard cell library with documented performance metrics.

18. Mini Chip Design Project

Description: Design a small functional block (e.g., ALU or controller) and implement a complete flow, including schematic, layout, and verification.

Expected Outcome: A fully verified mini VLSI design demonstrating complete design flow.

Note:

- The cornerstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The evaluation of the Cornerstone Project shall be based on the project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository (if applicable).

Text Books:

1. Essentials of VLSI Circuits and Systems by Kamran Eshraghian, Douglas, and A. Pucknell, and Sholeh Eshraghian, Prentice-Hall of India Private Limited, ISBN:978-8120327726.
2. VLSI Design-Black Book By Dr. K.V.K.K. Prasad, Kattula Shyamala, Kogent Learning Solutions Inc, ISBN: 978-9350048047.

Reference Books:

1. VLSI Design, A. Albert Raj & T. Latha, PHI Learning Private Limited, ISBN:978-8120334311.
2. VLSI Design, A. Shanthi and A. Kavita, New Age International Private Limited, First Edition, ISBN:978-8122418668.
3. VLSI Design By Debaprasad Das, Oxford University Press, ISBN: 978-0198067665.

Web Links:

1. <https://www.southampton.ac.uk/~bim/notes/cad/>
2. http://www.ece.utep.edu/courses/web5392/Lab_7.html
3. <http://www.ece.utep.edu/courses/web5392/Notes.html>
4. <http://www.ittc.ku.edu/~jstiles/312/handouts/>
5. <https://www.mepits.com/tutorial/384/vlsi/steps-for-ic-manufacturing>
6. <https://www.youtube.com/@IITRoorkeeJuly/videos>
7. https://www.youtube.com/@VLSIDesign_SSG/videos
8. <https://www.youtube.com/@dr.hariprasadnaikbhattu/videos>
9. <https://www.youtube.com/@vlsiclasses/videos>
10. <https://www.youtube.com/@electronicechos/videos>

Microprocessors & Microcontrollers

Course Code: 241EC012

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Interpret the architecture of microcomputer systems.
- CO2:** Develop assembly language program for 8086.
- CO3:** Demonstrate the interfacing of peripherals to microprocessor.
- CO4:** Infer the architecture of 8051 microcontroller.
- CO5:** Demonstrate the interfacing of peripherals to 8051 microcontrollers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	2	1	1	-	-	-	-	-	1
CO2	3	2	2	1	2	-	-	-	-	-	1
CO3	3	2	2	1	2	-	-	-	-	-	1
CO4	3	1	2	1	2	-	-	-	-	-	1
CO5	3	1	2	1	2	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

Unit – I

Introduction: Overview of microcomputer systems and their building blocks, Basic Microprocessor architecture, 8086 Microprocessor, Main features, 8086 internal architecture, Register Organization of 8086. Memory Segmentation. Pin description of 8086, Physical Memory Organization, system timing, minimum mode and maximum mode configuration, interrupt structure and Interrupt Vector table.

Practice:

1. Introduction to MASM Software.

Unit – II

8086 Programming: Instruction set, addressing modes, assembler directives, writing programs with an assembler, assembly language program development tools.

Practice:

1. Write an Assembly language program to perform Arithmetic operations on 8-bit data.
2. Write an Assembly language program to perform Multi byte addition and subtraction.
3. Write an Assembly language to sort the given numbers in an ascending order.
4. Write an Assembly language program to move block of data.
5. Write an Assembly language program to compare the given strings.

Unit – III

8086 Interfacing: Memory Interfacing: Semiconductor memories interfacing (RAM, ROM).

I/O Interfacing: 8255 programmable peripheral interface- Interfacing of switches and LEDs, keyboard interfacing, Interfacing of stepper motor, Interfacing of A/D and D/A converters. 8237 DMA controller, 8259 programmable interrupt controller.

Practice:

1. Interface DAC to 8086 using 8255 to generate square wave and triangular wave.
2. Interface stepper motor to 8086 using 8255 to rotate clockwise and anti-clock wise directions.

Unit – IV

Intel 8051 Microcontroller: Features, pin description, architecture, external memory connection, counters and timers, serial data input/output ports, interrupts, instruction set, addressing modes, programs.

Practice:

1. Introduction to KEIL Software.
2. Write an ALP to find Number of 1's and number of 0's in a given 8-bit.
3. Write an ALP to generate square wave using Timer control.

Unit – V

8051 Interfacing: Interfacing of A/D and D/A converters, keyboard, displays (LED, 7-segment display unit and LCD) and Stepper motor.

Practice:

1. Interface 7-Segment Display to 8051 using proteus software.

Cornerstone Projects:

14. Temperature Monitoring System

Description: This project uses the LM35 temperature sensor to measure temperature. The sensor sends analog signals to the 8051 microcontrollers, which processes and displays the temperature on an LCD.

Expected Outcome: Real-time temperature measurement displayed on LCD, useful in industrial monitoring.

15. Water Level Monitoring & Control System

Description: Water level sensors detect the water level in a tank. The 8051 microcontroller processes the sensor data and indicates the water level through LEDs or an LCD.

Expected Outcome: Displays current water level, prevents overflow, and reduces water wastage.

16. Smart Irrigation System

Description: A soil moisture sensor detects soil dryness. The 8051 microcontroller switches ON the water pump when soil is dry and turns it OFF when sufficient moisture is reached.

Expected Outcome: Automatic watering of plants, saving water and improving irrigation efficiency.

17. Gas Leakage Detection System

Description: The MQ-2 gas sensor detects LPG or gas leakage. When leakage is detected, the 8051 microcontroller activates a buzzer alarm.

Expected Outcome: Quick detection of gas leakage with buzzer alert, improving home safety.

18. Automatic Room Light Controller

Description: Using IR sensors at the entrance, the system counts the number of people entering and leaving the room. Based on occupancy, the 8051 microcontroller turns the room lights ON or OFF.

Expected Outcome: Lights turn ON when someone enters and OFF when the room is empty, saving electricity.

19. Automatic Street Light Controller

Description: This project uses an LDR sensor to detect ambient light intensity. During daytime, the street lights remain OFF, and during nighttime, the lights automatically turn ON. The 8051 microcontroller reads the sensor value and controls the street light through a relay.

Expected Outcome: Street lights automatically turn ON in darkness, turn OFF in daylight, and save electrical energy.

20. Digital Visitor Counter

Description: This system counts the number of visitors entering a room using IR sensors placed at the entrance. The 8051 microcontroller increments the count and displays it on an LCD.

Expected Outcome: Accurate counting of visitors with real-time display on LCD, useful for halls, malls, and offices.

21. Traffic Light Controller

Description: The 8051 microcontroller controls red, yellow, and green LEDs in sequence using programmed timing delays to simulate traffic signals.

Expected Outcome: Sequential traffic light operation demonstrating timer-based control.

22. Automatic Car Parking System

Description: To automate the process of monitoring and managing vehicle parking spaces. It uses IR sensors placed at the entry and exit points of the parking area to detect vehicles. These sensor signals are sent to the 8051 Microcontroller, which keeps track of the number of cars entering and leaving the parking lot.

Expected Outcome: Automatically detects vehicles entering and exiting the parking area.

23. Password-Based Door Lock System

Description: A keypad is used to enter a password. The 8051 microcontroller verifies the password and activates a relay or motor to unlock the door.

Expected Outcome: Door opens only for valid password, enhancing security and preventing unauthorized access.

24. Digital Clock

Description: Displays current time using timers and LCD.

Expected Outcome: Real-time clock display.

25. Ultrasonic Distance Measurement

Description: The Ultrasonic Distance Measurement System measures the distance between an object and the sensor using an ultrasonic sensor such as the HC-SR04 Ultrasonic Sensor. The sensor transmits ultrasonic waves and receives the reflected echo from the object.

Expected Outcome:

Measures the distance between the sensor and an object accurately. Displays the measured distance on the LCD screen.

Note:

- The cornerstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.

- The evaluation of the Cornerstone Project shall be based on the project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository (if applicable).

Text Books:

1. Microprocessors & Interfacing, Douglas V Hall, McGraw Hill, Revised 3rd Edition, ISBN: 978-1259006159.
2. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 2nd Edition, ISBN: 978-0314201881.

Reference Books:

1. Advanced Microprocessors and Interfacing, K.M. Bhurchandi, A.K. Ray, Tata McGraw Hill, 3rd Edition, ISBN: 978-1259006135.
2. The 8051 Microcontrollers and Embedded systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2nd Edition, ISBN: 978-8131758991.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/108103157/>
2. <https://archive.nptel.ac.in/courses/106/108/106108100/>

Antenna & Microwave Engineering

	L	T	P	C
Course Code: 241EC013	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Make comment on various antenna performance parameters.
- CO2:** Infer the fields and patterns of different antennas.
- CO3:** Explain the behavior of different RF and Microwave antenna structures.
- CO4:** Explain the characteristics of wave guide structures and its performance.
- CO5:** Apply different measurement techniques at Microwave range on Active and Passive devices to determine their properties.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1					1	1		
CO2	3	2	1					2	2		
CO3	2	2						2	2		
CO4	3	2		1				1	1		
CO5	3	2	1					1			1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	
CO2	2	
CO3	3	
CO4	2	
CO5	2	

UNIT – I

Antenna Fundamentals: Introduction, Radiation Mechanism, Single wire and Two wire antenna, Half wave dipole, Basic Antenna Parameters, Radiation Pattern, Beam width, Radiation Intensity, Directivity and Gain, Antenna aperture, Beam efficiency, Effective antenna height, Antenna bandwidth, Input impedance, Antenna temperature and Friis transmission equation.

Practice:

1. Measurement of radiation pattern of an antenna.

UNIT – II

Antenna Arrays: Introduction-2-element arrays – different cases, Principle of Pattern Multiplication, N-element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity (no derivations).

UNIT – III

VHF, UHF and Microwave Antennas: Folded Dipoles and their characteristics, Arrays with Parasitic Elements, Yagi - Uda Arrays. Helical Antennas – Significance, Geometry, Design Parameters; Parabolic Reflector Antenna, Horn Antennas–Types and analysis. **Antenna Measurements:** Set up, Pattern measurement, Impedance measurement, Directivity and Gain measurements.

Practice:

1. Measurement of gain of an antenna

UNIT – IV

Microwave transmission lines: History of microwaves, Microwave Frequency bands, Characteristics, advantages, disadvantages and applications, Analysis of Microwave Transmission Lines- Rectangular waveguide.

Multipoint networks: Overview on wave guide discontinuities-Iris, Tuning Screws, Posts and Matched loads. S-Matrix calculations and analysis for E-plane and H-plane Tees, Magic Tee and Directional Coupler.

Practice:

1. Measurement of Directional Coupler characteristics.
2. Measurement of Circulator characteristics.

UNIT – V

Microwave Tubes: Limitations and Losses of conventional tubes at microwave frequencies, Two Cavity Klystron - Velocity Modulation and Applegate Diagram, Bunching Process. Reflex Klystron - Applegate Diagram and Principle.

Microwave Measurements: Measurement of Power, Impedance, Attenuation, and VSWR.

Practice:

1. S/N & C/N measurement by using Satellite Tx. and Rx. Set up.
2. Frequency Measurement by using Doppler RADAR Set up.
3. Measurement of VSWR using microwave bench.
4. Measurement of Reflex Klystron Characteristics.
5. Measurement of Attenuation of a given RF Slot.
6. Measurement of GUNN Diode (TED) V-I Characteristics.

Additional Practice:

1. Measurement of waveguide parameters.
2. Measurement of antenna parameters by using Antenna Trainer.
3. Measurement of transmission/reception characteristics by using Satellite Tx. and Rx. Set up.
4. Measurement of transmission/reception characteristics by using Satellite Tx and Rx Set up.

Text Books:

1. Antenna Theory analysis and design, Constantine A. Balanis, John Wiley publication, 4th Edition, ISBN: 978-1118642061.
2. Microwave Devices and circuits, Samuel Y. Liao, PHI, 3rd Edition, ISBN: 978-8177583533.

Reference Books:

1. Antenna & Wave Propagation, K. D. Prasad, Khanna Publication, Revised and enlarged Edition, 2021, ISBN: 978-8176840255.
2. Antennas and Wave Propagation, John D. Kraus and Ronald J. Marhefka, TMH, 5th Edition, ISBN: 978-9352606184.
3. Microwave Engineering, Sushrut Das, Oxford University Press, ISBN: 9780198094746.
4. Microwave Engineering, David M Pozar, John Wiley, 4th Edition, ISBN: 978-1119770619.

Web Links:

1. <http://www.amanogawa.com/antenna.html>
2. [http://nptel.ac.in/courses/117107035/byDr. Amalendu Patnaik](http://nptel.ac.in/courses/117107035/byDr.AmalenduPatnaik)
3. <http://www.radio-electronics.com/info/antennas/>
4. <http://www.radartutorial.eu/index.en.html>

Minor Stream Courses (MSC)

Minor Streams

- Minor Stream in VLSI
- Minor Stream in Embedded Systems
- Minor Stream in Signal Processing and Communication Technology
- Minor Stream in Space Technology
- Minor Stream in Technology for Digital Resilience Industry Integrated Program- L & T
- Minor Stream in Smart Infrastructure (Electronics) Industry Integrated Program- L & T

Minor Stream: VLSI

Course Code	Minor Stream Course	level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC086	Digital System Design through Verilog	IC	2		1	3	50	50	100	DELD
241EC026	Digital Design through system Verilog	AC	2		1	3	50	50	100	DDTV
241EC023	CMOS Digital IC Design	IC	3			3	50	50	100	DELD
241EC022	Design For Testability	IC	3			3	50	50	100	DDTV
241EC030	Testing & Verification of VLSI Circuits	IC	3			3	50	50	100	VLSI
241EC024	Analog VLSI Design	IC	3			3	50	50	100	VLSI
241EC027	FPGAs & ASIC Design	AC	3			3	50	50	100	DDTV
241EC028	Low Power VLSI Design	AC	3			3	50	50	100	VLSI
241EC029	SoC Design	AC	3			3	50	50	100	MPMC
241EC025	CMOS Mixed signal IC Design	AC	2		1	3	50	50	100	CDIC, AVLSI
241EC031	VLSI Physical Design	AC	2			2	50	50	100	LPVLSI
	Total		29		3	32				

Digital System Design through Verilog

	L	T	P	C
Course Code:241EC086	2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Infer the design process of HDL based digital systems.
- CO2:** Interpret Verilog HDL modelling at various levels of abstraction.
- CO3:** Develop Combinational Logic Circuits using Verilog HDL Program.
- CO4:** Model sequential Logic Circuits using Verilog HDL Program.
- CO5:** Construct synchronous sequential circuits using finite state machines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1			2			1	2		1
CO2	2	3			2			2	2		1
CO3	2	3	3	2	2			2	2		1
CO4	2	3	3	2	2			2	2		1
CO5	2	3	3	1	2			2	2		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction to Verilog HDL Design Concepts:

The Design flow for VHDL/Verilog HDL, Introduction to CAD Tools, Introduction to Verilog HDL , Structure of Verilog module, signals in Verilog code, identifier names, net and variable types, signal values, numbers and parameters, Operators,tasks and functions.

Practice:

- Write a Verilog code to perform arithmetic and logic operations using operators.
- Write a Verilog code to perform shift operation on the given data using shift Operators

UNIT – II

Digital logic design using Verilog HDL:

Structure of Verilog Data flow description, Verilog Structural description, Concurrent statements, Verilog Behavioral Description, Procedural statements, The case statement, If and if-else constructs, For loop, While loop, Programming at various Levels of abstractions- Logic gates, Half Adder, full Adder, Half Subtractor, full Subtractor, Verilog test bench, Introduction to Switch level Modelling.

Practice:

1. Verify the functionality of logic gates with the help of Verilog code using operators and gate primitives.
2. Design a full adder using two half-adders and an OR gate using structural modeling.
3. Design a full subtractor using if-else and case constructs.

UNIT – III

Combinational logic circuit design using Verilog HDL:

Dataflow and structural description of Multiplexers, Decoders, Encoders, Code converters, Arithmetic comparison circuits, Ripple-Carry Adder, Carry Look-Ahead Adder, Multiplier, Arithmetic and Logic Unit.

Practice:

1. Construct a BCD to 7-Segment decoder using continuous assignment statements.
2. Design a 8X3 encoder using for loop construct.
3. Design a n-bit ripple Carry adder using structural modeling.

UNIT – IV

Sequential Logic Design using Verilog HDL:

Latches and flip flops, Ring Counter, Johnson Counter, Design of Modulus N Synchronous Counters, Shift Registers, Universal Shift Registers, Behavioral description of sequential circuits using Verilog HDL.

Practice:

1. Construct a 4 –bit ring Counter using Verilog Behavioral modeling.
2. Design a 4-bit universal shift register Verilog Structural modeling.

UNIT – V

Synchronous Sequential Circuits using Verilog HDL:

Basic design steps: State diagram, state table, state assignment, choice of flip flops and derivation of next state and output expressions, timing diagram. Mealy and Moore type FSM for serial adder, Verilog HDL code for the serial adder.

Practice:

1. Write a Verilog HDL code for the serial adder.

Text Books:

1. Fundamentals of Digital Logic with Verilog Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, ISBN: 978-0-07-338054-4.
2. Advanced digital design with the Verilog HDL, Michael D. Ciletti, Eastern economy Edition, PHI, ISBN: 9789332584464.

Reference Books:

1. A Verilog HDL primer by J.Bhaskar, Star galaxy publishing, 3rd Edition, 2018, ISBN: 9780984629244.
2. Design through Verilog HDL by T. R. Padmanabhan, B. Bala Tripura Sundari, A John Wiley & Sons, Inc., Publication, ISBN: 978-0-471-44148-9.

Web Links:

1. <http://nptel.ac.in/courses/117105080/> by Prof.D. Roy chaudhry, IIT Kharagpur
2. <http://nptel.ac.in/courses/117106086/1> by Prof.S.Srinivasan, IIT Madras
3. https://onlinecourses-archive.nptel.ac.in/noc17_cs21/course by Prof. Indranil Sen Gupta, IIT Kharagpur

Digital Design Through System Verilog

Course Code: 241EC026

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the basics of system verilog HDL.
- CO2:** Develop various combinational circuit using system verilog HDL
- CO3:** Illustrate various asynchronous sequential model circuits.
- CO4:** Make use of System Verilog concepts for sequential circuits design.
- CO5:** Interpret on various system model synthesis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	2	1	3	1							1
CO3	3	2		1							1
CO4	2	1	2								1
CO5	2	3	1	1							1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		3
CO2		3
CO3		3
CO4		3
CO5		3

UNIT- I

Introduction to System Verilog HDL: Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools.

Language Constructs and Conventions: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operators.

Practice:

1. Study and implementation of basic SystemVerilog constructs

2. Design and simulation of arithmetic and logical operations. Develop a test bench to verify all operations and analyze the simulation results.

UNIT-II

Combinational Logic building blocks: Introduction, multiplexers, Decoders, parameterizable decoder, seven segment decoder, priority encoder, adders, parity checker, three state buffers, design using System Verilog, test benches for combinational blocks.

Practice:

1. Design and verification of Multiplexer. Develop a test bench to verify the functionality of the circuits through simulation.
2. Design and verification of Seven Segment Decoder. Develop a test bench to verify the correctness of outputs for all possible input combinations.

UNIT-III

Sequential Logic Design using system verilog: Latches and flip flops, Ring Counter, Johnson Counter, Design of Modulus-N Synchronous Counters, Shift Registers, Universal Shift Registers, Modeling of sequential circuits using System verilog.

Asynchronous Sequential design: Introduction, Asynchronous sequential circuits, design of asynchronous circuits, asynchronous state machines, setup and hold times, metastability using system verilog HDL.

Practice:

1. Design and implementation of Shift Registers.
2. Design and implementation of Counters.

UNIT-IV

Synchronous Sequential design: Basic synchronous sequential systems, model of synchronous sequential systems, algorithmic state machines, synthesis from ASM charts, state machine in system verilog, test benches for state machines and complex sequential systems.

Practice:

1. Design and implementation of Moore State Machine.
2. Design and implementation of Mealy State Machine.

UNIT-V

System verilog synthesis: Introduction, RTL synthesis-combinational logic, RTL synthesis rules, constraints-attributes, area and structural constraints, synthesis for FPGA, behavioural synthesis, timing simulations

Practice:

1. RTL Synthesis of Combinational and Sequential Circuits.

2. FPGA Implementation and Timing Simulation.

Text Books:

1. System Verilog for Design, Stuart Sutherland, Simon Davidmann, Peter Flake, 2nd Edition, ISBN: 9780387364957.
2. System Verilog Functional Verification, Sasaniman, Smith, 1st Edition, ISBN : 9780981656212.

Reference Books:

1. Fundamentals of Logic Design with Verilog Design by Stephen Brown and Zvonko Vranesic, TMH, 2nd Edition, ISBN: 978-0077211646.
2. Advanced Digital Logic Design using Verilog, State Machine & Synthesis for FPGA – Sunggu Lee, Cengage Learning, ISBN: 9780534551612.

Web Links:

1. <http://nptel.ac.in/courses/117105080/> by Prof.D. Roy Chaudhry
2. <http://nptel.ac.in/courses/117106086/1> by Prof.S.Srinivasan

CMOS Digital IC Design

Course Code: 241EC023

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the design parameters of MOS logic.
- CO2:** Build combinational circuits using CMOS logic.
- CO3:** Build sequential circuits using CMOS logic.
- CO4:** Infer the dynamic characteristics of CMOS logic.
- CO5:** Analyze the semiconductor memories for logic design.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	2									1
CO3	3	2									1
CO4	3	2	1								1
CO5	3	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

MOS Design:

Pseudo NMOS Logic: Inverter, Inverter threshold voltage, Output high voltage, Output L voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NM logic gates, Transistor equivalency, CMOS Inverter logic.

UNIT – II

Combinational MOS Logic Circuits:

MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gates, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

UNIT – III

Sequential MOS Logic Circuits:

The behavior of bi-stable elements, SR Latch, Clocked latch and flip-flop circuits, CMOS D latch, and edge-triggered flip-flop.

UNIT – IV

Dynamic Logic Circuits:

Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High-performance Dynamic CMOS circuits.

UNIT – V

Semiconductor Memories:

Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NAND flash.

Text Books:

1. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Edition, ISBN: 9780072925074.
2. Digital Integrated Circuits, Jan M Rabaey, Pearson Education, 2nd Edition, ISBN: 9780130909961.

Reference Books:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective, Ming - BO Lin, CRC Press, ISBN: 9781439868591.
2. Digital Integrated Circuits –A Design Perspective, JanM.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, PHI, 2nd Edition, ISBN: 9789332573925.
3. Digital Integrated Circuit Design, Ken Martin, Oxford University Press, ISBN: 9780195125849.

Web Links:

1. <https://subodhtripathi.files.wordpress.com/2012/01/0072460539cmos1.pdf>
2. [https://onlinecourses.nptel.ac.in/noc21_ee09/preview\(By Prof. Sudeb Dasgupta, IIT Roorkee\)](https://onlinecourses.nptel.ac.in/noc21_ee09/preview(By Prof. Sudeb Dasgupta, IIT Roorkee))

Design for Testability

Course Code:241EC022

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Interpret the fault modeling and logic simulation.
- CO2:** Develop test pattern for combinational logic circuits.
- CO3:** Develop test pattern for sequential logic circuits.
- CO4:** Outline the testable sequential circuits.
- CO5:** Outline the testable memory circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	2									1
CO3	3	2									1
CO4	3	2	1								1
CO5	3	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction to Testing:

Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modeling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault.

UNIT – II

Logic and Fault Simulation:

Simulation for Design Verification and Test Evaluation, Modeling Circuits for Simulation, Algorithms for True value Simulation, Algorithms for Fault Simulation.

UNIT – III

SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

UNIT – IV

Built-In Self-Test:

The Economic Case for BIST, Random Logic BIST: Definitions, BIST Process, Pattern Generation, Response Compaction, Built-In Logic Block Observers, Test-Per- Clock, Test-Per-Scan BIST Systems, Circular Self-Test Path System, Memory BIST, Delay Fault BIST.

UNIT – V

Boundary Scan Standard:

Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BSDL Description Components, Pin Descriptions.

Text Books:

1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits -M.L. Bushnell, V. D. Agrawal, Kluwer Academic Publishers, ISBN: 9780792379911.
2. Digital Systems and Testable Design, M. Abramovici, M.A.Breuer and A.D Friedman, Jaico Publishing House, ISBN: 0-9660176-3-3.

Reference Books:

1. Digital Circuits Testing and Testability - P.K. Lala, Academic Press, ISBN: 9780124343306.
2. Digital Systems and Testable Design - M. Abramovici, M.A.Breuer and A.D.Friedman, Jaico Publishing House, ISBN: 0-9660176-3-3.

Web Links:

1. <https://www.slideshare.net/labishettybhanu/trends-and-challenges-in-vlsi>
2. <http://www.engr.uconn.edu/~tehrani/teaching/test>
3. <http://nptel.ac.in/courses/106103116/34>
4. <http://eesemi.com/bist.html>

Testing & Verification of VLSI Circuits

Course Code:241EC030

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Infer the challenges in VLSI Testing at different abstraction levels.
- CO2:** Explain the fault models for generation of test vectors.
- CO3:** Analyze the observability and controllability parameters of circuit.
- CO4:** Make use of simulation techniques for designing and testing of VLSI circuits.
- CO5:** Identify characteristics of verification methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1									1
CO2	1	1									1
CO3	1	1									1
CO4	2	2	2								1
CO5	2	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Basics of Testing:

Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing-based testing. Classification of sequential ATPG methods. Fault collapsing and simulation.

UNIT – II

Universal test sets:

Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.

UNIT – III

Delay fault testing:

Introduction, Combinational test generation, Combinational fault simulation, Combinational delay fault diagnosis, Sequential test generation, Sequential fault simulation, Pitfalls in delay fault testing and some remedies, Unconventional delay fault testing techniques. CMOS testing: Testing of static and dynamic circuits. Fault diagnosis: Fault models for diagnosis, Cause- effect diagnosis, Effect-cause diagnosis.

UNIT – IV

High-level test synthesis:

Introduction, RTL test generation, RTL fault simulation, RTL design for testability, RTL built-in self-test, Behavioral modification for testability, Behavioral synthesis for testability.

UNIT – V

Verification Techniques:

Introduction to Hardware Verification and methodologies Binary Decision Diagrams (BDDs) and algorithms over BDDs Combinational equivalence checking Temporal Logics modelling sequential systems and model checking Symbolic model checking.

Text Books:

1. Testing of Digital Systems, N. Jha & S.D. Gupta, Cambridge, ISBN: 0 521 77356 3.
2. VLSI Test Principles and Architectures Design for Testability, W.W.Wen, Morgan Kaufmann Publishers, ISBN: 978-0123705976.

Reference Books:

1. Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits, Michael L. Bushnell & Vishwani D. Agrawal, Kluwer Academic Publishers, ISBN: 9780792379911.
2. Digital circuit Testing and Testability, P. K. Lala, Academic Press, ISBN: 9780124343306.

Web Links:

1. [https://archive.nptel.ac.in/courses/106/103/106103116/\(Prof. Jatindra Kumar Deka, IIT Guwahati\)](https://archive.nptel.ac.in/courses/106/103/106103116/(Prof.JatindraKumarDeka,IITGuwahati))
2. <https://www.maven-silicon.com/blog/difference-between-vlsi-verification-and-vlsi-testing/>

Analog VLSI Design

Course Code: 241EC024

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the MOS I/V, C-V Characteristics & Single Stage amplifie.
- CO2:** Analyze the characteristics of CMOS differential Amplifier & Current Mirrors.
- CO3:** Develop the knowledge of Bandgap Reference.
- CO4:** Analyze the two stage CMOS operational amplifiers.
- CO5:** Develop basic Analog layout & CMOS Processing based knowledge acquired in the course.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	1	3		2							1
CO3	1	3	2	2							1
CO4	2	3	2								1
CO5	2	2	3								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		1
CO2		3
CO3		2
CO4		3
CO5		3

UNIT – I

Introduction to Analog Design- Basic MOS Device Physics, MOSFET Structure, MOS I/V Characteristics, MOS Transconductance, Second-Order Effects, MOS Device Capacitances. Single-Stage Amplifiers- Common-Source Stage with Resistive Load, CS Stage with Diode-Connected Load, CS Stage with Current-Source Load.

UNIT – II

Differential Amplifier- Basic Differential Pair, Qualitative Analysis, Common-Mode Response. Differential Pair with MOS Load. Current Mirrors and Biasing Techniques- Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors- Large Signal Analysis, Small Signal Analysis, Biasing Techniques – CS biasing, CG Biasing.

UNIT – III

Band Gap References:

General Considerations, Supply-Independent Biasing, Temperature-Independent References, PTAT Current Generation, Constant-Gm Biasing, Low-Voltage Band Gap References.

UNIT – IV

MOS Operational Amplifier:

General Considerations, One-Stage Op Amps, Two-Stage Op Amps, Gain Boosting, Output Swing Calculation, Common Mode Feedback– Basic Concepts, CM sensing Techniques, CM feedback Techniques, Input Range Limitations, Slew Rate, Power Supply Rejection.

UNIT – V

CMOS Processing Technology:

General Considerations, Photolithography, Oxidation, Ion Implantation, Deposition and Etching. Analog Layout Techniques- Antenna Effect, Multifinger Transistors, Well Proximity Effect, Latch Up Prevention.

Text Books:

1. Design of Analog CMOS Integrated Circuits by Behzad Razavi 2nd Edition, ISBN:9780071188395, 0071188398 .
2. R.Jacob Baker, H.W.Li, and D.E. Boyce CMOS Circuit Design, Layout and Simulation, Prentice-Hall of India, ISBN:9781118038239, 1118038231 .

Reference Books:

1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, ISBN:9788126517787, 8126517786
2. Analysis and Design of Analog Integrated Circuits, ISV by Meyer Gray, Hurst, Lewis. 5th Edition, ISBN:9788126521487, 8126521481 .

Web Links:

1. https://onlinecourses.nptel.ac.in/noc23_ee142/preview(Prof. Imon Mondal, IIT Kanpur)
2. <https://nptel.ac.in/courses/117101105> (Prof. A.N. Chandorkar, IIT Bombay)

FPGAs & ASIC Design

Course Code: 241EC027

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Compare the performance of different FPGAs and their programming Technologies.

CO2: Identify different SRAM and Anti-Fuse programmable FPGA architectures.

CO3: Develop digital circuits with ACT architectures.

CO4: Illustrate the different types of ASICs with I/O modules and their interconnects.

CO5: Explain the construction, simulation and testing of ASICs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3									1
CO2	2	3									1
CO3	1	2	3								1
CO4	3	2									1
CO5	3	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Field Programmable Gate Arrays:

Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, Applications of FPGAs.

UNIT – II

Programming FPGAs:

SRAM Programmable FPGAs, Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 and XC4000 Architectures. ACT FPGA Architectures: Anti-Fuse Programmed FPGAs, Introduction, Programming Technology, Device Architecture, The Actel AC1, AC2 and ACT3 Architectures.

Applications: Design Applications, General Design Issues, Counter Examples, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices.

UNIT – III

Introduction to ASICs: Types of ASICs, Design Flow, Case Study, Economics of ASICs, ASIC Cell Libraries, Transistors as resistors, Transistor Parasitic Capacitance, Logical Effort, Library Cell Design, Library Architecture, Gate-Array Design, Standard Cell Design, Data Path Cell Design.

UNIT – IV

Programable ASICs and Programable ASIC Logic Cells:

The Anti fuse, Static RAM, EPROM and EEPROM Technology, Practical Issues, Specifications, PREDP Benchmarks, FPGA Economics, Actel ACT, Xilinx LCA, Altera Flex, Altera Max, DC Output, AC Output, DC input, AC input, Clock input, Power input, Xilinx I/O block, Other I/O Cells. Low Level Design Entry and Logic Synthesis: Schematic Entry, Low level Design Languages, PLA Tools, EDIF, A logic synthesis example, A Comparator/MUX, Inside a Logic Synthesizer, Synthesis of Viterbi Decoder, Verilog and Logic synthesis, VHDL and Logic Synthesis, Finite State Machine Synthesis, Memory Synthesis, The Engine Controller, Performance Driven Synthesis, Optimization of the viterbi decoder.

UNIT – V

Simulation, Test and ASIC Construction:

Types of Simulation, The Comparator/MUX Example, Logic Systems, How Logic Simulation Works, Cell Models, Delay Models, Static Timing Analysis, Formal Verification, Switch Level Simulation, Transistor Level Simulation, The importance of test, Boundary Scan Test, Faults, Faults Simulation, Automatic Test Pattern Generator, Scan Test, Built in Self Test, A simple test Example, Physical Design, CAD Tools, System Partitioning, Estimating ASIC Size, Power Dissipation, FPGA Partitioning, Partitioning Methods.

Text Books:

1. Field Programmable Gate Array Technology, Stephen M. Trimberger, Springer International Edition, ISBN: 978-1461361831.
2. Application Specific Integrated Circuits, Michael John Sebastian Smith, Pearson Education, ISBN : 978-8177584080.

Reference Books:

1. Digital Design Using Field Programmable Gate Arrays, Pak K. Chan/Samiha Mourad, Pearson Low Price Edition, ISBN: 9788131724408.

2. Advanced ASIC Chip Synthesis using Synopsis Design compiler, Himanshu Bhatnagar, Kluwer Academic, 2nd Edition, ISBN: 9780792385370.

Web Links:

1. <https://nptel.ac.in/courses/117108040/> by Prof. Kuruvilla Varghese\
2. <http://www.eng.ucy.ac.cy/theocharides/Courses/ECE664/L5.pdf>

Low Power VLSI Design

Course Code: 241EC028

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Outline the fundamentals of low-power logic design.
- CO2:** Interpret low-power design approaches.
- CO3:** Interpret the constraints for low power design through CAD Tools.
- CO4:** Contrast adder architectures for the efficient subsystem design.
- CO5:** Outline the low-power multiplier architectures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	2									1
CO3	3	2									1
CO4	3	2	1								1
CO5	3	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction:

Introduction to Low Power VLSI design, Importance of low power design, Challenges in low power VLSI design, Application of Low Power VLSI circuits, Power analysis of CMOS circuits, Themes of Low Power VLSI design, Supply voltage scaling, Reduction of load capacitances.

UNIT – II

Low Voltage Process Technology and Device Modelling:

CMOS device structure and process fabrication, Innovation on process technology for low power consumption, Multi-threshold process technology, Latch up problem in CMOS technology, Discussion on SPICE Models of MOS transistor, MOS Capacitances, CMOS Low voltage analytical model, Threshold voltage definitions, Different Short Channel Effects.

UNIT – III

Techniques for low power design at Logic Design Level:

CMOS logic design style, CMOS Inverter design, Transfer characteristics of CMOS inverter, Delay calculation of CMOS Logic gates, Analysis of various logic design styles for their power consumption (CPL, Domino Logic, NORA CMOS, TSPC Logic, DCVSL, etc.).

UNIT – IV

Low power design techniques at Architectre and System Level:

Importance of parallelism, Introduction to Pipelining, Low power design utilizing redundancy and Data Encoding, Importance of Regularity and Locality, Reduction of complexity to improve power consumption, Low power design techniques at system level.

UNIT – V

Low Power Random Access Memory Circuits:

Introduction to Static RAM Design, Low power Bit-line Conditioning Circuits, Low Power Techniques, Sense Amplifiers, Dynamic RAM Design, Bit line capacitance reduction methodologies, Self-Refresh Techniques, Low Voltage DRAM Operations, and Leakage Power Analysis.

Text Books:

1. Low-power CMOS digital design, A.P.Chandrakasan and R.W.Broderson, Low Power CMOS Design, IEEE Press, ISBN: ISBN: 978-1-4615-2325-3.
2. Low-Power Digital VLSI Design: Circuits and Systems, A. Bellaouar and M. I. Elmasry, Springer, ISBN: ISBN : 9780792395874.

Reference Books

1. Low-Power VLSI Circuits and Systems, Ajit Pal, Springer, ISBN: ISBN: 9788132219361.
2. Low Power Design Methodologies, Jan M. Rabaey, Massoud Pedram, Springer Science+Business Media,LLC, ISBN: ISBN: 978-1-46 13-5975-3.

Web Links:

1. <https://www.synopsys.com/glossary/what-is-low-power-design.html>
2. <https://resources.system-analysis.cadence.com/blog/msa2021-implementing-low-power-design-through-voltage-scaling-in-vlsi>
3. <https://link.springer.com/book/10.1007/978-1-4615-2355-0>

SoC Design

Course Code: 241EC029

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course student will be able to:

- CO1:** Explain all the building blocks of SoC.
- CO2:** Classify the concept of processors and instruction handling.
- CO3:** Analyze vector, VLIW and superscalar processors.
- CO4:** Develop a Memory as part of SoC.
- CO5:** Illustrate the concepts of interconnect optimization and configuration in SoC.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	3	2									1
CO3	2	2	1								1
CO4	2	2	2								1
CO5	2	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction to the System Approach:

System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

UNIT – II

Processors:

Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

UNIT – III

Memory Design for SOC:

Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction.

UNIT – IV**Interconnect Customization:**

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor.

UNIT – V**Interconnect Configuration:**

Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

Text Books:

1. Computer System Design System-on-Chip, Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd, ISBN: 978-0470643365.
2. ARM System on Chip Architecture, Steve Furber, Addison Wesley Professional, 2nd Edition, ISBN : 9780201675191 .

Reference Books:

1. Design of System on a Chip: Devices and Components, Ricardo Reis, Springer 1st Edition, ISBN: 978-1441954541.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Jason Andrews, Newnes, BK and CDROM, ISBN: 978-0750677301.
3. System on Chip Verification–Methodologies and Techniques, Prakash Rashinkar, Peter Paterson and Leena Singh L, Kluwer Academic Publishers, ISBN: 978-0792372790.

Web Links:

1. <https://www.peterindia.net/System-On-ChipLinks.html>
2. <https://www.ieee-socc.org/>
3. <http://nptel.ac.in/courses/108102045/10> (Prof. Santanu Chaudhary, IIT Delhi)

CMOS Mixed Signal IC Design

Course Code:241EC025

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Infer the characteristics of CMOS based Switched capacitor and PLL.
- CO2:** Analyze the performance of sampling circuits.
- CO3:** Demonstrate the non idealities of data converters.
- CO4:** Apply appropriate techniques and tools in development of data converters.
- CO5:** Model the frequency and Q tunable time domain filters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2			1	1		1
CO2	3	2			2			1	1		1
CO3	3	2			2			1	1		1
CO4	1	2	3		2			1	1		1
CO5	1	2	3		2			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

PLL & Switched Capacitors:

Characterization of a comparator, Basic CMOS comparator design, Analog multiplier, PLL – simple PLL, charge-pump PLL, applications of PLL, Switched Capacitor circuits – basic principles, switched capacitor sensitive integrator and insensitive integrator, switched capacitor filter, switched capacitor amplifier.

Practice:

1. Design of PLL
2. Design of switched capacitor circuits.

UNIT – II

Sampling Circuits:

Basic sampling circuits for Analog signal sampling, performance metrics of sampling circuits, different types of sampling switches. Sample-and-Hold Architectures: Open-loop &

closed-loop architectures, open-loop architecture with miller capacitance, multiplexed-input architectures, recycling architecture.

Practice:

1. Design Sample hold circuit.
2. Estimation of open loop Miller capacitance.

UNIT – III

Digital-to-Analog Conversion:

Input/output characteristics of an ideal D/A converter, performance metrics of D/A converter, Resistor string 3-bit DAC, Binary scale DACs, Cyclic DAC. D/A Converter architectures: Resistor-Ladder architectures, current-steering, Pipeline DAC.

Practice:

1. Design of basic DAC.
2. Design of Resistor string 3-bit DAC.

UNIT – IV

Analog-To-Digital Conversion:

Input/output characteristics and quantization error of an A/D converter, performance metrics of A/D converter. A/D converter architectures: Flash architectures, interpolate and folding architectures, pipelined architectures, Ramp type ADC, Integrating (Dual slope) ADC, Successive approximation architectures, Sigma Delta ADC, Design of Decimation filter.

Practice:

1. Design of basic ADC.
2. Design of Successive approximation ADC.

UNIT – V

Analog CMOS Filters :

Low Pass filters, active-RC fully differential integrator, Two transistor MOSFET- C integrator, gm-C Integrator, Active RC integrators.

Practice:

1. Design of first order filters.
2. Design of Gm-C Integrator.

Text Books:

1. Design of Analog CMOS Integrated Circuits, B.Razavi, 2nd Edition, McGrawHill, ISBN: 9780072524932.
2. CMOS Mixed-Signal Circuit Design, Jacob Bakeret, IEEE Press, ISBN: 9780471227540.

Reference Books:

1. Analog MOS Integrated Circuit for signal processing, R Gregorian, G.C. Temes, John Wiley & Sons, ISBN: 978-0-471-09797-6.
2. Understanding Delta-Sigma Data Converters, Schreier & Temes, Wiley – IEEE Press, ISBN: 9781119258292.

Web Links:

1. <https://ioe.iitm.ac.in/project/rf-analog-and-mixed-signal-integrated-circuits/>
2. https://link.springer.com/chapter/10.1007/978-0-387-35597-9_29
3. <https://www.ims.fraunhofer.de/en/Core-Competence/Smart-Sensor-Systems/Integrated-Sensor-Systems/Mixed-Signal-IC-Design.html>

VLSI Physical Design

Course Code: 241EC031

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the VLSI physical design cycle at various levels of abstraction
- CO2:** Choose different algorithms for system partitioning.
- CO3:** Develop floor planning for different VLSI Circuits.
- CO4:** Make use of placement & routing algorithms for placement and routing purpose.
- CO5:** Explain the concepts of timing closure involved in placement & routing..

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	2	3									
CO3	2	1	3	1							
CO4	1	1	3	1							
CO5	2	2									

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT- I

Introduction to physical design automation

VLSI design flow, Physical design cycle, design styles, Layout layers and design rules, Physical design optimizations

UNIT- II

Net list and system partitioning

Introduction, terminology, optimization goals, partitioning algorithms, a frame work for multi level partitioning

UNIT-III

Floor planning

Introduction to floor planning, optimization goals, terminology, floor plan representations, floor planning algorithms, pin assignment, power and ground routing.

UNIT-IV

Placement & Routing: Global placement, Representation of routing regions, The global routing flow, single net routing, full net list routing, Detailed routing- horizontal and vertical constraints graph, channel routing algorithms, switch box routing.

UNIT-V

Timing Closure: Introduction, timing analysis and performance constraints, timing driven placement, timing driven routing

Text Books:

1. VLSI Physical Design: From Graph Partitioning to Timing Closure-Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu ,Springer, ISBN: 978-94-007-9020-9.
2. VLSI Physical Design Automation Theory and Practice by Sadiq M. Sait, Habib Youssef, world scientific, ISBN : 9789810238834.

Reference Books:

1. Modern VLSI DesignSystem-on-Chip Design by Wayne Wolf, Pearson education, 3rdEdition, ISBN: 978-8178086538.
2. Analog Integrated Circuit Design AutomationPlacement, Routing and Parasitic Extraction Techniques by Ricardo Martins, Nuno Lourenço, Nuno Horta, springer international publishing, ISBN: 978-3319816685.

Web Links:

1. <https://nptel.ac.in/courses/106105161> - by Prof. Indranil Sen Gupta, IIT Khargpur.
2. <https://nptel.ac.in/courses/117101004> - by Prof.D.K.Sharma, Prof. Sachin Patkar,Prof. Virendra singh, Prof.A.N.Chandorkar, IIT Bombay.
3. <https://nptel.ac.in/courses/117103125> - by Dr.Santosh Biswas, IIT Guwahati.

Minor Stream: Embedded Systems

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC037	Sensors & Actuators	FC	3			3	50	50	100	-
241EC040	Embedded C	IC	3			3	50	50	100	-
241EC036	Hardware interfacing & Networking	IC	3			3	50	50	100	-
241EC038	Microcontrollers for Embedded Systems	IC	3			3	50	50	100	MPMC
241EC032	Embedded Real Time Systems	AC	3			3	50	50	100	-
241EC042	Wireless LANs & PANs	IC	3			3	50	50	100	-
241EC039	System Programming	AC	3			3	50	50	100	-
241EC034	Embedded System Design	AC	2		1	3	50	50	100	-
241EC041	Real Time operating System using QNX	AC	0	0	2	2	50	50	100	RTOS
241EC033	Machine Learning for Embedded Systems	AC	3			3	50	50	100	-
241EC035	Hardware & Software Co-Design	AC	3			3	50	50	100	-
	Total		29		3	32				

Sensors & Actuators

Course Code: 241EC037

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain fundamentals of sensors and measurement systems.
- CO2:** Analyze resistive, capacitive, and inductive sensors.
- CO3:** Describe optical and modern sensors.
- CO4:** Explain signal conditioning and sensor interfacing.
- CO5:** Describe actuators and their applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2	3	2	1								
CO3	3	2									
CO4	2	2	1								
CO5	2	1	1								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	2	1
CO3	2	1
CO4	2	2
CO5	2	2

The course is covered at a conceptual level with emphasis on working principles, block diagrams, and applications. Detailed mathematical derivations and implementation-level complexities are excluded.

UNIT – I

Fundamentals of Sensors and Measurement:

Introduction to sensors, transducers, and actuators; Differences between sensors, transducers, and actuators; Measurement system components; Classification of sensors (active/passive, analog/digital); Static characteristics (accuracy, precision, sensitivity, and linearity); Dynamic characteristics (response time and bandwidth); Error analysis and calibration.

UNIT – II

Resistive, Capacitive and Inductive Sensors:

Resistive sensors: potentiometer, strain gauge; Temperature sensors: RTD, thermistor; Capacitive sensors: principle, construction, and applications; Inductive sensors: LVDT (working principle and characteristics); Comparison of sensor types (resistive, capacitive, inductive); Advantages, limitations, and selection criteria.

UNIT-III

Optical and Application-Based Sensors:

Optical sensors: photodiode, LDR; Infrared sensors: principle and applications; Ultrasonic sensors: time-of-flight concept; Magnetic sensors: Hall effect sensor; Motion sensors: accelerometer and Gyroscope (working principle and applications); Introduction to smart sensors (features and advantages) and MEMS sensors (basic concept, structure, and applications).

UNIT- IV

Signal Conditioning and Sensor Interfacing:

Need for signal conditioning; Sensor signal characteristics (low-level signals, noise, impedance); Instrumentation amplifier for sensor applications; Signal conditioning for resistive and capacitive sensors; Isolation and impedance matching; Noise reduction techniques (shielding, grounding, and filtering); Data acquisition system (block diagram and working); Multiplexing in data acquisition; and basic concept of sensor interfacing with microcontrollers.

UNIT-V

Actuators and Applications:

Introduction to actuators and their working principles; Classification of actuators; Electrical actuators: DC motor, stepper motor, and servo motor (working principles and basic characteristics); Basic concepts of hydraulic and pneumatic actuators; Relay and switching devices; Actuator control (open-loop and closed-loop concept); Integration of sensors and actuators; Applications in automation systems, robotics, and IoT.

Text Books:

1. Handbook of Modern Sensors: Physics, Designs, and Applications, Jacob Fraden, Springer 4th Edition, ISBN: 978-1441964656.
2. Sensors and Transducers, D. Patranabis, PHI Learning Pvt. Ltd., 2nd Edition, ISBN: 978 8120326941.

Reference Books:

1. Principles of Measurement Systems, John P. Bentley, Pearson Education, 4th Edition, ISBN: 978-0130430281.
2. Electronic Instrumentation, H.S. Kalsi, McGraw-Hill Education, 3rd Edition, ISBN: 978-0070702066.
3. Measurement Systems: Application and Design, Ernest O. Doebelin and Dhanesh N. Manik, McGraw-Hill, 5th Edition, ISBN: 978-0072426328.

Web Links:

1. <https://nptel.ac.in/courses/108105064>
2. <https://nptel.ac.in/courses/108106165>
3. <https://www.youtube.com/watch?v=nE1C4ghfvac&list=PLgMDNELGJ1CbufZjqWa8uoSIQWKqVwPN7>

EMBEDDED C

	L	T	P	C
Course Code: 241EC040	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain embedded system concepts and 8051 architecture
- CO2:** Apply Embedded C programming for interfacing peripherals
- CO3:** Analyze real-time systems using timers, interrupts, and delays.
- CO4:** Develop multi-state embedded systems using timed and input-based state machines.
- CO5:** Develop complete embedded system applications by integrating peripherals

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	3	2		3						
CO3	3	3	2	3	2						
CO4	3	3	3	2	3						
CO5	3	3	3	3	3						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction:

Introduction to embedded systems, Processor suitable for embedded system, Selection of programming language, Operating system, Development of embedded software. Introduction to microcontroller family, External interface of the Standard 8051, Reset requirements, Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts Serial interface Power consumption.

UNIT – II

Introduction to Reading switches:

Basic techniques for reading from port pins, Example: Reading ,writing bytes and Bits, The need for pull-up resistors, dealing with switch bounce with an example.

Adding Structure to the Code:

Introduction to adding structure to your code, Object-oriented programming with C, The

Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the 'Hello Embedded World', Example: Restructuring the goat-counting, Further examples.

UNIT – III

Meeting real-time constraints: Introduction, creating 'hardware delays' using Timer 0 and Timer 1, Example: Generating a precise 50ms delay, creating a portable hardware delay, Need for Timeout Mechanism, Creating loop Timeouts with Examples, Creating hardware Timeouts with Examples .

UNIT – IV

Introduction to multi-state systems and function sequences, Implementing a Multi-State (Timed) system, Example: Traffic light sequencing, Example: Animatronic dinosaur, Implementing a Multi-State (Input/Timed) system, Example: Controller for a washing machine.

UNIT – V

Case study:

Intruder alarm system, Software architecture of Intruder alarm system, Key software components used in Intruder alarm system, Intruder alarm system program using Embedded C.

Text Books:

1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008.
2. An Embedded Software Primer, David. E. Simon, Pearson Education, 2001.
3. Embedded Software Development with C, Kai Qian, David Den Haring, Li Cao (auth.), Springer US, 2009.

Reference Books:

1. Embedded Microcomputer Systems, Jonathan W. Valvano, Brooks / Cole, Thompson Learning.
2. Fundamentals of Embedded Software where C and Assembly meet, Daniel W. Lewis, PHI, 2002.
3. Embedded System Design, Frank Vahid and Tony Gwargie, John Wiley & sons, 2002.

Web Links:

1. <https://nptel.ac.in/courses/106/105/106105193/> Prof. Indranil Sen Gupta, IIT, Kharagpur (NPTEL course)
2. https://onlinecourses.nptel.ac.in/noc20_ee98/preview Prof. Dhananjay V. Gadre, Prof. Badri Subudhi | Netaji Subhas University of Technology, IIT Jammu
3. <http://www.ecpe.nu.ac.th/ponpisut/22323006-Embedded-c-Tutorial-8051.pdf>

Hardware Interfacing & Networking

Course Code: 241EC036

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the fundamentals of serial communication and UART-based protocols used in embedded systems.
- CO2:** Describe synchronous communication protocols such as SPI and I2C for peripheral interfacing in embedded applications.
- CO3:** Explain the architecture and communication mechanisms of industrial protocols including CAN, MODBUS, PROFIBUS, and LIN bus.
- CO4:** Describe Ethernet networking fundamentals, network hardware components, and Internet protocol concepts used in embedded networking.
- CO5:** Explain embedded Ethernet communication using TCP/IP, UDP, FTP, web-based communication, and network security concepts.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2								1	
CO2	3	2								1	
CO3	2	3								1	
CO4	2	2								1	
CO5	2	2	2							1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Fundamental Serial Communication Protocols: Introduction to embedded communication, serial communication basics, RS-232 standard, RS-485 standard, MAX232, electrical characteristics and interfacing, UART protocol, asynchronous transmission, framing and baud rate.

UNIT – II

Synchronous Peripheral Communication Protocols:

Synchronous serial communication, SPI protocol, architecture and data transfer modes, timing characteristics, I2C protocol, addressing schemes, arbitration, clock synchronization and data transfer.

UNIT – III

Industrial communication Protocols:

USB Bus - Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types, introduction to CAN, CAN architecture, signalling and bit timing, data frame format, arbitration mechanism, CAN bus operation. MODBUS protocol, message structure and communication, Profibus protocol, architecture and communication model, LIN bus protocol.

UNIT – IV

Ethernet Basics: Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components – Ethernet Controllers –Using the internet in local and internet communications – Inside the Internet protocol.

UNIT – V

Embedded Ethernet: Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

Text Books:

1. Embedded Systems Design: A Unified Hardware/Software Introduction - Frank Vahid, Tony Givargis, John & Wiley Publications, ISBN: 9788126508372.
2. Embedded networking with CAN and CAN open by Olaf Pfeiffer, Andrew Ayre and Christian Keydel, Copper hill Technologies Corporation, ISBN: 978-0976511625.
3. Embedded Ethernet and Internet Complete - Jan Axelson, Penram publications, ISBN: 978-1931448000.

Reference Books:

1. Modbus-IDA, MODBUS application protocol specification, Modbus-IDA,. Siemens, Profibus network manual, Siemens manual.
2. Profibus in practice: System Architecture and Design byXiu Ji, CRC press, ISBN: 978-1507633045.
3. Lin Application note AN1278 by SGS-Thompson, SGS - Thompson Ltd.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/102/108102045/>.
2. <https://archive.nptel.ac.in/courses/108/105/108105057/>.

Microcontrollers for Embedded Systems

Course Code: 241EC038

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the basic architecture and features of PIC microcontrollers.
- CO2:** Explain architecture and programming model of ARM 7TDMI.
- CO3:** Interpret the programmer's model of ARM cortex M3-processor.
- CO4:** Compare the various exceptions present in the processor.
- CO5:** Summarize the low power modes of MSP 430 micro controller.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	2									1
CO3	2	3	1	1							1
CO4	3	2									1
CO5	2	3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Arduino Microcontroller (ATmega328P):

Introduction to Arduino Uno, Features and architecture overview, Pin configuration Programming Fundamentals, Digital and analog operations, Serial communication and debugging, Arduino Libraries & Code Reusability, logic-based LED pattern generation.

UNIT – II

PIC Microcontrollers:

PIC16F877 Architecture, Instructions Set, addressing modes, PIC16F877

Peripherals: Timers, CCP modules, ADC modules.

UNIT-III

MSP430 16 - BIT MICROCONTROLLER :

The MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x. Low power aspects of MSP430 : low power modes, active Vs standby current consumption, FRAM Vs Flash for low power and reliability.

UNIT- IV

ARM7 Microcontroller:

ARM7 microcontroller architecture, memory organization, description of functional units of microcontroller: ports, interrupts, on chip ADCs, DACs, serial peripheral interface, timers, programmable counter array.

UNIT-V

ARM Cortex-M3 processor:

Applications, Programming model– Registers, Operation modes, Instruction Set, Memory Maps, Exceptions and Interrupts, Reset Sequence, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces.

Text Books:

1. Micro Controller theory and Application ,Ajay .V. Deshmukh, TATA McGraw –Hill, 1st Edition, ISBN: 9780070585959.
2. ARM System Developer's Guide: Design in and Optimizing, Sloss Andrew N, Symes Dominic, Wright Chris, Morgan Kaufman Publication,ISBN: 978-1-55860-874-0.

Reference Books:

1. ARM System-on-Chip Architecture, Steve furber, Addison-Wesley Educational Publishe Inc, 2nd Edition, ISBN: 9780201675191
2. PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18Muhamn Ali Mazidi, Rolin D. Mc Kinlay, Danny Causey, Pearson Prentice Hall, ISBN: 9780136009023.
3. MSP 430 Micro controller basics, John H. Davies, Elsevier, ISBN: 978-0-7506-8276-3.

Web Links:

1. <http://nptel.ac.in/courses/117/106/117106086>.
2. https://onlinecourses.nptel.ac.in/noc20_ee42
3. <https://nptel.ac.in/courses/117106111>

Embedded Real Time Systems

Course Code: 241EC032

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the services and tasks in RTOS.
- CO2:** Infer interrupts and timer services for embedded applications.
- CO3:** Outline memory management in embedded systems.
- CO4:** Illustrate program modeling for case studies.
- CO5:** Identify Fundamental Issues in Hardware software co- design

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	1									1
CO3	3	2									1
CO4	3	2									1
CO5		3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Operating System Concepts: History of Operating Systems, Functions performed by an OS, Kernel, Tasks, Processes, Threads, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, Tasks States, Task Operations and Task Structure.

UNIT – II

Synchronization and Inter Process Communication:

Defining Semaphore, Typical Semaphore Operation, Typical Semaphore Uses, Defining Message Queue, Message Queue States, Typical Message Queue Operation, Typical Message Queue Use, Pipes, Event Registers, Signals, Condition variables.

UNIT – III

Exceptions, Interrupts and Timers:

Exceptions, Interrupts, Applications of Exceptions and Interrupts, Processing General Exceptions, Nature of Spurious Interrupts, Introduction to Timers, Programmable Interval Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

UNIT – IV

Memory Management:

Dynamic Memory Allocation in Embedded Systems, Fixed-Size Memory management in Embedded Systems, Blocking VS. Non-Blocking Memory Functions, Hardware Memory Management Units.

UNIT – V

Case study and Example RTOS:

Linux POSIX system, MicroC/OS-II, Vx Works, QNX RTOS, Kernel Design Issues-process states, data structures, inter-task communication mechanism, Scheduling.

Text Books:

1. Embedded/Real-Time Systems Dr. K.V.K.K. Prasad, Dream Tech Publications, Blackpad book, ISBN: 978-8177224610.
2. Real Time Concepts for Embedded Systems – Qing Li, Caroline Yao, Taylor & Francis Group, CRC Press, ISBN: 9781482280821
3. Embedded Systems, An Integrated Approach, Lyla B.Das, Pearson Education, ISBN: 9789332511675

Reference Books:

1. Embedded Systems-Architecture, Programming and Design ,Rajkamal,Tata McGraw Hill Publications, Second Edition,ISBN: 978-0070667648.
2. Real-Time Systems: Scheduling, Analysis and Verific Cheng WileyInter science, ISBN: 9780471460848
3. Real-Time Systems: Design Principles for Distributed Embedded Applica Hermann Kopetz, Kluwer, ISBN: 9781441982377

Web Links:

1. <http://www.nptelvideos.in/2012/11/embedded-systems.html>
2. http://www.dauniv.ac.in/Embedded_Sys.php
3. <https://sites.google.com/site/embeddedsystemddr/ppt>

Wireless LANs & PANs

Course Code: 241EC042

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course student will be able to:

- CO1:** Explain the fundamentals of computer networks, reference models, IoT concepts, communication models, and layered architecture.
- CO2:** Describe WLAN technologies based on IEEE 802.11 standards.
- CO3:** Illustrate the architecture, operation, and applications of short-range wireless communication technologies.
- CO4:** Illustrate the architecture, operation, and applications of long Range and w-power wireless communication Communication Technologies.
- CO5:** Discuss IoT communication protocols such as WirelessHART, Z-Wave, 6LoWPAN, CoAP, and MQTT for smart and industrial applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	2									1
CO3	3	3									1
CO4	3	3									1
CO5	3	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Computer Networks Basics: Basics of Computer Networks, Types of Networks: PAN, LAN, MAN, WAN, OSI Reference Model, TCP/IP Reference Model,

IoT Fundamentals: Introduction, Evolution of IOT, IOT and M2M, IoT communication models, Functionality of Layers in IoT.

UNIT – II

Random Access Protocols: Multiple access Techniques, random access protocols, Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA.

WLAN : Wireless LAN Introduction, WLAN Topologies: Infrastructure and Ad-hoc, Features of IEEE 802.11 Standards (a/b/g/n/ac/ax), Wi-Fi Architecture and Operation, Wired LAN vs Wireless LAN Comparison.

UNIT – III

Short Range Wireless Technologies (WPAN):

Bluetooth protocol, architecture and operation, Bluetooth Low Energy (BLE), IEEE 802.15.4 standard, low-rate WPAN communication principles, ZigBee protocol, architecture and network topologies, RFID communication principles, NFC Technology.

UNIT – IV

Long Range and Low-Power Wireless Communication Technologies:

LPWAN communication, LoRa and LoRaWAN architecture, end devices, gateways and network server, Sigfox Overview, NB-IoT Basics, LTE-M Technology, Introduction to 5G IoT Communication (mMTC, URLLC, eMBB).

UNIT – V

IoT Communication Protocols:

Architecture and Applications of IoT Communication protocols - Wireless HART, Z-Wave, 6LoWPAN, CoAP, MQTT.

Text Books:

1. Ad Hoc and Sensor Networks - Carlos de Morais Cordeiro and Dharma Prakash Agrawal, World Scientific, ISBN: 978-9814338882.
2. Wireless Communications and Networking - Vijay K.Garg, Morgan Kaufmann Publishers, ISBN: 978-0123735805.
3. Internet of Things by Raj Kamal, McGraw-Hill Education. Copyright.

Reference Books:

1. Principles of Wireless Networks - Kaveh Pahlaram, Prashant Krishnamurthy, PHI, ISBN:978-0130930033.
2. Guide to Wireless Communication- Marks Ciampor, Jeorge Olenewa, Cengage Learning, ISBN: 9781111307318.
3. Internet of Things (A Hands-on- Approach) by Vijay Madisetti and ArshdeepBahga, 1 stEdition, VPT, 2014.

Web Links:

1. <https://archive.nptel.ac.in/courses/106/105/106105183/>
2. <https://archive.nptel.ac.in/courses/108/108/108108179/>

3. https://onlinecourses.nptel.ac.in/noc21_cs17/preview?msclkid=16aacd77c08211ec97fb643b5beb9cd2 Introduction to internet of things - Course (nptel.ac.in)
4. [Design for internet of things](#) By Prof. Prabhakar T V | IISc Bangalore [Design for internet of things - Course \(nptel.ac.in\)](#)

System Programming

Course Code: 241EC039

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply the fundamental concepts of C programming and data structures to solve basic computational problems.
- CO2:** Apply knowledge of Linux basics in SHELL programming.
- CO3:** Analyze the components of embedded Linux systems to understand their roles and interactions.
- CO4:** Apply kernel module programming techniques to develop and test basic device driver programs.
- CO5:** Design and implement embedded and Linux-based development environments using state-of-the-art hardware and software tools.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1								
CO2	2	2	1								
CO3	3	3	2								
CO4	3	3	2								
CO5	3	2	3								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Programming Concepts with C and Data Structures:

Basic concepts of C, Embedded C Vs C, Embedded programming aspects with respect to firmware, Bitwise manipulation, Functions, Recursive Functions, Arrays, pointers, Function Pointers, File Handling, Preprocessor Directives, structures, Union, and Inputs/Outputs, static and dynamic memory allocation, Linked list, Single linked list, Double linked list and Queues.

UNIT – II

Linux Essentials with Shell Scripting Techniques

Command prompt, X windows basics, navigating file system, finding files, working with folders, reading files text editing in Linux, Compression and archiving tools, Basic shell commands, File Management, I/O Handling, File Locking. Processes, giving more than one command at a time, prioritizing and killing processes, Scheduling Commands, pipes and

redirection, regular expression, pattern matching, Scripting using for while, if and other commands.

UNIT – III

Embedded Linux Development Essentials:

Introduction to Embedded Linux - Linux Kernel Basics for Embedded Systems - Build Systems and Cross-Compilation - Root Filesystem Essentials - Device Drivers and Hardware Interfacing - Debugging Techniques.

UNIT – IV

Kernel Module Programming:

Compiling kernel, Configuring Kernel and compilation, Kernel code, browsers, Static linking, dynamic linking of modules, User space, kernel space concepts, writing simple modules – Writing, Make-files for modules.

UNIT – V

Device Driver concepts:

Driver concepts, Block & character driver distinction, Low level drivers, OS drivers etc, Writing character drivers – GPIO driver, Device major, minor number.

Text Books:

1. Neil Mathew, Richard stones, Beginning Linux Programming, 2012, 4th Edition, Wrox – Wiley Publishing, USA.
2. Eric Foster Johnson, John C. Welch, Micah Anderson, Beginning shell scripting, 2012, 1st Edition, Wrox – Wiley Publishing, USA.

Reference Books:

1. Derek Molloy, Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux, 2015, 1st Edition, Wiley Publications, USA
2. Frank Vasquez, Profile Icon Chris Simmonds, Mastering Embedded Linux Programming, 2021, 3rd Edition, Packt Publishing, UK.

Web Links:

1. <https://www.coursera.org/specializations/c-programming-linux#courses>
2. <https://www.coursera.org/learn/linux-system-programming-introduction-to-buildroot>

Embedded System Design

Course Code: 241EC034

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the building blocks of an Embedded system.
- CO2:** Interpret the hardware modules required to design an Embedded system.
- CO3:** Infer the firmware design approaches for an Embedded system.
- CO4:** Discuss the functionalities of Real time Operating Systems.
- CO5:** Develop Embedded systems based on their applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2						1	1		1
CO2	3	2	1	1	2			1	1		1
CO3	2	3			2			1	1		1
CO4	2	3			2			1	1		1
CO5	2	2	3	1	2			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction:

Embedded System-Definition, History of embedded system, Characteristics of an embedded system, classification of embedded systems, Embedded System Architecture Quality attributes of embedded systems, Challenges in Embedded System Design, Examples of an embedded system.

UNIT – II

Designing Embedded Computing Platform:

Introduction to Processors & Controllers, Sensors, Actuators, Analog and digital electronic components, I/O types and examples, Memory Classification, Timer and counting devices, Watchdog Timers, RTC, Wireless Protocols.

Practice:

1. Introduce Proteus & create a basic simulation in Proteus and write an Embedded C program to blink an LED?
2. Write an Embedded C Program to interface the switch with a microcontroller in Proteus to control an LED using I/O Ports

UNIT – III**Embedded Firmware:**

Classification of OS, Embedded Firmware design approaches & development languages, POSIX Thread Programming, Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, C versus Embedded C, ALP Programming.

Practice:

1. Write an Embedded C Program to interface a 16×2 LCD with a microcontroller and display messages.
2. Write an Embedded C Program to Interface stepper motor be controlled (CW/CCW rotation and speed control) using a microcontroller and Proteus simulation.

UNIT – IV**Real-Time Operating Systems:**

Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

Practice:

1. Write an Embedded C Program for timer interrupts and external interrupts in a microcontroller demonstrate them through Proteus
2. configure UART serial communication and perform data transmission and reception using Embedded C?

UNIT – V**Embedded System Development:**

The IDE, Types of files generated on cross- compilation, Deassembler/ Decompile, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

Various wireless protocols and its applications: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, Wi-Fi. CAN, Programming in Embedded C, Embedded system design using Arduino.

Practice:

1. Develop an Application to interface a 4×4 keypad with a microcontroller and display the key pressed using LCD or serial terminal in Proteus?
2. Design and simulate a complete embedded system application in Proteus using Embedded C (e.g., password door lock, digital clock, sensor system, etc.)

Text Books:

1. Embedded Systems, Shibu.K. V, Tata McGraw Hill Education Private Limited, ISBN: 978-9339219680.
2. Computers as Components – Principles of Embedded Computing System Design, Marilyn Wolf, Morgan Kaufmann Publisher (An imprint from Elsevier), 3rd Edition, ISBN: 0128053879.

Reference Books:

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, ISBN: 9781222995374.
2. The Designer's Guide to the Cortex-M Processor Family - A Tutorial Approach, Trevor Martin, Elsevier Science, st Edition, ISBN: 9780080982991.

Web Links:

1. http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf
2. <http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>
3. <http://www.vtt.fi/inf/pdf/publications/2004/P526.pdf>

Real Time operating System using QNX

Course Code: 241EC041

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the QNX OS architecture and its microkernel-based design.
- CO2:** Develop and debug QNX-based applications using appropriate tools.
- CO3:** Apply process/thread management and synchronization techniques in QNX.
- CO4:** Implement inter-process communication methods for real-time systems.
- CO5:** Configure and build QNX boot/OS images for specific hardware platforms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2						1
CO2	3	1			2						1
CO3	3	2			2						1
CO4	3	2			2						1
CO5		3			2						1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction to QNX OS Architecture:

Overview of QNX OS architecture: microkernel, process manager, and standards. Protected address spaces, process/thread model, and scheduling. Introduction to inter-process communication (IPC) and synchronization. Resource managers and shared objects.

Practice:

- Introduction to QNX Software and installation
 - QNX SOFTWARE Centre
 - Momentics IDE
 - QNX800
 - VMware Workstation
- Execution of a program-print “hello world” using IDE environment and VMware
- Installing QNX image into Raspberry Pi board- Execution of a program-print “hello world”

UNIT – II

Processes, Threads, and Synchronization:

Process management: creation, termination, and memory protection. Thread management: creation, termination, and synchronization. Synchronization techniques: mutexes, semaphores, and condition variables.

Practice:

1. Multiple Child creation using fork, exec and spawn, detecting termination of a child
2. Multiple thread creation-Thread Synchronization-Thread join and Mutex.
3. Condition variable

UNIT – III

Inter-Process Communication (IPC):

Overview of IPC methods in QNX: message passing, pulses, and shared memory. Comparing IPC methods: advantages and disadvantages.

Practice:

1. IPC-Client Server-Message passing.
2. IPC-Pulse and Name-attach and Name-open
3. IPC-IOV & Pulses events

UNIT – IV

Hardware Programming and Timing:

Hardware access methods: IO-mapped and memory-mapped IO. Interrupt handling and DMA-safe memory allocation. Timing architecture: periodic timing, one-shot timing, and timeouts.

Practice:

1. Simple interrupt handling
2. Implement two processes that communicate via shared memory using shm_open and mmap. One process writes data, and the other reads and displays it.

UNIT – V

Building and Configuring QNX Boot/OS Images:

Overview of QNX boot/OS image structure. Components of a boot image: startup code, kernel, drivers, and scripts. Building and loading boot images onto target hardware. Introduction to resource managers and their implementation.

Practice:

1. BSP Booting
2. Create a new virtual machine image with a larger boot disk.

Web Links:

1. [https://blackberry .qnx.com/en/products/qnx-everywhere](https://blackberry.qnx.com/en/products/qnx-everywhere)
2. <https://gitlab.com/qnx>
3. <https://www.reddit.com/r/QNX/>
4. <https://stackoverflow.com/questions/tagged/qnx>
5. <https://www.youtube.com/qnxcam>

Machine Learning for Embedded System

Course Code: 241EC033

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand ML fundamentals and TinyML concepts.
- CO2:** Apply neural network training and optimization techniques.
- CO3:** Apply ML algorithms for embedded applications.
- CO4:** Discuss deep learning architectures for embedded systems.
- CO5:** Apply deployment frameworks for real-world embedded AI applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2								1	
CO2	3	3	2							1	
CO3	2	3	2							1	
CO4	2	2	3							1	
CO5	2	2	3							1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Foundations of Machine Learning in Embedded System:

Various paradigms of learning problems, Forms of Learning: Supervised, and Unsupervised algorithms, Reinforcement Learning, Machine Learning Terminologies and Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-Score, training, testing, validation, cross-validation, overfitting, underfitting, early stopping, regularization, bias and variance, Introduction to TinyML and Edge AI.

UNIT – II

Neural Networks and Model Training:

Differences between Biological and Artificial Neural Networks - General Architecture, Multi-layer neural network, Linear Separability, Perceptron, Adaline, Standard Back propagation, Training Algorithms for Pattern Association - Hebb rule and Delta rule,

Gradient descent, Boltzmann Machine Learning, Model training vs inference on embedded systems, Lightweight Neural Network deployment strategies -quantization, and pruning.

UNIT – III

Advanced Machine Learning Techniques:

Feature Engineering, Dimensionality Reduction, Classifiers: K-Nearest Neighbour (KNN), Support Vector Machine (SVM), Decision Trees, Naïve Bayes, Binary Classification, Multi-class Classification, Clustering, Ensemble learning, Low-power classification methods for Embedded controllers.

UNIT – IV

Deep Learning Architectures:

Convolutional Neural Networks: Convolution layers, Pooling layers, Fully connected layers, Advanced CNN models: Alexnet, VGGnet, ResNet, Handling overfitting in CNN: drop out, transfer learning, data augmentation, Recurrent Neural Networks, Structure of RNN Cell, LSTM and GRU, Autoencoders: Convolutional Autoencoders, Denoising Autoencoders, Variational Autoencoders, Lightweight DL architectures for embedded systems: Squeeze Net, MobileNetV3, and Tiny-YOLO.

UNIT – V

Generative Models, Deployment and Real-World Applications:

Generative Adversarial Networks (GANs): The Discriminator, Generator, Introduction to BERT Transformer, Real-world applications in NLP, Computer Vision, Healthcare, and Finance, Deployment frameworks: TensorFlow Lite, PyTorch Mobile.

Text Books:

1. ShaiShalev-Shwartz and Shai Ben-David, Understanding Machine Learning, 2017,1st Edition, Cambridge University Press., ISBN: 978-1107057135.
2. Ian Good fellow, Yoshua Bengio and Aaron Courville, Deep Learning, 2016, MIT Press, ISBN: 9780262035613.

Reference Books:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012,1st Edition, PHI learning.ISBN: 9780132610667.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, 2009,2nd Edition, Springer Series. ISBN: 9780387848846.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, 2016, Springer, ISBN: 978-0-387-31073-2.

Web Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee53
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs74

Hardware & Software Co-Design

Course Code:241EC035

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Analyze embedded system's hardware and software design issues.
- CO2:** Develop the applications on 8051, ADSP2106 and TMS320C60 processors.
- CO3:** Explain modern embedded architectures and compilation technologies.
- CO4:** Interpret the Design, co design by using design verification tools.
- CO5:** Develop a system from system level specification languages.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3									
CO2	2	2	2								
CO3	3										
CO4	3	1									
CO5	2	2	1								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Co- Design Issues: Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.

Co-Synthesis Algorithms: Hardware software synthesis algorithms, hardware, software partitioning distributed system co synthesis.

UNIT – II

Prototyping and Emulation: Prototyping and emulation techniques, prototyping and emulation environments.

Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Architecture for control dominated systems (8051-Architectures), Architecture for Data dominated systems (ADSP21060).

UNIT – III

Compilation Techniques and Tools for Embedded Processor Architectures: Modern embedded architectures(MMDSP Processor), embedded software development needs, compilation technologies.

UNIT – IV

Design Specification and Verification: Design,co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, interface verification.

UNIT – V

Languages for System – Level Specification and Design-I: System – level specification, design representation for system level synthesis, system level specification languages. **Languages for System-Level Specification and Design-II:** Heterogeneous specifications and multi-language co-simulation.

Text Books:

1. Hardware / Software Co- Design Principles and Practice, Jorgen Staunstrup, Wayne Wolf, Springer, ISBN: 978-1441950185.
2. Hardware / Software Co- Design, Giovanni DeMicheli, Mariagiovanna Sami, Kluwer Academic Publishers, ISBN: 978-0792338833.

Reference Books:

1. A Practical Introduction to Hardware/Software Co-design, Patrick R.Schaumont, Springer Publications, ISBN: 978-1441959997.

Web Links:

1. <https://embedded.eecs.berkeley.edu/Research/hsc/abstract.html>
2. <http://ieeexplore.ieee.org/document/6172642/>
3. <http://www.tik.ee.ethz.ch/education/lectures/hswcd/>
4. <http://ieeexplore.ieee.org/document/715400/>

Minor Stream: Signal Processing and Communication Technology

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC045	Fundamentals of Speech Processing	IC	2		1	3	50	50	100	S&S
241EC046	Information Theory & Coding Techniques	IC	2		1	3	50	50	100	-
241EC044	Digital Signal Processors & Architectures	IC	3			3	50	50	100	DSP
241EC043	Digital Image Processing	IC	2		1	3	50	50	100	S&S
241EC049	Radar Engineering	IC	3			3	50	50	100	ADCM
241EC051	Soft Computing Techniques	AC	3			3	50	50	100	-
241EC047	Optical Communications	AC	3			3	50	50	100	ADCM
241EC050	Satellite Communications	AC	3			3	50	50	100	ADCM
241EC048	Pattern Recognition	AC	2			2	50	50	100	DIP
241EC052	Wireless Communications	AC	3			3	50	50	100	ADCM
241EC053	Wireless Sensor Networks	AC	3			3	50	50	100	IOT
Total			29		3	32				

Fundamentals of Speech Processing

Course Code: 241EC045

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Interpret the basic concepts of speech production and perception.
- CO2:** Classify the concepts of analysis and processing of speech signals .
- CO3:** Analyze the enhancement of speech signals in the presence of different background noises.
- CO4:** Interpret the concepts pattern recognition system and different statistical modeling approaches.
- CO5:** Analyze the applications of speech processing including speaker recognition and speech recognition.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3		1			1	1		1
CO2	2	3			1			1	1		1
CO3	2	3	2		1			1	1		1
CO4	2	3	2		1			1	1		1
CO5	2	2	3		1			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction to Speech Processing:

Speech Fundamentals, Speech production and perception, information sources in speech signal, linguistic aspect of speech, acoustic and articulatory phonetics, nature of speech, models for speech analysis and perception, short-term processing of speech, time, frequency and time-frequency analysis, development of short-term Fourier transform (STFT), transform and filter-bank views of STFT.

Practice:

1. Manual speech signal-to-symbol transformation for speech signal.
2. Time-varying nature of the speech signal in the time domain as well as frequency domain.

UNIT – II

Speech Analysis:

Basis and development cepstrum analysis of speech, real and complex cepstrum, pitch detection, formant estimation, Mel-frequency cepstral coefficient (MFCC), delta and delta-delta MFCC, Linear Prediction (LP) analysis, LP analysis of speech, solution of LP equation using Levinson-Durbin's method, normalized error, LP spectrum, LP cepstrum, LP residual.

Practice:

1. Analyze speech signals by computing the cepstrum for various voiced and unvoiced sounds.
2. Analyze the characteristics of speech using linear prediction (LP) analysis.

UNIT – III

Speech enhancement:

objective, issues, enhancement of noisy speech, reverberant speech and multi-speaker speech using time, frequency and time-frequency approaches.

Practice:

1. Spectrographic Analysis of voiced, unvoiced and plosive Speech.
2. Short-time spectrum analysis of speech signals, the effect of size of the analysis window (less than one pitch period, one pitch period, two to four pitch periods).

UNIT – IV

Basic concepts of pattern recognition:

Feature extraction, modeling, testing, Objective, issues, block diagram description of automatic speech recognition (ASR) system, development of ASR system using vector quantization (VQ), dynamic time warping (DTW), Hidden Markov Model (HMM) and Neural networks (NN).

Practice:

1. Analyze speech signals by computing the cepstrum for various voiced and unvoiced sounds.
2. Analyze effects of sampling (aliasing) and quantization on speech signals by playing them at different sampling rates and bits per sample.

UNIT – V

Speech Recognition:

Objective, issues, block diagram description of speaker recognition system, classification of speaker recognition systems, development of speaker recognition system using VQ, Gaussian mixture model (GMM), Adapted-GMM and I-vector.

Practice:

1. Speaker voice activity detection in speech.
2. Reconstruct the spectrum of various components (source, system) using the spectrum.

Text Books:

1. Digital Processing of Speech Signals, L.R. Rabiner and R.W. Schafer, Pearson Education, Delhi, India, ISBN: 978813170513.
2. Fundamentals of speech recognition, L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana, Pearson Education, ISBN: 8177585606.

Reference Books:

1. Discrete-Time Processing of Speech Signals, J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Wiley-IEEE Press, NY, USA, ISBN: 0780353862.
2. Discrete time processing of speech signals, T. F. Quatieri, Pearson Education, ISBN: 013242942X.
3. Speech and Audio Processing, Dr.Shaila D.Apte -, First Edition, WILEY, ISBN: 978-8126534081.
4. Statistical Methods of Speech Recognition, Frederick Jelinek, MIT Press, 2022, ISBN: 9780262546607.

Web Links:

1. <https://archive.nptel.ac.in/courses/117/105/117105145/#/> Prof. S.K. Das Mandal
2. <https://www.cse.iitb.ac.in/~pjyothi/cs753/index.html/> Prof. Preethi Jyothi
3. <https://ssp-iiith.vlabs.ac.in/Introduction.html/> Speech Signal Processing Lab
4. <https://vlab.amrita.edu/index.php?sub=59&brch=164/> Speech Signal Processing Lab

Information Theory & Coding Techniques

Course Code: 241EC046

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the basics of Information theory.
- CO2:** Implement the various types of source coding algorithms and analyze their performance.
- CO3:** Design a channel coding scheme for a communication system.
- CO4:** Discuss the different types of entropy and coding theorem for Gaussian channels.
- CO5:** Evaluate the performance of coding techniques and error corrections.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1				1	2	1		1
CO2	3	3	1				1	2	1		1
CO3	3	3	2				1	2	1		1
CO4	2	3	2				1	2	1		1
CO5	2	3	2				1	2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Information Theory:

Entropy, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information, Chain Rules, Data-Processing Inequality, Fano's Inequality.

Practice:

1. Write a program using matlab for the determination of various entropies and mutual information of a given channel. Test various types of channel such as
 - a) Noise free channel b) Error free channel c) Binary symmetric channel
 - d) Noisy channel

UNIT – II

Source Coding:

Shannon –Fano Coding, Optimality of Huffman Coding, Capacity of a Gaussian channel, bandwidth –S/N trade off, Capacity of discrete channels, Related Problems.

Practice:

1. Minimize coding redundancy using Source Encoder and Decoder using hardware kit.
2. Analyze the channel coding techniques in time and frequency domain using hardware kit.
3. Write a program for generation and evaluation of variable length source coding using matlab.
a) Shannon – Fano coding and decoding.
4. Write a program for generation and evaluation of variable length source coding using matlab.
a) Huffman coding and decoding.

UNIT – III**Linear Block Codes:**

Introduction, Matrix description of Linear Block Codes, Error detection and error correction capabilities of Linear block codes, Hamming codes, Binary Cyclic Codes, Algebraic structure, Encoding, Syndrome calculation, BCH Codes.

Practice:

1. Perform error detection and correction using Linear Block Code-Encoder and Decoder using hardware kit.
2. Write a program for encoding and decoding of BCH codes using matlab.

UNIT – IV**Cyclic Codes:**

Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes, shortened cyclic codes – Turbo code.

Practice:

1. Perform error detection and correction using Binary Cyclic Code – Encoder and Decoder using hardware kit.

UNIT – V**Convolutional Codes:**

Encoding of Convolutional Codes- Structural and Distance Properties, state, tree, trellis diagrams, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system. Low Density Parity Check (LDPC) codes.

Practice:

1. Perform error detection and correction using Convolution Code – Encoder and Decoder using hardware kit.
2. Implementation of ARQ technique using matlab.

Text Books:

1. Information theory and coding - K. N. Hari Bhat , D. Ganesh Rao ,Cengage India Private Limited, First Edition, ISBN: 978-9386650924.
2. Information theory and coding by Anoop Singh poonia,Rupal Bansal,Ashirwad publisher,Fifth Edition, ISBN: 8190571109.

Reference Books:

1. Digital Communications, John Proakis, TMH, 5th Edition, ISBN: 978-0072957167.
2. Information Theory and Coding (Wiley India: 2015) by Dr. Mrualidhar Kulkarni Dr. Shivaprakash K S, Wiley, 2nd Edition, ISBN: 9788126553051.

Web Links:

1. [NPTEL :Electrical Engineering - NOC:Information Theory, Coding and Cryptography by IIT Delhi.](https://archive.nptel.ac.in/courses/108/102/108102117/)
<https://archive.nptel.ac.in/courses/108/102/108102117/>
2. <https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee39/>

Digital Signal Processors & Architectures

Course Code:241EC044

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the concepts of number formats and various DSP related errors.
- CO2:** Illustrate the architectural features of Programmable digital signal processors.
- CO3:** Infer the TMS320C54XX processor architecture details, addressing modes and on-Chip peripherals.
- CO4:** Implement the basic DSP algorithms using digital signal processors.
- CO5:** Interpret the interfacing of devices with digital signal processors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	1									1
CO3	2	3	1								1
CO4	2	3	2								1
CO5	2	3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Computational Accuracy in DSP implementations:

Review of Digital signal processing, Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors.

UNIT – II

Architectures for Programmable DSP Devices:

Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.

UNIT – III

Programmable Digital Signal Processors:

Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX Instructions and Programming, On Chip Peripherals, Interrupts of TMS320C54XX Processors, Pipeline Operation of TMS320C54XX Processors. Architectural features of TMS320C67XX Processors.

UNIT – IV

Implementations of basic DSP algorithms:

The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX, Computation of the signal spectrum.

UNIT – V

Interfacing Memory and I/O Peripherals to Programmable DSP Devices:

Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts, Direct memory access (DMA).

Text Books:

1. Digital Signal Processing, Avtar Singh and S. Srinivasan, Thomson Press, ISBN: 9788131500347.
2. Digital Signal Processing: Principles, Algorithms & Applications – J.G. Proakis & D.G. Manolakis, PHI, 4th Edition, ISBN: 9788131710005..

Reference Books:

1. A Practical Approach to Digital Signal Processing, K Padmanabhan, R.Vijayarajeswaran, and Ananthi S, New Age International, 2nd Edition, ISBN: 978-8122432428.
2. Embedded Signal Processing with the Micro Signal Architecture, Woon-Seng Gan, and Sen M. Kuo, Wiley-IEEE Press, 1st Edition, ISBN. 978-0471738411.
3. DSP Processor Fundamentals, Architectures & Features, Lapsley et al, S. Chand &Co, 1st Edition, ISBN: 978-8126523542.

Web Links:

1. <https://nptel.ac.in/courses/108/101/108101174> NPTEL course on “Digital Signal Processing and its Applications”.
2. <https://nptel.ac.in/courses/108106149> NPTEL course on “Mapping Signal Processing Algorithms to Architectures”.
3. <https://www.analog.com/en/design-center/landing-pages/001/beginners-guide-to-dsp.html>

Digital Image Processing

Course Code: 241EC043

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Interpret the concepts of digital image processing and image transforms.
- CO2:** Apply spatial and frequency domain techniques for image enhancement and Restoration.
- CO3:** Apply discontinuity and similarity based techniques for image segmentation.
- CO4:** Perform compression techniques for images.
- CO5:** Utilize color models for image processing applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	1	1			1	1		1
CO2	3	2	2	1	1			1	1		1
CO3	3	2	2	1	1			1	1		1
CO4	3	2	2	1	1			1	1		1
CO5	3	2	2	1	1			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction: Introduction to Image Processing, Fundamental steps in digital image processing, Components of an image processing system, Image sensing and acquisition, Image sampling and quantization, Some basic relationships between pixels, An introduction to the mathematical tools used in digital image processing.

Image Transforms: Need for image transforms, Discrete Fourier transform (DFT) of one variable, Extension to functions of two variables, some properties of the 2-D Discrete Fourier transform, Importance of Phase, DCT, DST, Walsh-Hadamard transform, KLT, Haar transform, Radon Transform

Practice:

1. Compute arithmetic and logical operations on images
2. Compute DFT, DCT and DST of an image also calculate phase

UNIT – II

Image Enhancement: Back ground, basic intensity transformation methods, histogram processing, fundamentals of spatial filtering, smoothing and sharpening spatial filters, Combining spatial enhancement methods. The basics of filtering in the frequency domain, image smoothing and sharpening using frequency domain filters, selective filtering.

Practice:

1. Obtain the enhancement of a low contrast image using histogram equalization
2. Perform unsharp masking and high boost filtering to sharpen the image.

UNIT – III

Image Restoration and Reconstruction: A model of the image degradation/ Restoration process, Noise models, restoration in the presence of noise only- Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position –Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering, constrained least squares filtering, geometric mean filter.

Practice:

1. Compute the denoised image using mean filters for the removal of noise and compare the results in terms of PSNR.
2. Compute the denoised image using order-statistics filters for the removal noise and compare the results in terms of PSNR.
3. Perform deblurring using inverse filter and Wiener filter.

UNIT – IV

Image Segmentation: Fundamentals, point, line, edge detection, thresholding, region – based segmentation, Hough Transform.

Image Compression: Fundamentals, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Symbol-Based coding, Bit-Plane coding, Block Transform coding, Predictive coding.

Practice:

1. Compute the edge of an image using Sobel and Prewitt operator.
2. Compress image using Huffman coding and Arithmetic coding techniques

UNIT – V

Color Image Processing: Color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening. Image segmentation based on color, noise in color images.

Morphological Image Processing: Dialation, Erosion, Opening, Closing.

Practice:

1. Compute smoothing on color images with and without noise
2. Compute sharpening on color images

Text Books:

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 4th Edition, 2018, ISBN: 978-9353062989
2. Digital Image Processing, Jayaraman, S. Esakkiraja and T. Veerakumar, Tata McGrawHill Education, 2nd Edition, ISBN: 9780070144798

Reference Books:

1. Fundamentals of Digital Image Processing, Anil K. Jain, Prentice Hall of India, 9th Edition, ISBN: 978-9332551916.
2. Digital Image Processing, S Sridhar, Oxford higher Education Publication, 2nd Edition, ISBN: . 978-0199459353.
3. Digital Image Processing using MATLAB, R. C. Gonzalez and R. E. Woods, Prentice Hall, 3rd Edition, ISBN: 978-0131687288.

Web Links:

1. [http://nptel.ac.in/courses/117105079/\(Digital Image Processing, IIT Kharagpur Prof. P.K. Biswas\)](http://nptel.ac.in/courses/117105079/(Digital%20Image%20Processing,%20IIT%20Kharagpur%20Prof.%20P.K.%20Biswas))
2. [https://www.coursera.org/learn/digital#ratings\(Fundamentals of digital image and video processing, Aggelos K. Katsaggelos, University of North westren\)](https://www.coursera.org/learn/digital#ratings(Fundamentals%20of%20digital%20image%20and%20video%20processing,%20Aggelos%20K.%20Katsaggelos,%20University%20of%20North%20westren))
3. <https://sisu.ut.ee/imageprocessing/avaleht>

RADAR Engineering

Course Code: 241EC049

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Model the RADAR range equation.
- CO2:** Outline the working principle of CW and FM-CW RADARs.
- CO3:** Illustrate the principle of MTI RADAR and its characteristics.
- CO4:** Infer the RADAR tracking techniques.
- CO5:** Analyze matched filter receiver characteristics and subsystems of RADAR receiver.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	2	3									1
CO3	3	2									1
CO4	3	2									1
CO5	2	3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Basics of Radar:

Introduction, nature of radar, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Illustrative Problems. Radar Equation: Modified Radar Range Equation, SNR, probability of detection, probability of False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.

UNIT – II

CW and Frequency Modulated Radar:

Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. Illustrative Problems. FM-CW Radar, FM-CW altimeter, Multiple Frequency CW Radar.

UNIT – III

MTI and Pulse Doppler Radar:

Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Range Gated Doppler Filters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar.

UNIT – IV

Tracking Radar:

Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers.

UNIT – V

Detection of Radar Signals in Noise:

Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation detection and Cross-correlation Receiver, Efficiency of Non-Matched Filters, Matched Filter with Non-white Noise, Noise Figure and Noise Temperature.

Radar Receivers: Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Series versus parallel feeds, Applications, Advantages and Limitations, Radomes.

Text Books:

1. Introduction to Radar Systems, Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, ISBN: 9780070634411.
2. Radar: Principles, Technology, Applications, Byron Edde, Pearson Education, ISBN: 9788131713839.

Reference Books:

1. Radar Principles – Peebles, Jr., P.Z., Wiley, New York, ISBN: 9780471252054.
2. Radar Handbook, Merrill I. Skolnik, McGraw Hill, Third, 3rd Edition, ISBN: 9780471252054.
3. Introduction to Radar System, KK Sharma, S.K. Kataria & Sons, 1st Edition, 2023, ISBN: 9789350142615.

Web Links:

1. <https://www.jlab.org/ir/MITSeries/V1-1.pdf>
2. <https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems-spring-2007/>, Dr. Robert M. O'Donnell
3. [https://onlinecourses.nptel.ac.in/noc24_ee104/previewPrinciples and Techniques of Modern Radar Systems Dr. Amitabha Bhattacharya, IIT Kharagpur- NPTEL course](https://onlinecourses.nptel.ac.in/noc24_ee104/previewPrinciples_and_Techniques_of_Modern_Radar_Systems_Dr._Amitabha_Bhattacharya,_IIT_Kharagpur-NPTEL_course)

Soft Computing Techniques

Course Code: 241EC051

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Discuss the basic concepts of soft computing techniques.
- CO2:** Explain Fuzzy systems, components and their applications.
- CO3:** Demonstrate Fuzzy modeling and control schemes for nonlinear systems.
- CO4:** Infer Genetic Algorithm for solving the optimization problems.
- CO5:** Develop proficiency in the Back Propagation algorithm for training Multilayer Perceptron networks.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	3									
CO3	3	3	1								
CO4	2	3	1								
CO5	2	3	1								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction:

Concept of computing systems, Soft computing versus Hard computing, Characteristics of Soft computing, Introduction to Fuzzy Computing, Neural Computing, Some applications of Soft computing techniques.

UNIT – II

Fuzzy Sets and Fuzzy Logic:

Introduction, Fuzzy Sets Versus Crisp Sets, Operations on Fuzzy Sets, Extension Principle, Fuzzy Relations and Relation Equations, Fuzzy Numbers, Linguistic Variables, Fuzzy Logic, Linguistic Hedges, Applications.

UNIT – III

Inference in Fuzzy Logic:

Fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzifications, Inferencing, and De-fuzzifications, Fuzzy modeling and control schemes for nonlinear systems, Fuzzy Pattern Recognition, Fuzzy Image Processing, Fuzzy Database.

UNIT – IV

Genetic Algorithm:

Basic concept of Genetic algorithm and detail algorithmic steps, Search space, working principle. Encoding: binary, Octal, Hexadecimal, permutation, Value and Tree. Decoding, fitness function, Selection: Roulette wheel, Boltzmann, Tournament, Rank and Steady-state. Crossover: single-point, two-point, multi-point, uniform, matrix and crossover rate, Mutation: mutation, mutation rate, Ant-colony optimization, Particle Swarm Optimization, Solving problems using GA.

UNIT – V

Artificial Neural Networks:

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, Single Neuron/Perceptron networks: training methodology, Typical application to linearly separable problems. Feed-forward Multilayer Perceptron, Multilayer Perceptron: Back propagation algorithm, virtues and limitation of BP algorithm, Modifications to back-propagation, Hopfield network.

Text Books:

1. Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, 2nd Edition, S. Rajasekharan, G. A. Vijayalakshmi Pal, Prentice Hall India, ISBN : 978-8120353343
2. Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering, Nikola K. Kasabov, MIT Press, ISBN : 0-262-11212-4

Reference Books:

1. Neural Networks and Learning Machine, Simon Haykins, Prentice Hall India, 3rd Edition, ISBN: 978-0-13-147139-9
2. Fuzzy Logic with Engineering Application, Timothy J. Ross, Wiley, 3rd Edition, ISBN: 0-470-86075-8

Web Links:

1. <https://archive.nptel.ac.in/courses/106/105/106105173/> (Prof. Debasis Samanta, IIT Kharagpur)
2. https://onlinecourses.nptel.ac.in/noc21_ge07/preview
3. <https://www.udemy.com/course/geneticalgorithm/?couponCode=LEADERSALE24A>
4. <https://www.udemy.com/course/fuzzylogic/>

Optical Communications

Course Code: 241EC047

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Realize the significance of optical fiber communications.
- CO2:** Recognize the construction and characteristics of optical fiber cable.
- CO3:** Illustrate the knowledge of optical signal sources and power launching.
- CO4:** Examine and understand the operation of various optical detectors.
- CO5:** Summarize the performance metrics of optical systems and WDM system.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2								1
CO2	3	1	3								1
CO3	2	3	2								1
CO4	3	2	2								1
CO5	2	3	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Overview of Optical Fiber Communication:

The general optical fiber communication system, Optical fiber wave guides, Ray theory transmission, Total Internal Reflection, acceptance angle, Cylindrical fibers- Modes Fiber materials, fiber fabrication techniques, fiber optic cables, classification of Optical Fibers: single mode fibers, graded index fibers.

UNIT – II

Signal Distortion In Optical Fibers:

Attenuation, absorption, scattering and bending losses, core and cladding losses, information capacity determination, group delay, Types of dispersion - material dispersion, wave-guide dispersion, polarization mode dispersion, intermodal dispersion, pulse broadening.

UNIT – III

Optical Sources:

Intrinsic and extrinsic materials-direct and indirect band gaps-LED-LED structures surface emitting LED-edge emitting LED-quantum efficiency and LED power-light source materials modulation of LED.

UNIT – IV

Optical Detectors:

Physical principles of PIN and APD, detector response time, temperature effect on avalanche gain, comparison of photo detectors.

UNIT – V

Optical System Design:

Considerations, component choice, multiplexing, point-to-point links, system considerations, link power budget with examples. WDM –passive DWDM components-elements of optical networks-SONET/SDH.

Text Books:

1. Optical Fiber Communications, Gerd Keiser, Tata Mc Graw-Hill International edition, 5th Edition, ISBN: 978-1259006876.
2. Optical Fiber Communications , John M. Senior, PHI, 3rd Edition, ISBN: 978-9332535787

Reference Books:

1. Fiber Optic Communication, J. C. Palais, Pearson Prentice Hall, ISBN: 978-8131717912.
2. Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson Prentice Hall, 2nd Edition, ISBN: 978-0132151498.

Web Links:

1. <http://nptel.ac.in/courses/117104127/2>, Prof. Shanti Bhattacharya, IIT Madras.
2. <https://www.linktionary.com/f/fiber-optic.html>

Satellite Communications

Course Code: 241EC050

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the trends of satellite communications.
- CO2:** Illustrate the orbital effects on satellite communication and associated sub systems.
- CO3:** Compare the multiple access techniques.
- CO4:** Analyze the parameters to enhance the satellite link performance and the satellite based link designs.
- CO5:** Outline the satellite-based navigation systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2								1
CO2	3	2	2								1
CO3	2	3	2								1
CO4	2	2	3								1
CO5	2	2	2								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction:

Origin of satellite communications, historical back-ground, basic concepts of satellite communications, frequency allocations for satellite services, future trends of satellite communications. Orbital mechanics and launchers: orbital mechanics, look angle determination, orbital perturbations, orbital determination, launches and launch vehicles, orbital effects in communication systems performance.

UNIT – II

Satellite Subsystems:

Introduction-attitude and orbit control system, telemetry, tracking, commanding and monitoring, power systems, communication subsystems, satellite antennas subsystems, propulsion subsystems equipment reliability and space qualification.

UNIT – III

Multiple Accesses Techniques:

Frequency Division Multiple Access (FDMA), intermodulation, calculation of C/N. Time Division Multiple Access (TDMA), frame structure, slotted aloha spread spectrum methodology.

UNIT – IV

Satellite Link Design:

Basic link analysis, uplink and downlink design equation, free space loss-atmospheric effects, ionospheric scintillation, rain induced attenuation and interference, system noise temperature, link design with and without frequency reuse.

UNIT – V

Satellite Applications:

Mobile satellite services: GSM, LEO, MEO, Satellite Navigational System-GPS, Satellite applications, VSAT , DTH television principles – Direct broadcast radios ,INSAT ,IRS satellites ,PSLVs ,GSLVs.

Text Books:

1. Satellite Communications ,Timothy Pratt & Jeremy Allnutt, WSE, John Wiley & Sons Publications, 3rd Edition, October2019, ISBN:978-1119482178.
2. Satellite Communications Engineering-,Wilbur L. Pritchard, Robert A Nelson, and Henri G. Suyderhoud, Pearson Publications, 2ndEdition, ISBN: 978-0137914685.

Reference Books:

1. Satellite Communication, D.C Agarwal & Rishabh Anand, Khanna Publications, 1stEdition, 2021, ISBN: 978-8194752844.
2. Satellite Communications: Design Principles- M. Richharia, B S publications, 2ndEdition, ISBN: 978-0070523746.

Web Links:

1. <https://archive.nptel.ac.in/courses/117/105/117105131/>,Prof. Kalyan Kumar Bandyopadhyay, IIT Kharagpur.
2. <https://www.coursera.org/learn/satellite-communications>.

Pattern Recognition

Course Code: 241EC048

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the various techniques involved in pattern recognition.
- CO2:** Categorize the various pattern recognition techniques into supervised and unsupervised.
- CO3:** Illustrate the artificial neural network-based pattern recognition.
- CO4:** Discuss the applications of pattern recognition in various applications.
- CO5:** Evaluate the performance of speech recognition systems and optimize them for real-world applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2								
CO2	3	3	2								
CO3	3	2	3								
CO4	2	2	2								
CO5	3	3	3								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction:

Fundamental concepts and blocks of a typical pattern recognition system. Decision functions- role and types, pattern and weight space, properties and implementation of decision functions.

UNIT – II

Feature Identification and Feature Selection:

Feature identification, selection and extraction. Distance measures, clustering transformation and feature ordering, clustering in feature selection, feature selection through maximization and approximations.

UNIT – III

Pattern Classification:

Pattern classification by distance functions. Clusters and cluster seeking algorithms. Pattern classification by likelihood functions. Baye's classifier and performance measures.

UNIT – IV

Artificial Neural Network:

Artificial neural network model, Neural network-based pattern associators, Feed forward networks and training by back-propagation- ART networks.

UNIT – V

Applications of Statistical and Neural Network:

Applications of statistical and neural network – based pattern classifiers in speech recognition, image recognition and target recognition.

Text Books:

1. Pattern Recognition Principles by J.I. Tou & R.C. Gonzalez, Addison-Wesley, ISBN: 9780201075878.
2. Pattern Recognition - Statistical, Structural and Neural Approaches by R. Schalkoff, John Wiley, ISBN: 978-8126513703.

Reference Books:

1. Pattern Recognition - A Statistical Approach by P.A. Devijer & J. Kittler, Prentice-Hall, ISBN: 978-0136542360.
2. Pattern recognition and machine learning by Christopher. M. Bishop, Springer, ISBN: 978-1493938438.

Web Links:

1. <https://www.geeksforgeeks.org/pattern-recognition-introduction>
2. <https://archive.nptel.ac.in/courses/117/105/117105101/>

Wireless Communications

Course Code: 241EC052

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the basic concepts of cellular networks.
- CO2:** Interpret concepts of mobile radio propagation.
- CO3:** Distinguish the concepts of modulation techniques and diversity.
- CO4:** Analyse the concepts of multiple access techniques.
- CO5:** Infer the wireless networking methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1								1
CO2	2	2	1								1
CO3	2	2	1								1
CO4	2	2	1								1
CO5	2	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Cellular System Design:

Introduction-frequency reuse, channel assignment strategies, Handoff strategies: prioritizing handoffs, practical handoff considerations, Interference and system capacity: Co-channel interference and system capacity, channel planning for wireless systems, adjacent channel interference, power control for reducing interference, trunking and grade of service.

UNIT – II

Mobile Radio Propagation:

Large scale path loss: Introduction to radio wave propagation, free space propagation model, small scale multipath propagation, fading effects due to multipath time delay spread, fading effects due to Doppler spread.

UNIT – III

Modulation Techniques and Diversity:

Digital Modulation: Factors that influence the choice of digital modulation, Spread Spectrum Modulation Techniques: Pseudo- Noise (PN) Sequences, Direct Sequence Spread Spectrum (DS-SS) - Diversity techniques: Practical space diversity considerations, polarization diversity, frequency diversity, time diversity.

UNIT – IV

Multiple Access Techniques:

Introduction to multiple access-Spread Spectrum Multiple Access, Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Space Division Multiple Access (SDMA), Packet Reservation Multiple Access (PRMA), Capacity of Cellular Systems.

UNIT – V

Wireless Networking:

Network transmission hierarchy, traffic routing in wireless networks: Circuit switching, packet switching, cellular packet, switched architecture, network databases: distributed database for mobility management, Universal Mobile Telecommunication Systems (UMTS).

Text Books:

1. Wireless Communications, Rappaport, Pearson Education, 2nd Edition, ISBN: 9788131731864
2. Wireless Communication, Andrea Goldsmith, Cambridge University Press, ISBN: 9780521837163

Reference Books:

1. Wireless Communications, Andreas.F. Molisch, John Wiley, India, 3rd Edition, November 2022, ISBN: 9781119117209
2. Wireless Communication, Upena Dalal, Oxford University Press, 1st Edition, ISBN: 9780198060666

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ee66/preview, by Prof. R. David Koilpillai, IIT, Madras.
2. <https://archive.nptel.ac.in/courses/117/104/117104117/> by Prof. Aditya K Jagannatham, IIT, Kanpur.

Wireless Sensor Networks

Course Code: 241EC053

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify the components of Wireless Sensor Networks.
- CO2:** Develop node architecture for specific applications.
- CO3:** Realize the challenges in establishment of infrastructure.
- CO4:** Program sensor network platforms using specialized operating system.
- CO5:** Summarize the challenges in Sensor Network protocols.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2								1
CO2	3	2	3								1
CO3	2	3	2								1
CO4	2	2	2								1
CO5	2	1	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction:

Constraints and Challenges, Opportunities and Challenges in Wireless Sensor Networks, Advantages of Sensor Networks (Energy Advantage and Detection Advantage), Sensor Network Applications, Smart Transportation, Collaborative Processing

UNIT – II

Sensor Network Architecture and Applications:

Introduction, Functional Architecture for Sensor Networks, Sample Implementation Architectures, Classification of WSNs, Characteristics, Technical Challenges, and Design Directions, Technical Approaches, Coverage in Wireless Sensor Networks, Location in Wireless Sensor Networks, Data Gathering and Processing.

UNIT – III

Infrastructure Establishment:

Topology Control, Clustering, Time Synchronization, Localization and Localization Services.

UNIT – IV

Sensor Network Platforms and Tools:

Individual Components of SN Nodes, Sensor Network Node, WSNs as Embedded Systems, Sensor Node Hardware, Sensor Network Programming Challenges.

UNIT – V

Taxonomy of Routing Techniques:

Routing Protocols, Applications/Application Layer Protocols, Localization Protocols, Time Synchronization Protocols, Transport Layer Protocols, Network Layer Protocols, Data Link Layer Protocols.

Text Books:

1. Wireless Sensor Networks, F. Zhao, C Guibas, Morgan Kaufmann, Elsevier, ISBN: 978-1558609143.
2. Hand book of Sensor Networks, Mohammad Ilyas, Imad Mahgoub, , CRC Press, ISBN: 9780429205576.

Reference Books:

1. Wireless Sensor Networks- Technology, Protocols, and Applications, Kazem Sohraby, Daniel Minoli, & Taieb Znati, John Wiley, ISBN: 978-0-470-11275-5.
2. Wireless Sensor Networks- An Information Processing Approach, Feng Zhao & Leonidas J. Guibas, Elsevier, ISBN: 9781558609143.

Web Links:

1. <https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-cs07/>, Prof.S Misra, IIT-Madras
2. [https://onlinecourses.nptel.ac.in/noc22_ee72/preview,Prof.Aditya_K_Jagannatham, IIT-Madras.](https://onlinecourses.nptel.ac.in/noc22_ee72/preview,Prof.Aditya_K_Jagannatham,IIT-Madras)

Minor Stream: Space Technology

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC054	Introduction to Space Laws	IC	3			3	50	50	100	-
241EC055	Aircraft Communication Systems	IC	3			3	50	50	100	-
241EC057	Aircraft Navigation Systems	IC	3			3	50	50	100	-
241EC062	Missile & Space Vehicle Guidance & Control	IC	2			2	50	50	100	-
241EC060	Flight Control Systems	IC	3			3	50	50	100	-
241EC058	Avionics Embedded Systems	IC	3			3	50	50	100	-
241EC059	Avionics Network Technology	AC	3			3	50	50	100	-
241EC064	Unmanned Aircraft Systems	AC	3			3	50	50	100	-
241EC056	Aerospace Electromagnetic Compatibility	AC	3			3	50	50	100	-
241EC061	Global Navigation Satellite Systems & Applications	AC	3			3	50	50	100	SC
241EC063	Remote Sensing & Digital Image Processing of Satellite Data	AC	3			3	50	50	100	DIP
Total			32			32				

Introduction to Space Laws

Course Code: 241EC054

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Infer the foundational principles and treaties of international space law, including the Outer Space Treaty, the Moon Agreement, and the Rescue Agreement.
- CO2:** Ability to summarize key provisions of major space treaties.
- CO3:** Critical analysis of national space policies and their alignment with international laws.
- CO4:** Discuss the legal implications of space resource utilization.
- CO5:** Discuss the legal obligations for environmental protection in space.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1								1
CO2	2	1	2								1
CO3	2	1	2								1
CO4	2	1	2								1
CO5	2	1	2								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT-I

Basic concepts of international law and space law: Introduction to international law, The Outer Space Treaty and the fundamental principles of space law, Other space treaties and General Assembly resolutions, National regulations, commercialization and privatization.

UNIT-II

Remote sensing/GIS, satellite meteorology and global climate + international law: International law relating to remote sensing, National legislation for remote sensing, Regional and global agreements on remote sensing, Sources of remote sensing data.

UNIT-III

International laws on Satellite communications: Overview of international law on satellite communications, Technical standards and national licensing, International trade in satellite communication services and global mobile personal communication services, Satellite broadcasting.

UNIT-IV

International law on Global navigation satellite systems (GNSS): International institutional context for GNSS operations, GNSS providers and GNSS augmentation, GNSS users, Legal framework for GNSS services, GNSS services.

UNIT-V

Space Law relating to commercial space activities: Legal issues in emerging trends of space activities - Human space flight, tourism, resource utilization, small satellite constellations, IPR.

Text Books:

1. Space Law - A treatise, Francis Lyall and Paul B. Larsen, Ashgate publishing Limited, England, ISBN: 978-1472447821.
2. Recent trends in international space law and policy, V.S Mani, S.Bhatt, V.Balakista Reddy, Asia Law house, ISBN: 978-9385556791.

Reference Books:

1. Handbook of space law, Frans von der Dunk, Fabio Tronchetti, Edward Elgar Publishing Limited, UK, ISBN: 978-1784713638.
Recent Developments in Space Law - Opportunities & Challenges, R. Venkata
2. Rao V. Gopalkrishnan, Kumar Abhijeet, Springer, ISBN: 978-9811049255.

Aircraft Communication Systems

	L	T	P	C	
Course Code: 241EC055		3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Explain the terminology of aircraft communication.

CO2: Learn the wave propagation types to be used for effective communication.

CO3: Aware of encryption standards in communication systems

CO4: Examine and understand the aircraft data links, communication band allotted for different satellites.

CO5: Get brief insight of future airborne communication systems – software defined radio.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	1									1
CO3	2	3	2								1
CO4	3	2	2								1
CO5	2	3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT-I

Introduction: The Isotropic Power Source and Free Space Path Loss, Radio Geometry - Radio Horizon Calculations, Earth Bulge Factor – k Factor, Great-circle Distances.

UNIT-II

Wave Propagation: Radio wave propagation – LOS, Complex Propagation: Refraction, Absorption, Non-LOS Propagation, Communication Frequency Bands and Allotment, Legacy and Modern Communications.

UNIT-III

Encryption standards in Communication Systems: Introduction to Cryptography, crypto systems and types. Traditional ciphers - Caesar Cipher, Transposition Cipher, Substitution Cipher.

UNIT-IV

Aircraft and UAV Data Links: Aircraft Data Link: VHF data link – ACARS, VDL 2, VDL 3, and VDL 4. UHF data link - Link-11, Link-16. SELCAL, ALE and HF Data link. UAV Data link functions and attributes, Video & Telemetry Links.

UNIT-V

Future Airborne Communication Systems: Software Defined Radio (SDR)- Need, characteristics and benefits, design principles, RF front end implementation – purpose, receiver topologies and importance of components.

Text Books:

1. Radio Communication Systems and Networks– Dale Stacey, Wiley, ISBN :978-0470018590.
2. Software Radio: A Modern Approach to Radio Engineering, Jeffrey H. Reed, PEA publication, ISBN: 9780130811585.

Reference Books:

1. Future Aeronautical Communications, Simon Plass., InTech, ISBN: 978-9533076256.
2. Cryptography and Network Security Principles and Practice, William Stallings, Pearson 6th Edition, ISBN: 978-9332518773.

Web Links:

1. <https://nptel.ac.in/courses/101101079>
2. [Fiber-Optic Cable \(Linktionary term\)](#)

Aircraft Navigation Systems

Course Code: 241EC057

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the various types of radio navigation systems.
- CO2:** Explain the architecture and components of inertial navigation systems.
- CO3:** Design and implement inertial navigation systems.
- CO4:** Demonstrate knowledge of practical applications of satellite and hybrid navigation systems.
- CO5:** Discuss the integration and interoperability of landing aids.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3									1
CO2	2	3									1
CO3	3	1	1								1
CO4	2	3	1								1
CO5	3	1									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Radio Navigation Systems

Different Types of navigation, Automatic Direction Finder, VHF Omni-directional Range, Distance Measuring Equipment, Tactical Air Navigation, VORTAC, Doppler Navigation – Beam Configurations.

UNIT – II

Inertial Navigation Sensors

Accelerometer - operating principle, classification- open loop pendulous, closed loop pendulous, vibrating beam and interferometric fibre optic accelerometer.

Gyroscope – Coriolis vibrating gyro, optical gyro – RLG, IFOG – Principle of operation, construction and working.

UNIT – III

Inertial Navigation System

Inertial navigation, Geometry of earth, gravitation and gravity, Reference frame ECI, LPI, ECEF and ENU. Navigation in rotating earth frame, Inertial system, Strap-down navigation.

UNIT – IV

Satellite and Hybrid Navigation System

GPS, position and velocity determination- Error sources, GDOP, position computation process. Velocity measurement, Precise Point Positioning (PPP), Integrated inertial navigation – processing of measurements, Complimentary nature of sensors, GNSS and INS fusion using Kalman filter.

UNIT – V

Landing aids, Secondary Surveillance Radar (SSR)

Low visibility operation, Mechanics of landing. Instrument Landing System (ILS), Satellite Landing Systems, Carrier-Landing Systems. Introduction, SSR modes, Interrogation, Mode-S.

Text Books:

1. Avionics Navigation Systems, Myron Kayton, Walter R. Fried, Wiley-Inter science 2nd Edition, ISBN: 978-0471547952.
2. Fundamentals of Navigation and inertial sensors, Amitava Bose, K.N.Bhat, Thomas Kurian, PHI learning Private limited, ISBN: 978-81-203-4859-2.
3. Radar Principles, Technology, Applications, Byron Edde, LPE, Pearson, ISBN: 978-0137523467

Reference Books:

1. Aircraft Communications & Navigation Systems: Principles Operation and Maintenance, Mike Tooley, David Wyatt, Butterworth-Heinemann an imprint of Elsevier, ISBN: 9780750681377.
2. Global Positioning Systems, Inertial Navigation and Integration, Mohinder S. Grewal, Lawrence R. Weill, Angus P. Andrews, Wiley-Inter science, 2nd Edition, ISBN: 978-0470041901.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc23_ce94/
2. https://onlinecourses.nptel.ac.in/noc21_ae12/

Missile & Space Vehicle Guidance & Control

	L	T	P	C
Course Code: 241EC062	2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

CO1: Discuss the basic of Missile Airframes and autopilots.

CO2: Explain the Missile guidance laws and control.

CO3: Describe the launch of strategic missiles.

CO4: Summarize the orbital mechanics of system.

CO5: Demonstrate the satellite guidance in free space.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	2	1									1
CO 2	3	2									1
CO 3	2	3									1
CO 4	2	3									1
CO 5	2	2									1

Mapping of course outcomes with program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO 1	3	
CO 2	2	
CO 3	2	
CO 4	2	
CO 5	2	

UNIT– I

Missile Airframes, Autopilots and Control

Missile aerodynamics: - Force Equations, Moment Equations, Phases of missile flight, Missile control configurations. Missile Mathematical Model, Autopilots - Definitions, Types of Autopilots, Example Applications, Open-loop autopilots, inertial instruments, and feedback.

UNIT – II

Missile Guidance Laws

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation.

UNIT – III

Strategic Missiles

Introduction, The Two-Body Problem, Lamberts Theorem, First-Order Motion of a Ballistic Missile Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Re-Entry, Ballistic Missile Intercept.

UNIT – IV

Orbital Mechanics

Orbital Transfers: Impulse Transfer between Circular Orbits, Hofmann Transfer, Other Coplanar and Non-coplanar Transfers-Orbital Plane Changes.

UNIT – V

Satellite Guidance

Space Plight, Space Vehicle Trajectories, Launch Vehicle Guidance Implicit and Explicit Guidance-Open loop and Closed loop Guidance, FE guidance- F. guidance-VG guidance-Q guidance-Delta guidance.

Text Books:

1. Fundamentals of Astrodynamics, Roger.R. Bate, Dover Publications, ISBN: 978-0486600611.
2. Navigation and Guidance in Space, Edwards V.B. Stearns, Prentice Hall, ISBN: B0007E24DA.

Reference Books:

1. Space Flight Dynamics, William Wiesel, Tata McGrawHill, Third Edition, ISBN: 978-1452879598.
2. Missile Guidance and Control systems, GM Siouris, Springer, ISBN: 978-0-387-00726.

Web Links:

1. [https://archive.nptel.ac.in/courses/101/108/101108054/Debasish Gose,IISC Bangalore](https://archive.nptel.ac.in/courses/101/108/101108054/Debasish%20Gose,IISC%20Bangalore).
2. <https://apps.dtic.mil/sti/tr/pdf/AD0813281.pdf>

Flight Control Systems

Course Code: 241EC060

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Discuss the static stability of an aircraft.
- CO2:** Interpret the Equations of Motions under different conditions.
- CO3:** Aware of Aircraft Response to Control or Atmospheric Inputs.
- CO4:** Infer classical control theory in aircraft design.
- CO5:** Interpret the essence of Auto pilot and aircraft design.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									1
CO2	3	1									1
CO3	2	3									1
CO4	3	2									1
CO5	2	3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT -I

Static Stability and Control: Introduction, Longitudinal Control, Stick Forces, Definition of Directional Stability, Directional Control, Roll Stability, Roll Control.

UNIT-II

Aircraft Equations of Motion-1: Introduction, Derivation of rigid Body Equations of Motion, Orientation and Position of the Airplane, Gravitational and Thrust Forces, Small Disturbance theory, Aerodynamic Force and Moment Representation.

UNIT -III

Aircraft Equations of Motion-2: Pure Pitching Motion, Stick Fixed Longitudinal Motion, Longitudinal Approximations, Influence of Stability Derivatives, Pure Rolling Motion, Pure Yawing Motion, Lateral Direction Equations of Motion.

UNIT -IV

Aircraft Response to Control or Atmospheric Inputs: Longitudinal Flying Qualities, Lateral Flying Qualities, Inertial Coupling, Equations of Motion in a Non Uniform Atmosphere, Pure Vertical or Plunging Motion.

UNIT -V

Control Theory applied to Aircraft design: Applications of Classical Control Theory to Aircraft Autopilot Design: Aircraft Transfer Functions Displacement Autopilot, Stability Augmentation, and Instrument Landing.

Text Books:

1. Flight Dynamics, Simulation, and Control for Rigid and Flexible Aircraft, Ranjan Vepa, CRC Press Taylor & Francis Group, ISBN: 9781466573352 .
2. Flight Stability and Automatic Control, Robert C Nelson, Tata McGraw-Hill, Second Edition, ISBN : 978-0070661103.

Reference Books:

1. Automatic control of Aircraft and missiles, Blakelock, J.H, John Wiley Sons, New York, ISBN: 978-0471506515.
2. Aircraft control & simulation, Stevens B.L & Lewis F.L, John Wiley Sons, New York, ISBN: 978-0471371458.

Web Links:

1. <https://nptel.ac.in/courses/101104330>

Avionics Embedded Systems

Course Code: 241EC058

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the building blocks of an embedded system.
- CO2:** Apply standard guidelines for development of Aircraft Systems.
- CO3:** Illustrate the services and tasks in RTOS.
- CO4:** Compare continuous dynamics and discrete dynamic mechanics.
- CO5:** Distinguish state machines based on computational models.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2										1
CO2	2	2									1
CO3	2										1
CO4	2	2									1
CO5	2	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT - I

Introduction to Embedded Systems

Categories, Overview of architecture, Characteristics, Recent trends, Architecture of Embedded systems: Hardware Architecture: CPU, Memory, Clock, Watch dog timer, I/O, Debug port, Communication interface, Power Supply.

UNIT – II

Embedded System Development

Development Process, Requirements, Design, Implementation, Integration and Testing, Packaging, Configuration Management. ARP-4754 Standard for systems engineering guidelines.

UNIT – III

RTOS

Real time concepts, Kernel Structure, Tasks and Scheduler, Time Management,

Event Control blocks, Semaphore management, Mutex, Event Management, Message mail box management, Message Queue management, memory management.

UNIT – IV

Modelling Dynamic Behaviors-1

Continuous Dynamics: Newtonian Mechanics, Actor Models, Properties of Systems, Feedback Control.

Discrete Dynamics: Discrete Systems, The Notion of State, Finite-State Machines, Extended State Machines, Non-determinism, Behaviors and Traces.

UNIT – V

Modelling Dynamic Behaviors-2

Composition of State Machines: Concurrent Composition, Hierarchical State Machines. Concurrent Models of Computation: Structure of Models, Synchronous-Reactive Models, Dataflow Models of Computation.

Text Books:

1. Introduction to Embedded Systems: A cyber physical systems approach by Edward Ashford Lee and Sanjit Arun kumar Seshia, MIT Press, Second Edition, ISBN: 978-0262533812.
2. Embedded /Real-Time Systems: Concepts, Design & Programming by K.V.K.K.Prasad, Dream tech Press, ISBN: 978-8177224610 .

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Approach by Frank Vahid, Tony Givargis, Wiley India Edition, 3rd Edition, ISBN: 978-8126508372.
2. Computers as Components-Principles of Embedded Computer System Design by Wayne Wolf, Morgan Kaufman Publisher, ISBN: 9780128053874.
3. Embedded Systems Architecture, Programming and Design by Rajkamal Tata McGraw Hill, 2nd Edition, ISBN: 978-0070667648.

Web Links:

1. <http://www.nptelvideos.in/2012/11/embedded-systems.html>

Avionics Network Technology

Course Code: 241EC059

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate the design and operation of optical access networks
- CO2:** Study protocols and standards unique to aviation communications
- CO3:** Compare sensor network with hoc network
- CO4:** Explore different network topologies suitable for wireless sensor networks
- CO5:** Explore the integration of smart antenna systems with various communication systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1								1
CO2	2	1	2								1
CO3	2	3	2								1
CO4	3	3	2								1
CO5	3	1	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT– I

Optical Networks: Fiber channel-WDMLAN-Fiber channel-RF over fiber -Highly integrated photonics (HIP)-Routing in optics- Amplification in optics.

UNIT – II

ATN (Aeronautical Telecommunication Network): ATN Concepts – ATN functionality – ATN Components – End Systems – ATN physical and administrative structures – ATN planning and implementation process – ATN Router.

UNIT – III

Wireless Sensor Network Attributes: Introduction-Challenges for wireless sensor networks-Comparison of sensor network with hoc network-single node architecture-Hardware components-energy consumption of sensor nodes.

UNIT – IV

Wireless Sensor Network Architecture: Network architecture-sensor network scenarios-types of sources and sinks-single hop versus multi hop networks-multiple sinks and sources-Design, principles :- Development of wireless sensor networks.

UNIT – V

Wideband Wireless Communication and Networks for Military Avionics

Communication data link (CDL)-IP based routing in FBW-Smart antenna networking.

Text Books:

1. Avionics Data Buses by Carry Spitzer, Fifth Edition, ISBN: 978-1138076983.
2. Smart Antennas for Wireless Communication by Frank Gross, Wiley Publications, Second Edition, ISBN: 978-0071447898.

References Books:

1. Wireless Sensor Networks by C.S.Raghavendra Krishna, M.Sivalingam and Taripznati, Springer publication.
2. Wireless Sensor Networks: Architecture and Protocol by H.Callaway, Edgar, CRS press, ISBN : 978-0849318238.

Web Links:

- 1.https://onlinecourses.nptel.ac.in/noc20_ae03
- 2.https://onlinecourses-archive.nptel.ac.in/noc18_cs09

Unmanned Aircraft Systems

Course Code: 241EC064

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the basic concepts of UAV.
- CO2:** Discuss the basics of airframe.
- CO3:** Describe the Avionics hardware.
- CO4:** Summarize the design considerations for communications payload and control.
- CO5:** Summarize the UAV certification standards.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1									1
CO2	3	2									1
CO3	2	3									1
CO4	2	3									1
CO5	2	2									1

Mapping of course outcomes with program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT– I

Introduction to UAV:

History and Overview, Classes and Missions of UAV's, System composition, few applications of Unmanned Aircraft Systems.

UNIT – II

Design of UAV Systems

Introduction to design and selection of system, Aerodynamics and airframe configurations, Characteristics of Aircraft Types, Design of stealth, Data links.

UNIT – III

Communication and Navigation of UAV

Communication media: Radio communication, Mid-Air collision (MAC) Avoidance, Data Rate and Bandwidth Usage, Antenna Types, NAVSTAR Global Positioning System, TACAN, LORAN-C, Radio Tracking, Inertial Navigation and Control Stations.

UNIT – IV

Development of UAV Systems

System development and certification, System ground testing -UAV component testing, sub-system testing, control station testing and System in flight testing.

UNIT – V

UAV Payloads

Surveillance payloads-overview, image sensors, Weapon payloads, Design issues related to Carriage and delivery of weapons, other issues related to combat operations, other payloads.

Text Books:

1. Introduction to UAV Systems by Paul Gerin Fahlstorm, Wiley Publication, Fourth Edition, ISBN: 9781118396780.
2. Unmanned Aircraft Systems-UVAS Design, Development and Deployment by Reg Austin, Wiley Publication, Third Edition, ISBN: 978-0470058190.

Reference Books:

1. Remote sensing and activation using UAV by Haiyang Chao and Yang Quan Chen, IEEE Press, ISBN: 978-1118122761.
2. Unmanned Aircraft Design A review of fundamentals by Mohammad H. Sadraey, Morgan & Claypool Publishers series, ISBN: 978-1681731681.

Web Links:

1. <https://archive.nptel.ac.in/courses/101/104/101104073/,Prof..SaderlaSubrahamanya m,IIT Kanpur.>
2. https://www.icao.int/meetings/uas/documents/circular%20328_en.pdf

Aerospace Electromagnetic Compatibility

	L	T	P	C
Course Code: 241EC056	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the concepts of EMI and EMC in transmission.
- CO2:** Analyse the EMI effect on aircraft.
- CO3:** Describes the various procedures for radiated measurement systems.
- CO4:** Analyse the effect of EMI on flight control systems.
- CO5:** Analyse the effect of EMI on unmanned flight control systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	2	3									1
CO3	3	2									1
CO4	2	3									1
CO5	2	3									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Introduction to Sources of EMI and EMC

Electromagnetic environment, Concepts, Practical experiences & concerns, Natural and Nuclear sources of EMI, Electromagnetic emissions, Cross talk in transmission lines, Transients in power supply lines, Electromagnetic Interference Principles and types of grounding, Shielding and bonding.

UNIT – II

Effects of EMI on Aircraft and Analysis

HEMP Threat to Aircraft, HEMP Coupling to Aircraft, Lightning interactions with Aircraft, Avionic Equipment functional verification in presence of lightning induced electrical transients.

UNIT – III

Avionics Subsystems Radiated and Conducted Measurement

Motivations for Testing, Test Plans for Avionics Sub-Systems. Open area test sites and measurements. Anechoic chamber, TEM cell, GTEM Cell, Conducted EMI from equipment, Immunity to conducted EMI, Detectors and measurements.

UNIT – IV

EMI Effects in Flight Control Systems and their Mitigations.

Analysis of the Contemporary Aerial EME, Elements of FBW System and Their Susceptibility to EMI, EMI Susceptibilities of FMS, EMC Test Methodologies of FCS.

UNIT – V

EMI Effects on Unmanned Flight Control Systems

EMI Susceptibilities of UAV Flight Control System, How EMI Couples to FCS, Modeling and Simulation, Some Special Considerations for EMI Mitigation.

Text Books:

1. Engineering Electromagnetic Compatibility by Dr.V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd, New Delhi, ISBN: 978-0780347434.
2. Handbook of Aerospace Electromagnetic Compatibility, Reinaldo J. Perez, IEEE Publication, Published by John Wiley & Sons, ISBN: 978-1118910511.

Reference Books:

1. Introduction to Electromagnetic Compatibility, Clayton R Paul, John Wiley, ISBN: 978-0471755005.
2. Principles and Techniques of EMC, Christos Christopoulos, CRC press, 2nd Edition, ISBN: 978-0849370359.
3. Handbook of Aerospace Electromagnetic Compatibility Editor(s): Dr. Reinaldo J. Perez, ISBN: 9781118910511.

Web Links:

1. <https://www.amazon.in/Handbook-Aerospace-Electromagnetic-Compatibility-Reinaldo/dp/1118910516>
2. <https://www.amazon.in/Handbook-Aerospace-Electromagnetic-Compatibility-Reinaldo-ebook/dp/B07L8DZP4F>
3. https://books.google.co.in/books/about/Handbook_of_Aerospace_Electromagnetic_Co.html?id=ac95DwAAQBAJ&redir_esc=y

Global Navigation Satellite Systems & Applications

	L	T	P	C
Course Code: 241EC061	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Illustrate the usage of GNSS in position determination

CO2: Classify various navigation satellite systems

CO3: Interpret the GNSS errors and correction methods

CO4: Utilize the GNSS for developing applications

CO5: Summarize the current trends and opportunities of GNSS

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									1
CO2	3	2									1
CO3	2	3									1
CO4	2										1
CO5	3										1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT– I

Introduction to Global Navigation Satellite System (GNSS), How position is determined by the GNSS, NAVSTAR - Global Positioning System

UNIT – II

Global Navigation Satellite System (GLONASS), BeiDou Navigation Satellite System (BDS), Indian Regional Navigation Satellite System (IRNSS), GALILEO, Quasi-Zenith Satellite System (QZSS)

UNIT – III

Differential Global Navigation Satellite System (DGNSS), REAL-TIME KINEMATIC (RTK), Satellite Based Augmentation System (SBAS), GNSS Errors, GNSS Correction Methods.

UNIT – IV

Why altitude estimated by GNSS receivers is not very accurate, Global Navigation Satellite Systems (GNSS) Applications.

UNIT – V

GNSS: Current Trends and Future, Opportunities in India

Text Books:

1. Environmental Monitoring using GNSS: Global Navigation Satellite Systems, Awange J. L, Springer, London, ISBN: 978-3540882558.
2. Global Navigation Satellite Systems: Insights into GPS, Glonass, Galileo, Compass, and Others, BS Publications, New Delhi, ISBN: 978-8178002200.

Reference Books:

1. GNSS – Global Navigation Satellite Systems, Hofmann-Wellenhof, B, Lichtenegger, Wasle, Springer, Verlag Wien, ISBN : 978-3211730126.
2. Global Positioning Systems, Inertial Navigation, and Integration, Grewal, M. S. Weill, L. R. Andrews, John Wiley & Sons, New York.
3. GNSS Systems and Engineering: The Chinese Beidou Navigation and Position Location Satellite, Tan, S., John Wiley & Sons, Singapore, ISBN: 978-1118897034.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc23_ce94 By Prof. Arun K. Saraf, IIT Roorkee
2. <https://www.spiceworks.com/tech/iot/articles/what-is-gnss/>

Remote Sensing & Digital Image Processing of Satellite Data

Course Code: 241EC063

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Outline the electromagnetic concepts in remote sensing technology

CO2: Contrast satellites based on the remote sensing

CO3: Make use of image interpretation for remote sensing

CO4: Illustrate about image acquisition and enhancement techniques

CO5: Utilize the multispectral transforms for image processing

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									1
CO2	3	2									1
CO3	2	2									1
CO4	3	2									1
CO5	2	2									1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	2	

UNIT - I

Development of remote sensing technology and advantages, Different platforms of remote sensing, EM spectrum, solar reflection and thermal emission remote sensing, Interaction of EM radiation with atmosphere including atmospheric scattering, absorption and emission.

UNIT – II

Interaction mechanisms of EM radiation with ground, spectral response curves, Principles of image interpretation, Multi Spectral scanners and imaging devices, Salient characteristics of LANDSAT, IRS, Cartosat, Resource Sat etc. sensors, Image characteristics and different resolutions in Remote Sensing.

UNIT – III

Image interpretation of different geological landforms, rock types and structures, Remote Sensing integration with GIS and GPS, Georeferencing Technique, Basic image enhancement techniques, Spatial filtering techniques, Image classification

techniques, InSAR Technique and its applications, Hyper spectral Remote Sensing, Integrated applications of RS and GIS in groundwater studies, Limitations of Remote Sensing Technique.

UNIT – IV

Different techniques of Image acquisition, Image characteristics and different resolutions in Remote Sensing, EM spectrum, solar reflection and thermal emission remote sensing, Colour representations and transforms, Image Histograms and statistics, Geometric transformations /Georeferencing Technique, Image enhancement techniques.

UNIT – V

Multispectral transforms: scatter plot, principal component analysis and decorrelation stretch, Spatial filtering techniques, Frequency domain - Fourier transformation, Basic Image Compression techniques and different image file formats, Image classification techniques, Principles of image interpretation, SAR Interferometry (InSAR) Technique, Image merging and mosaicking techniques, Applications of Image Analysis, Limitations and future of Digital Image Processing Technique.

Text Books:

1. Introduction to Remote Sensing, James B. Campbell and Randolph H. Wynne, The Guildford Press, New York, 5th Edition, ISBN: 978-1609181765.
2. Remote Sensing and Image Interpretation, Lillesand, T.M., Kiefer, R.W. and Chapman, J.W., John Wiley & Sons, 7th Edition, ISBN: 978-1118343289.

Reference Books:

1. Image Interpretation in Geology by Drury, S. A., Allen & Unwin, 2nd Edition, ISBN: 978-0412488801.
2. Introduction to Remote Sensing, Cracknell, A.P., Tylor & Francis, London, 2nd Edition, ISBN: 978-0849392559.
3. Digital Image Processing by Gonzalez, Rafael C. and Richard E. Woods, Pearson Education, London, 3rd Edition, ISBN: 978-0131687288.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc19_ce38 By Prof. Arun K. Saraf, IIT Roorkee
2. <https://www.geeksforgeeks.org/satellite-image-processing/>

UNIVERSITY OPEN ELECTIVE COURSES

AI & ML											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241AI002	Artificial Intelligence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241AI005	Machine Learning	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI027	AI & Data Science	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI028	AI in Healthcare	IC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
241AI011	Deep Learning	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI010	Natural Language Processing	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI009	Reinforcement Learning	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
241AI029	AI in Agriculture	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
241AI030	Robotics & AI	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
241AI031	AI in Finance & Economics	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
Total			20		12	32					

Artificial Intelligence

Course Code: 241AI002

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the historical development of AI, key milestones and contributors.
- CO2:** Apply the basic principles of AI in problem solving
- CO3:** Apply Local Search Algorithms and Optimization Techniques.
- CO4:** Choose the appropriate representation of Knowledge.
- CO5:** Summarize the expert systems and real time applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3			1				1	1		1
CO2	3	2		2				1	1		1
CO3	3	2	1	2	1			1	1		1
CO4	2		1					1	1		
CO5	2	2	1	1	1			1	1		1

UNIT-I

Introduction:

What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Practice :

1. Introduction to LISP :
 - To demonstrate simple recursive functions and list manipulation in LISP
2. Introduction to Prolog :
 - Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

UNIT-II

Problem formulation:

Problem Definition Production systems, Control strategies, Search strategies. Problem characteristics, Problem Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies

Practice :

1. Implementation of DFS for water jug problem using LISP/PROLOG
2. Implementation of BFS for tic-tac-toe problem using LISP/PROLOG

UNIT-III

Problem solving methods

Problem graphs, Matching, Indexing and Heuristic functions Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

Practice :

1. Implementation of TSP using heuristic approach using LISP/Prolog
2. Implementation of Hill climbing to solve 8 Puzzle Problem

UNIT-IV

Knowledge representation

Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic Structured representation of knowledge Basic plan generation systems – Strips Advanced plan generation systems – K strips Strategic explanations Why, why not and how explanations.

Practice :

1. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.
2. Create a frame based representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

UNIT – V

Expert Learning

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Practice :

1. Using PYTHON / LISP , develop an expert system to help users plan travel itineraries, including transportation, accommodation, and activities. Utilize knowledge about travel destinations, transportation options, and user preferences to generate personalized travel plans.
2. Using PYTHON / LISP , create an expert system to assist students in selecting courses, majors, or career paths based on their interests, skills, and academic performance. Use knowledge about educational programs, career prospects, and academic requirements to make personalized recommendations.

Text Books:

- 1 Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig , Pearson, 3rd Edition, ISBN: 978-9332543515
- 2 Artificial Intelligence: Structures and Strategies for Complex Problem Solving by George F. Luger, 2nd Edition, ISBN: 978-0805347807

Reference Books:

- 1 Artificial Intelligence, Saroj Kaushik, Cengage Learning India, ISBN: 978-8131510995
- 2 Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill, ISBN: 978-0-07-052263-3

- 3 Artificial Intelligence: Foundations for Computational Agents, David Poole and Alan Mackworth, Cambridge University Press, ISBN: 978-1107195394

Web Links:

- 1 <https://nptel.ac.in/courses/106105077>
- 2 <https://nptel.ac.in/courses/106106126>
- 3 <https://aima.cs.berkeley.edu>

Machine Learning

Course Code: 241AI005

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Outline the Concepts of Machine Learning and Statistical Learning
- CO2:** Build Regression and Classification models for given data.
- CO3:** Apply Instance based Learning techniques and SVM techniques linear and nonlinear data.
- CO4:** Apply clustering techniques on high dimensional data to group the similar entities.
- CO5:** Make use of ensemble learning techniques to improve the performance of a model.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			2	2		1	1		
CO2	2	2	3		2	2		1	1		
CO3	3	2	3		2			1	1		2
CO4	3	2	3		2			1	1		
CO5	2	2	2		2			1	1		2

UNIT-I

INTRODUCTION

Machine Learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. Statistical Learning: Introduction, Supervised and Unsupervised Learning, The Learning Problem, Feasibility of Learning.

Practice :

1. Installation of Jupiter/Spider notebook and working on basic commands.
2. Loading and apply key preprocessing techniques on the dataset and also analyse the dataset.

UNIT-II

Supervised Learning(Regression/Classification):Basic Methods:

Concept Learning: General-to-Specific Hypotheses Ordering, Find-S and Candidate Elimination Algorithm, Version Space, and Inductive Bias.

Bayesian Learning: Probability Overview, MLE and MAP Estimates, Gaussian Naive Bayes Classifier, Bayesian Networks.

Instance-based Learning: k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN, Distance Metrics and Curse of Dimensionality.

Practice :

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Exercises to solve the real-world problems using Binary Classifier
4. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

UNIT-III

Linear Models and Regression: Linear Classification, Linear Regression, Non-linear Transformation, Logistic Regression.

Support Vector Machines: Decision Boundary and Support Vector: Optimization and Primal-Dual Problem, Soft Margin and Non-linear Decision Boundary, Kernel Functions and Radial Basis Functions introduction.

Practice :

1. Exercises to solve the real-world problems using Linear Regression
2. Exercises to solve the real-world problems using Logistic Regression
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients.

UNIT-IV

Classifier / Hypothesis Evaluation: Accuracy, Precision, Recall and F-Measures, Scores, Sampling, Bootstrapping and ROC, Hypotheses Testing and Cross-validation.

Unsupervised Learning:

Clustering : Partitional Clustering and Hierarchical Clustering, Cluster Types, Attributes and Salient Features, Hierarchical and Density-based Clustering Algorithms, Inter and Intra Clustering Similarity, Cohesion and Separation. MST and DBSCAN Clustering Algorithms.

Practice :

1. Develop a program for Bias, Variance, Remove duplicates , Cross Validation
2. Write a program to implement One-hot Encoding.
3. Write a program to implement Categorical Encoding.

UNIT – V

Ensemble Learning :

Bagging and Boosting, Adaboost and Random Forest ,

Computational Learning Theory : Error and Noise Formalisms, Training vs. Testing, Theory of Generalization, PAC Learnability and VC Dimensions , Overfitting, Regularization and Validation.

Practice :

1. Write a program to demonstrate the working of Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
2. Use a sentiment analysis dataset from Twitter or other social media platforms, available on platforms like Kaggle and apply bagging and boosting techniques for prediction.

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Corner Stone Project:

PROJECT 1: Intelligent Loan Risk Assessment System (End-to-End ML Pipeline)

Project Implementation, Documentation and Viva Voce

- **Implementation mainly focuses on**

- Collecting and integrating multiple datasets (loan + financial history)
- Advanced preprocessing (missing values, outliers, feature engineering)
- Implementing multiple models (Logistic Regression, Random Forest, XGBoost)
- Handling imbalanced data (SMOTE / resampling techniques)
- Model evaluation using ROC-AUC, F1-score, cross-validation
- Building a simple UI (Streamlit/Web app) for predictions
- Model comparison and optimization

- **Documentation must contain**

- Objective & real-world problem definition
- Dataset merging and preprocessing pipeline
- Feature engineering techniques
- Model comparison and evaluation metrics
- System architecture diagram
- Screenshots (UI + outputs)
- Enhancements (hyperparameter tuning, deployment)

PROJECT 2: Smart Disease Prediction System with Model Ensemble

- **Implementation mainly focuses on**

- Using medical datasets (heart disease/diabetes/multi-disease)
- Data preprocessing and feature selection
- Applying multiple classifiers (SVM, kNN, Random Forest, Gradient Boosting)
- Ensemble learning (Voting / Stacking models)
- Model evaluation using confusion matrix, ROC curves
- Explainability (feature importance / SHAP basics)
- Web-based prediction interface

- **Documentation must contain**

- Objective
- Dataset and preprocessing steps
- Model architecture and ensemble approach
- Evaluation metrics and comparison
- Screenshots (prediction system)
- Enhancements (multi-disease prediction)

PROJECT 3: Real-Time Sentiment Analysis System with Web Scraping

- **Implementation mainly focuses on**

- Scraping live data (Twitter/news using APIs or scraping tools)
- Text preprocessing (stopwords, stemming, vectorization – TF-IDF)
- Training models (Naïve Bayes, Logistic Regression, LSTM optional)
- Real-time sentiment prediction
- Visualization dashboard (charts for sentiment trends)
- Handling large-scale streaming data

- **Documentation must contain**

- Objective

- Data collection methodology (APIs/web scraping)
- NLP preprocessing pipeline
- Model building and evaluation
- Dashboard explanation
- Screenshots
- Enhancements (real-time alerts, topic modeling)

PROJECT 4: Heart Disease Prediction using SVM

• **Implementation mainly focuses on**

- Loading patient dataset
- Applying Support Vector Machine (SVM)
- Data preprocessing and feature scaling
- Classification of patients (disease/no disease)
- Model evaluation using confusion matrix

• **Documentation must contain**

- Objective
- Dataset description
- SVM working principle
- Evaluation metrics
- Output results
- Screenshots
- Enhancements (kernel comparison)

PROJECT 5: Customer Segmentation using Clustering

• **Implementation mainly focuses on**

- Loading customer dataset
- Applying K-Means clustering
- Identifying groups based on features
- Visualizing clusters using plots
- Comparing clustering results

• **Documentation must contain**

- Objective
- Dataset details
- Clustering technique explanation
- Cluster visualization
- Results interpretation
- Screenshots
- Enhancements (DBSCAN comparison)

PROJECT 6: Fake News Detection System using Machine Learning

• **Implementation mainly focuses on**

- Dataset collection (news datasets / scraping)
- Text preprocessing (tokenization, TF-IDF, n-grams)
- Applying classification models (Logistic Regression, SVM, Random Forest)
- Model evaluation using precision, recall, F1-score
- Comparing multiple models
- Building a simple interface for prediction

• **Documentation must contain**

- Objective
- Dataset description
- NLP pipeline
- Model comparison

- Evaluation metrics
- Screenshots
- Enhancements (deep learning models)

PROJECT 7: Sentiment Analysis using Ensemble Learning

• Implementation mainly focuses on

- Collecting dataset (Twitter/Kaggle)
- Text preprocessing
- Applying Bagging and Boosting techniques
- Training ensemble models (Random Forest / AdaBoost)
- Predicting sentiment (positive/negative)

• Documentation must contain

- Objective
- Dataset source
- Preprocessing steps
- Ensemble methods explanation
- Performance comparison
- Screenshots
- Enhancements (real-time data analysis)

PROJECT 8: Model Evaluation and Comparison System

• Implementation mainly focuses on

- Implementing multiple models (kNN, SVM, Regression)
- Performing cross-validation
- Calculating accuracy, precision, recall, F1-score
- Comparing model performance
- Visualizing results using graphs

• Documentation must contain

- Objective
- Models used
- Evaluation metrics explanation
- Comparison results
- Graphs and charts
- Screenshots
- Enhancements (hyperparameter tuning)

Text Books:

- 1 Hands On Machine Learning with ScikitLearn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019, ISBN: 978-1492032649
- 2 Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 2019, ISBN: 978-1138492530

Reference Books:

- 1 Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, ISBN: 9780262018029
- 2 Machine Learning Tools, Dr Muddafa Maruli Krishna, Dr A Vanathi, Final Thawaksr, Dr Lokesh P. Gangani, publisher: Book Rivers, ISBN: 978-93-5515-730-0

Web Links:

- 1 <https://www.deeplearning.ai/machinelearningyearning/>
- 2 <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>
- 3 https://onlinecourses.nptel.ac.in/noc21_cs24/preview

Note:

- Students must submit the Certificate of Completion offered by any Industry.
- The capstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The SEE – Lab shall be evaluated for 50 marks based on project implementation, oral presentation, 10-minute video presentation, and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.

AI & Data Science

Course Code: 241AI027

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the historical evolution, architecture, tools and applications of AI
- CO2:** Explain the fundamentals of Data Science, including its need, processes, and tools
- CO3:** Utilize pandas for effective data handling, including data structures, indexing, filtering, data summarization, and handling missing data.
- CO4:** Develop skills in data loading, storage, and file format management
- CO5:** Develop proficiency in data visualization techniques using Matplotlib

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1		2	1		2			1			3
CO2		2	1		2			1			3
CO3		2		3	1			1			1
CO4	2	2	3		1			1			
CO5	1	2	3		1			1			

UNIT-I

Introduction to AI

Historical Evolution and AI today, Architecture of AI Systems, Theory (Knowledge, Logic, Search, Reasoning, Planning, Learning), Tools and Applications, Interface (Sensing, Actuation, Control), Domains and Scope of AI Applications, Inter-disciplinary Problem Solving, Intelligent/Expert Knowledge based Systems, Case-studies and Success Stories.

Practice:

1. Create a basic AI system architecture using a knowledge-based or expert system for a simple medical diagnosis system.

UNIT-II

Introduction To Data Science: Need for Data Science – What is Data Science Data Science Process – Business Intelligence and Data Science – Prerequisites for a Data Scientist – Tools and Skills required.

NumPy Basics: The NumPy ndarray: A Multidimensional Array Object, creating ndarrays, Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and Slicing, Boolean Indexing, Fancy Indexing, Data Processing Using Arrays, Expressing Conditional Logic as Array Operations, Methods for Boolean Arrays, Sorting, Unique

Practice:

1. Perform various data manipulation tasks using NumPy, such as creating multidimensional arrays, conducting operations between arrays, indexing, slicing, and applying Boolean and fancy indexing

UNIT-III

Getting Started with pandas

Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, Data Frame, Index Objects, Essential Functionality Reindexing, dropping entries from an axis, Indexing, selection, and filtering, Sorting and ranking, Summarizing and Computing Descriptive Statistics, Unique Values, Value Counts, Handling Missing Data, filtering out missing data.

Practice:

1. Analyse the dataset to derive meaningful insights, such as summarizing data trends or finding unique values

UNIT-IV

Data Loading, Storage, and File Formats

Reading and Writing Data in Text Format, Reading TextFiles in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice :

1. Load data from multiple formats, including text files, JSON, XML, and Excel, and store it in various formats such as HDF5 or MongoDB

UNIT – V

Plotting and Visualization

A Brief matplotlib lib A PIPrimer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, Plotting Functions in pandas, Line Plots, Bar Plots, Histograms and Density Plots, Scatter Plots.

Practice :

1. Create various plots (line, bar, histogram, scatter) using Matplotlib and pandas to visualize data from a dataset.

Text Books:

- 1 Python for Data Analysis, Wes McKinney, O'REILLY, 1st Edition, ISBN:978-1-449-31979-3
- 2 Doing Data Science, Rachel Schutt & O'neil, O'REILLY, 1st Edition, ISBN:978-1-449-35865-5

Reference Books:

- 1 Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media, ISBN : 978-9352130962
- 2 Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , Matt Harrison, O'Reilly, ISBN : ISBN 153359824X.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc24_cs133/preview
- 2 https://onlinecourses.nptel.ac.in/noc24_cs68/preview
- 3 <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>

AI in Health Care

Course Code: 241AI028

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain fundamentals of Healthcare Data Analytics
- CO2:** Demonstrate the technologies for analyzing Biomedical Image
- CO3:** Apply predictive modeling techniques for Clinical Data
- CO4:** Apply predictive analysis techniques for genomic data
- CO5:** Illustrate NLP and Data mining for clinical text.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1		2	1		2			1			3
CO2		2	1		2			1			3
CO3		2		3	1			1			1
CO4	2	2	3		1			1			
CO5	1	2	3		1			1			

UNIT-I

Fundamentals of Healthcare Data Analytics:

Healthcare Data Sources and Basic Analytics Advanced Data Analytics for Healthcare Applications and Practical Systems for Healthcare Resources for Healthcare Data Analytics Electronic Health Records Components of EHR Coding Systems Benefits of EHR Barriers to Adopting EHR Challenges of Using EHR Data.

Practice:

1. Clean and explore a health care dataset to understand its structure and key attributes.
Use the Diabetes dataset from the UCI Machine Learning Repository.

UNIT-II

Image Recognition and Analysis of Biomedical Images

Biomedical Imaging Modalities Object Detection Image Segmentation Image Registration Feature Extraction Mining of Sensor Data in Healthcare Mining Sensor Data in Medical Informatics Challenges in Healthcare Data Analysis Sensor Data Mining Applications.

Practice:

1. Build a model to predict if a patient will be readmitted to the hospital within 30 days. Use the Hospital Readmissions Reduction Program (HRRP) dataset.

UNIT-III

Predictive Modelling for Integrating Clinical and Genomic Data:

Introduction Issues and Challenges Different Types of Integration Different Goals of Integrative Studies Validation Information Retrieval for Healthcare KnowledgeBased Information in Healthcare and Biomedicine Content of KnowledgeBased Information Resources Indexing Retrieval Evaluation Research Directions.

Practice:

1. Perform survival analysis on a dataset of cancer patients to estimate survival rates.
Use the SEER Cancer Incidence dataset

UNIT-IV

Basics of NLP in medical analysis

Processing Mining Information from Clinical Text Challenges of Processing Clinical Reports Clinical Applications Social Media Analytics for Healthcare Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks Social Media Analysis for Public Health Research Analysis of Social Media Use in Healthcare.

Practice:

1. Segment patients into different groups based on their health care utilization patterns.
Use a dataset containing patient visit records, such as the National Hospital Ambulatory Medical Care Survey (NHAMCS).

UNIT – V

Advance topics in healthcare with AI

Automated Decision Systems The Artificial Intelligence field Basic concepts of Expert Systems Applications of Expert Systems Structure of Expert Systems Knowledge Engineering Development of Expert Systems – Locationbased Analytics Cloud Computing Business Intelligence.

Practice:

1. Analyze health care costs and identify factors driving high costs. Use the Medical Expenditure Panel Survey (MEPS) dataset.

Text Books:

- 1 Healthcare Data Analytics, Chandan K. Reddy, Charu C. Aggarwal, CRC Press, ISBN : 978-0367575687, 2020.

Reference Books:

- 1 Analytics in Healthcare A Practical Introduction, Christo El Morr, Hossam Ali Hassan, 2019, ISBN : 978-3030045050

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_hs40/preview
- 2 <https://nptel.ac.in/courses/109107190>

Deep Learning

Course Code: 241AI011

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate the basic statistical concepts in deep learning.
- CO2:** Explain architecture and mathematical foundation for various deep neural networks.
- CO3:** Illustrate the challenges and optimization strategies in Deep Learning.
- CO4:** Build a convolutional neural network using different activation functions.
- CO5:** Build and train RNN and LSTMs using sequence modelling.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1		2	1		2			1	1		3
CO2		2	1		2			1	1		3
CO3		2		3	1			1	1		1
CO4	2	2	3		1			1	1		
CO5	1	2	3		1			1	1		

UNIT-I

DEEP LEARNING CONCEPTS

Fundamentals about Deep Learning, Perception Learning Algorithms, Probabilistic modelling, Early Neural Networks, How Deep Learning different from Machine Learning, Scalars. Vectors, Matrixes, Higher Dimensional Tensors, Manipulating Tensors. Vector Data, Hyper parameters Vs Parameters - validation sets - Estimators, Bias, Variance , Overfitting and Underfitting, Introduction to Keras and TensorFlow and PyTorch.

Practice:

1. Installation and basic commands of scikit, TensorFlow and PyTorch
2. Implement Random Forest by using scikit, TensorFlow and PyTorch
3. Implement multilayer perceptron algorithm for MNIST Handwritten Digit Classification

UNIT-II

NEURAL NETWORKS

About Neural Network, Building Blocks of Neural Network, Introduction to Neural Networks, Feed-forward Networks, Deep Feed-forward Networks - Learning XOR, Gradient Based learning, Hidden Units, Back-propagation and other Differential Algorithms, Data Pre-processing for neural networks, Feature Engineering.

Practice:

1. Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
2. a) Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset
b) Design a neural network for predicting house prices using Boston Housing Price dataset.

UNIT-III

OPTIMIZATION TECHNIQUES

Optimizers – SGD (Stochastic Gradient Descent), Mini-batch Gradient Descent, MS prop (Root Mean Square Propagation), Adagrad (Adaptive Gradient Algorithm), Adadelta (Adaptive Delta), Adam (Adaptive Moment Estimation), Adamax (Adaptive Moment Estimation with Infinity Norm).

Activation Functions : sigmoid, tanh, ReLU, leaky ReLU, Soft Max, Linear Loss Functions - cross-entropy loss, the mean-squared error, the Huber loss, the hinge loss, L2 loss, mean absolute loss
Regularization – L1, L2 and drop out . Learning Rate, Normalization

Practice :

1. Implement word embeddings for IMDB dataset.
2. Implement one hot encoding of words or characters.
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients. Also apply the optimization techniques.
4. Write a Python program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set

UNIT-IV

CONVOLUTIONAL NEURAL NETWORK

About CNN, Building a convolutional neural network, Input Layers, Convolution Layers, Pooling Layers, Dense Layers, Backpropagation Through the Convolutional Layer, Filters and Feature Maps, Backpropagation Through the Pooling Layers, Dropout Layers and Regularization, Batch Normalization

Pre trained CNN: LeNet, Alex Net, VGG16, ResNet.

Practice :

1. Build a Convolution Neural Network for MNIST Handwritten Digit Classification.
2. a) Use a pre-trained convolution neural network (VGG16) for image classification
b) Build a Convolution Neural Network for simple image (dogs and Cats) Classification
3. Student Portfolio Creation using GitHub, Hugging Face & Kaggl

UNIT – V

RNN

Recurrent Neural Networks ,Sequence-to-Sequence Modelling – Embedding - Recurrent Neural Networks - Bidirectional RNNs, Analysing Variable Length Inputs – Tackling seq2seq Problem – Beam Search and Global Normalization – Recurrent Neural Networks (RNN)– Hidden States – Perplexity – Character-level Language Models –Modern RNNs: Gated Recurrent Units (GRU), Long Short-Term Memory (LSTM).

Practice:

1. Implement a Recurrent Neural Network for IMDB movie review classification problem.
2. Implement Boosting algorithms using scikit, Tensorflow and PyTorch

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Cornerstone Projects :

PROJECT 1: Student Performance Prediction using Deep Neural Networks

Project Implementation, Documentation and Viva Voce

Implementation mainly focuses on:

- Collecting and preprocessing student academic datasets
- Handling missing values and feature normalization
- Applying feature engineering techniques
- Building a Deep Feed Forward Neural Network using TensorFlow/Keras
- Training the model for student performance prediction
- Applying activation functions such as ReLU and Softmax
- Using optimizers like SGD and Adam for model training
- Evaluating prediction accuracy using confusion matrix and classification report
- Comparing different optimization techniques and activation functions

Documentation must contain:

- Objective and problem definition
- Dataset description and preprocessing methods
- Neural network architecture diagram
- Optimizer and activation function comparison
- Training and validation performance graphs
- Prediction results and accuracy analysis
- Challenges faced during implementation
- Future enhancements using ensemble learning

PROJECT 2: Heart Disease Prediction System using Deep Learning

Project Implementation, Documentation and Viva Voce

Implementation mainly focuses on:

- Loading and preprocessing heart disease datasets
- Performing normalization and feature selection
- Building Deep Neural Network models for disease prediction
- Applying dropout and regularization techniques to reduce overfitting
- Comparing DNN performance with SVM classifier
- Using TensorFlow/PyTorch for implementation
- Evaluating the model using accuracy, precision, recall, and F1-score
- Creating a simple prediction interface/dashboard
- Analyzing loss convergence and optimizer performance

Documentation must contain:

- Objective and healthcare problem statement
- Dataset details and preprocessing techniques
- DNN architecture and workflow diagram
- Optimization and regularization techniques used
- Model evaluation metrics and confusion matrix
- Prediction screenshots and analysis
- Challenges and limitations
- Future scope and enhancements

PROJECT 3: Handwritten Digit Recognition using Convolutional Neural Networks

Project Implementation, Documentation and Viva Voce

Implementation mainly focuses on:

- Loading and preprocessing the MNIST dataset
- Performing image normalization and reshaping
- Building a CNN model with convolution, pooling, and dense layers
- Applying dropout and batch normalization techniques

- Training and validating the CNN model
- Visualizing feature maps and convolution outputs
- Predicting handwritten digits from custom images
- Comparing CNN performance with traditional neural networks
- Evaluating accuracy and loss convergence

Documentation must contain:

- Objective and problem definition
- Dataset description and preprocessing steps
- CNN architecture diagram
- Training parameters and optimizer details
- Accuracy and loss analysis
- Sample prediction outputs
- Feature visualization results
- Future enhancements using pre-trained CNN models

PROJECT 4: Animal Image Classification using Transfer Learning

Project Implementation, Documentation and Viva Voce

Implementation mainly focuses on:

- Collecting and preprocessing animal image datasets
- Performing image augmentation and normalization
- Using pre-trained CNN models such as VGG16 or ResNet
- Applying transfer learning for image classification
- Fine-tuning dense layers for improved performance
- Training and validating the classification model
- Comparing transfer learning with custom CNN models
- Predicting unseen animal images
- Generating classification reports and confusion matrix

Documentation must contain:

- Objective and application overview
- Dataset preparation and augmentation methods
- Transfer learning workflow diagram
- Pre-trained model architecture explanation
- Model evaluation and performance analysis
- Accuracy comparison graphs
- Prediction screenshots and outputs
- Future enhancements using advanced CNN architectures

PROJECT 5: Movie Review Sentiment Analysis using LSTM

Project Implementation, Documentation and Viva Voce

Implementation mainly focuses on:

- Loading and preprocessing IMDB movie review dataset
- Performing text cleaning and tokenization
- Applying one-hot encoding and word embeddings
- Building an LSTM-based sentiment analysis model
- Training the model for binary text classification
- Using sequence padding and embedding layers
- Evaluating model accuracy and loss convergence
- Predicting sentiment for custom user reviews
- Comparing RNN and LSTM performance

Documentation must contain:

- Objective and problem statement
- Dataset and vocabulary analysis
- Text preprocessing methodology

- LSTM architecture and sequence flow diagram
- Training parameters and optimizer details
- Accuracy/loss convergence graphs
- Sample prediction outputs
- Future scope using Bidirectional LSTM or Transformers

PROJECT 6: News Category Classification using RNN and Word Embeddings

Project Implementation, Documentation and Viva Voce

Implementation mainly focuses on:

- Collecting and preprocessing news article datasets
- Performing tokenization and sequence generation
- Implementing one-hot encoding and word embeddings
- Building RNN/LSTM models for multi-class text classification
- Training the model to classify news into categories
- Applying dropout and regularization techniques
- Evaluating model performance using precision, recall, and F1-score
- Visualizing training accuracy and loss graphs
- Comparing Simple RNN and LSTM model performance

Documentation must contain:

- Objective and problem definition
- Dataset description and preprocessing techniques
- RNN/LSTM architecture workflow
- Embedding and sequence modeling explanation
- Training configuration and evaluation metrics
- Classification results and confusion matrix
- Challenges in sequence modeling
- Future enhancements using attention mechanisms

Textbooks:

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, ISBN: 9780262035613
- 2 Deep learning: A practitioner's approach, Josh Patterson and Adam Gibson, O'Reilly Media, First Edition, ISBN: 978-1491914250

Reference Books:

- 1 Fundamentals of Deep Learning, Designing next generation machine intelligence algorithms, Nikhil Buduma, O'Reilly, Shroff Publishers, ISBN: 978-9352135608
- 2 Deep learning Cookbook, Practical recipes to get started Quickly, Douwe Osinga, O'Reilly, Shroff Publishers, ISBN: 978-9352137572

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_cs62/preview
- 2 <https://keras.io/datasets/>

Note:

- The cornerstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The evaluation of the Cornerstone Project shall be based on the project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository (if applicable).

Natural Language Processing

Course Code: 241AI010

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain datasets for NLP tasks and context free grammar.
- CO2:** Explain Text preprocessing and stemming algorithms.
- CO3:** Explain feature engineering on text data
- CO4:** Apply similarity measures and word embedding models
- CO5:** Explain text summarization and semantic analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1		1			1	1		2
CO2	2	2	2		2			1	1		2
CO3	2	2	3		1			1	1		2
CO4	2	2	3		1			1	1		1
CO5	2	2	3		1			1	1		1

UNIT – I

Overview of Natural Language Processing, Natural Language Processing and Python: Understanding Natural language Processing and applications, NLTK, Corpus and Dataset, understanding structure of sentence Defining Context free grammar, Morphological Analysis

Practice:

1. Word Analysis Learn about morphological features of a word by analysing it
2. Word Generation generate word forms from root and suffix information.

UNIT – II

Syntactic Analysis, Semantic analysis, Ambiguity resolution, Discourse integration, Preprocessing tokenization, stemming, lemmatization, Word tokenization and lemmatization

Practice:

1. Implement Porter Stemming Algorithm
2. NGrams learn to calculate bigrams from a given corpus and calculate probability of a sentence

UNIT – III

Feature engineering and NLP algorithms parsers, context free grammars, different types of parsers, POS tagging and different types of POS parsers.

Practice:

1. Morphology understanding the morphology of a word by the use of AddDelete table.
2. POS Tagging – calculate emission and transition matrix which will be helpful for tagging Parts of Speech

UNIT – IV

Basic statistical features of NLP: TFIDF, Vectorization Encoders and Decoders, Normalization, Advanced feature engineering and NLP algorithms Basics of Word2Vec

Practice:

1. Apply term frequency(TFIDF) to Measures the importance of a word to a specific document
2. Implement word embedding using word2vec

UNIT – V

Rule Based system for NLP, Machine Learning for NLP problems, Applications of NLP Text Summarization, Sentiment Analysis

Practice:

1. Chunking understand the concept of chunking and get familiar with the basic chunk tag set.
2. Building Chunker the importance of selecting proper features for training a model and size of training corpus in learning how to do chunking.

Text Books:

- 1 Python Natural Language Processing, Thanaki J, Packt Publishing Ltd, ISBN: 9781787121423
- 2 Springer Handbook of Speech Processing, Jacob Benesty, M. M. Sondhi, Yiteng Huang Springer, ISBN: 978-3-540-49127-9

Reference Books:

- 1 Speech & language processing, Jurafsky D, Pearson Education India, ISBN: 978-9332518414
- 2 Foundations of Statistical Natural Language Processing, Christopher, D. Manning and Hinrich Schütze, MIT Press, ISBN: 9780262133609

Web Links:

- 1 <https://www.nltk.org/data.html>
- 2 <https://www.analyticsvidhya.com/blog/2017/01/ultimateguidetounderstandimplementnaturallanguageprocessingcodesinpython/>
- 3 https://datahack.analyticsvidhya.com/contest/linguipediacontestnaturallanguageprocessing1/?utm_source=ultimateguidetounderstandimplementnaturallanguageprocessingcodesinpython&utm_medium=blog

Reinforcement Learning

Course Code: 241AI009

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Outline the basic concepts of Reinforcement learning.
- CO2:** Identify the appropriate learning tasks for Reinforcement learning techniques.
- CO3:** Implement adversarial training techniques to train GAN models.
- CO4:** Analyse the applications of VAEs in various domains.
- CO5:** Evaluate the ethical considerations and societal impact of reinforcement learning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2			2					1		
CO2	2	2			2					1		
CO3	3	2			2					1		
CO4	3	2	1		2					1		
CO5	2	1	1		2					1		

UNIT – I

Introduction to Reinforcement Learning

Basics of reinforcement learning (RL), RL components: agents, environments, rewardsbased Markov Decision Processes (MDPs), Exploration vs. Exploitation dilemma, Basic algorithms: Qlearning, SARSA, MonteCarlo (MC) Learning.

Practice:

1. Installation of TensorFlow and implement the basic programs.
2. Installation of PYTORCH and implement the basic programs.

UNIT – II

Advanced Reinforcement Learning Techniques

Deep QNetworks (DQN), Policy Gradient methods, ActorCritic architectures, Advantage ActorCritic (A2C) and Proximal Policy Optimization (PPO).

Practice:

1. Model an agent learning to drive a car up a steep mountain by applying the correct amount of throttle and braking. (Policy Gradient Methods)
2. Use deep reinforcement learning to train an agent to play various Atari games, such as Breakout, Space Invaders, or PacMan.

UNIT – III

Generative Adversarial Networks (GANs)

Introduction to generative models, Basics of GANs: generator, discriminator, Training GANs: adversarial training, Variants of GANs: Conditional GANs, Wasserstein GANs, etc., data augmentation.

Practice:

1. Train an agent to play Flappy Bird, a sidescrolling game where the agent controls the flight of a bird through a series of pipes.
2. Simulate a colony of ants foraging for food in a dynamic environment, where the agent learns to find and retrieve food while avoiding obstacles and predators.

UNIT – IV

Variational Autoencoders (VAEs)

Introduction to autoencoders, Variational inference and latent variable models, Encoder and decoder architectures in VAEs, Training VAEs Maximizing Evidence Lower Bound (ELBO).

Practice:

1. Track Detection for Autonomous vehicles using VAE
2. Train a robotic arm to perform various tasks, such as reaching a target location or manipulating objects, using reinforcement learning.

UNIT – V

Advanced Topics in Reinforcement Learning

Modelbased RL and world models, multiagent reinforcement learning, Transfer learning and metalearning in RL

Practice:

1. Develop a trading agent that learns to make profitable trades in financial markets by analyzing historical data and adapting its trading strategy over time
2. Experiment with different strategies for solving the multiarmed bandit problem, where an agent must decide which arm of a slot machine to pull to maximize cumulative reward.

Text Books:

- 1 Reinforcement Learning An Introduction, R. S. Sutton and A. G. Barto, MIT Press, 2018, ISBN: 9780262039246

Reference Books:

- 1 Algorithms for Reinforcement Learning, Szepesvári, Csaba, United States: Morgan & Claypool, ISBN: 978-1608454921
- 2 Markov Decision Processes: Discrete Stochastic Dynamic Programming, Arman, Martin L., Germany, Wiley, ISBN: 978-0471727828

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_cs74/preview
- 2 <https://www.coursera.org/learn/fundamentalsofreinforcementlearning>

AI in Agriculture

Course Code: 241AI029

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate the basic statistical concepts in Artificial Intelligence.
- CO2:** Apply AI techniques like machine learning, image processing, and IoT for efficient soil management
- CO3:** Develop AI-based decision support systems for water management
- CO4:** Utilize AI for farm mechanization, focusing on the navigation of farm machinery
- CO5:** Implement AI and ML methods in food processing, packaging, and market analysis

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1		2	1		2			1			3
CO2		2	1		2			1			3
CO3		2		3	1			1			1
CO4	2	2	3		1			1			
CO5	1	2	3		1			1			

UNIT-I

AI fundamentals

Basic concepts of Artificial Intelligence (AI), Artificial Neural Networks (ANNs), Machine Learning (ML), Machine Vision, Internet of Things (IoT), Cloud Computing, Statistical Computing, Deep Learning, Expert Systems, Automated Data Analytics.

Practice:

1. Implement a simple Artificial Neural Network (ANN) to classify a dataset for predicting crop type based on soil features.

UNIT-II

AI for Agricultural Systems

Application of AI-ML for digital soil mapping, augmented reality for precise soil sampling, image processing for rapid soil property prediction via smartphone, soil spectroscopy-exploring the high dimensional soil spectral data, spectral preprocessing methods, modelling soil properties via ML algorithms, IoT in soil management.

Practice:

1. Use AI and ML techniques to create a digital soil map by processing soil data, utilizing spectral preprocessing methods, and building models to predict soil properties.

UNIT-III

AI for Water Management:

On-farm water, nutrient and pest management, crop damage assessment, decision support systems, crop modelling, smart irrigation, yield prediction, rainfall-runoff, streamflow, sediment and water quality.

Practice:

1. Implement an AI model for predicting rainfall-runoff, streamflow, and water quality, and validate it against historical data to optimize water use in agriculture.

UNIT-IV

AI for Farm Mechanization

Application of AI for navigation of farm machinery, energy demand prediction for farm mechanization, and quality of tillage; Uniformity prediction for sowing, planting and transplanting; Crop disease detection, quantification of severity and mitigation; crop yield monitoring, and prediction of harvesting and threshing quality; AI for farm machinery management and custom hiring.

Practice:

1. Create a model using AI to navigate farm machinery and predict energy demand for various farm tasks.

UNIT – V

AI for Food Processing

Application of AI and ML in food processing and packaging. Non-destructive quality evaluation of food based on spectral data, Image based quality detection, varietal identification of fruits and vegetables, sorting of products and packages, decision making for the consumers and profit enhancement by the industry people by proper market survey using AI, new product formulation.

Practice:

1. Implement an AI solution for non-destructive quality evaluation of food products based on spectral data.

Text Books:

- 1 Artificial Intelligence in Agriculture: A Comprehensive Guide, Rajesh Singh, Anita Gehlot, and Lakhveer Kaur, 2021, ISBN: 978-1119714743.
- 2 Artificial Intelligence in Agriculture: A Systems Approach, Mohammad Naushad Emmambux, 2023 ISBN: 978-9819925243.

Reference Books:

- 1 Data Science and Artificial Intelligence for Agricultural Applications S. Raja, P. Vignesh, and R. Bhuvaneswari, 2021, ISBN: 978-3030852129.

Web Links:

- 1 <https://keras.io/datasets/>
- 2 <http://deeplearning.net/tutorial/deeplearning.pdf>

Robotics & AI

Course Code: 241AI030

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the fundamental concepts of robotics and AI, including key components and types of robots.
- CO2:** Analyse and apply kinematics and dynamics for robotic motion and trajectory planning.
- CO3:** Develop and implement perception and sensing techniques for robotic applications.
- CO4:** Design control systems and apply AI techniques for autonomous robot operation and navigation.
- CO5:** evaluate current applications and future trends in robotics and AI, considering ethical implications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1		2	1		2			1			3
CO2		2	1		2			1			3
CO3		2		3	1			1			1
CO4	2	2	3		1			1			
CO5	1	2	3		1			1			

UNIT-I

Introduction to Robotics and AI

Definition and History of Robotics and AI, Fundamental Concepts: Autonomous Systems, Artificial Intelligence, Machine Learning, Types of Robots: Industrial, Service, Humanoids, Autonomous Vehicles, Key Components of a Robot: Sensors, Actuators, Control Systems, Power Supply, Overview of Robotics Software: ROS (Robot Operating System), Ethical Considerations and Challenges in Robotics and AI

Practice:

1. Implement forward and inverse kinematics for a 2-DOF or 3-DOF robotic arm and plan a path for the end effector to reach a target position.

UNIT-II

Kinematics and Dynamics of Robots

Basics of Kinematics: Forward and Inverse Kinematics, Types of Robotic Manipulators: Articulated, SCARA, Cartesian, Delta Denavit-Hartenberg (D-H) Parameters and Transformation Matrices, Robot Dynamics: Newton-Euler and Lagrangian Methods, Trajectory Planning and Control, Practical Examples and Case Studies in Robotic Motion

Practice:

1. Develop a computer vision-based system for detecting and tracking objects in real-time.

UNIT-III

Robot Perception and Sensing

Introduction to Sensors in Robotics: Proximity, Vision, LIDAR, IMU, GPS, Computer Vision and Image Processing for Robotics, Object Detection, Recognition, and Tracking

Depth Sensing and 3D Perception, Sensor Fusion Techniques, Introduction to SLAM (Simultaneous Localization and Mapping), Machine Learning in Perception: Neural Networks and Deep Learning for Robotics

Practice:

1. Implement a basic SLAM algorithm to enable a mobile robot to navigate an unknown environment.

UNIT-IV

Robot Control Systems and AI Techniques

Basics of Control Theory: PID Controllers, State-Space Representation, Advanced Control Techniques: Adaptive and Robust Control, Fuzzy Logic, and Neural Network-Based Control, Reinforcement Learning for Robotics: Basics and Applications, Motion Planning Algorithms: A*, Dijkstra, RRT (Rapidly exploring Random Trees)

Practice:

1. Train a robot to navigate through an environment using reinforcement learning techniques

UNIT – V

AI in Robotics

Autonomous Navigation, Decision Making, and Task Planning, Swarm Robotics: Principles and Coordination Algorithms

Practice:

1. Develop a simple HRI interface that allows a robot to understand and respond to basic voice commands

Text Books:

- 1 Deep Learning, Ian Goodfellow, YoshuaBengio, Aaron Courville, MIT Press, ISBN : 978-0262035613, 2016.
- 2 Deep learning: A practitioner's approach, Josh Patterson and Adam Gibson, O'Reilly Media, First Edition , ISBN : 978-1491914250, 2017.

Reference Books:

- 1 Fundamentals of Deep Learning, Designing next-generation machine intelligence algorithms, Nikhil Buduma, O'Reilly, Shroff Publishers, ISBN: 978-1492082187, 2022.
- 2 Deep learning Cookbook, Practical recipes to get started Quickly, DouweOsinga, O'Reilly, Shroff Publishers, ISBN : 978-9352137572, 2018.

Web Links:

- 1 <https://keras.io/datasets/>
- 2 <http://deeplearning.net/tutorial/deeplearning.pdf>
- 3 <https://arxiv.org/pdf/1404.7828v4.pdf>

AI in finance & Economics

Course Code: 241AI031

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate financial market fundamentals, risk-return analysis, and statistical methods.
- CO2:** Apply R programming to economic theories, portfolio construction, asset pricing models.
- CO3:** Analyse algorithmic trading strategies, including trend determination, risk measures
- CO4:** Formulate economic problems using AI/ML techniques, optimization and search methods
- CO5:** Evaluate causal relationships and decision-making in economics through techniques like Granger causality, Shapley value analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1		2	1		2			1			3
CO2		2	1		2			1			3
CO3		2		3	1			1			1
CO4	2	2	3		1			1			
CO5	1	2	3		1			1			

UNIT-I

Introduction

financial markets, Risk-Return Analysis in Investment Decisions – Measures of Risk and Return, Introduction to probability and statistics ,Statistical Inference: Hypothesis Testing and Confidence Intervals

UNIT-II

Introduction to R programming

Programming with R, Economic Theory of Choice, Market Microstructure and Liquidity (Order-drive vs. Quote-driven markets) Introduction to portfolio construction and optimization, Introduction to Asset pricing models, CAPM, Single and Multi-index models, Portfolio management and performance evaluation

Practice:

1. AI and Machine Learning in Trading execution and portfolio management:
Regression Algorithm and Case Study

UNIT-III

Algorithmic Trading

Optimizers – Introduction to tail risk measures-VaR and CVaR ,Algorithmic trading, trend determination, moving average indicators, momentum indicators

Practice:

1. AI and Machine Learning in Banking and Financial Services: Classification Algorithm and Case Study

UNIT-IV

Basic ideas of AI/ML in Economics

Motivating Applications of AI/ML in Economics & Politics. formulating / deciphering real life problems using these techniques, Optimization and Search techniques, Basic Predictive Algorithms, Time Series Prediction

Practice:

1. Learning Theory for Economics
2. Customer Behavior Analysis for Recommender Systems

UNIT – V

Causality and Attribution & Auction Theory

Shapley value analysis of predictive models, Granger Causality, Causal Graphical Models and do-Calculus, Randomized Control Trials , Mechanism Design with Economics applications, Vickrey, Myerson Auctions, Case studies of auctions, advertising strategies on the internet

Practice:

1. Reinforcement Learning in Finance
2. Multi-agent simulation of economic systems, Econo-physics

Text Books:

- 1 Sohnke M. Bartram, Mark M. Carhart, and John M. Griffin, “Artificial Intelligence in Asset Management”, ISBN: 978-1108497261, 2021.

Reference Books:

- 1 Christian L. Dunis, Peter W. Middleton, Andreas Karathanasopolous, and Konstantinos Theofilatos, "Artificial Intelligence for Financial Markets: Cutting Edge Applications for Risk Management, Portfolio Optimization, and Economics", ISBN: 978-3030307152, 2020.

Web Links:

- 1 <https://keras.io/datasets/>
- 2 <http://machinelearning.net/tutorial/machinelearning.pdf>

Production Excellence											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241ME081	Fundamentals of Production Excellence	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME082	Six Sigma for Production Excellence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME083	Quality Excellence in Production	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME084	Digital Transformation for Production Excellence	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME085	Agile Production Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME086	Process Excellence & Optimization	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME087	Risk Management in Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
241ME088	Ethical & Social Responsibility in Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE

241ME089	Data-Driven Decision Making for Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
241ME058	Industry 5.0 for Engineers	AC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
1ME090	Cost Excellence in Production	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
Total			2 3		9	32					

Fundamentals of Production Excellence

Course Code: 241ME081

L	T	P	C
2	0	0	2

Unit 1: Introduction to Production Excellence

Definition and Importance of Production Excellence: Overview of production systems and their evolution, Key principles of production excellence, Relationship between production excellence and organizational success

Elements of Production Excellence: Lean manufacturing principles, Continuous improvement (Kaizen) and problem-solving techniques, Process optimization and operational efficiency

Productivity and Competitiveness: How production excellence contributes to competitiveness, Benchmarking against industry best practices, Role of leadership and culture in driving excellence

Assignments:

- Case Study: Analysis of a company that has successfully implemented production excellence
- Research Project: Benchmarking production processes in a selected industry

Unit 2: Lean Manufacturing and Waste Reduction

Overview of Lean Manufacturing: History and philosophy of lean production, Key concepts: value, waste, flow, pull, and perfection, Lean tools: 5S, Just-In-Time (JIT), Kanban, and value stream mapping

Types of Waste (Muda): Identifying the 7 types of waste (overproduction, waiting, transportation, etc.), Techniques for waste reduction and elimination, Case studies of waste reduction in manufacturing

Lean Implementation Strategies: Steps for implementing lean manufacturing, Challenges in lean transformation and how to overcome them, The role of technology in lean manufacturing (automation, AI, IoT)

Assignments:

- Group Project: Develop a waste reduction plan for a manufacturing process
- Value Stream Mapping Exercise: Apply lean tools to optimize a production flow

Unit 3: Quality Management and Continuous Improvement

Total Quality Management (TQM): Principles of TQM and its impact on production , excellence, Key quality management tools (Pareto charts, cause-and-effect diagrams, etc.), The role of customer focus in quality management

Six Sigma and Process Improvement: Introduction to Six Sigma methodologies (DMAIC, DMADV), Tools for process improvement (control charts, process mapping, FMEA), Case studies of Six Sigma projects in production environments.

Continuous Improvement (Kaizen): Philosophy and techniques of Kaizen, Engaging employees in continuous improvement initiatives, Measuring and sustaining improvement over time

Assignments:

- Case Study: Application of TQM in a real-world production setting
- Six Sigma Project: Analyze a production problem using Six Sigma tools

Unit 4: Resource Efficiency and Sustainability in Production

Resource Optimization: Efficient use of materials, energy, and water in production processes, Lean manufacturing's role in resource efficiency, Techniques for reducing resource waste and improving operational efficiency

Sustainable Manufacturing Practices: Principles of sustainable production, Environmental impact of production processes and how to mitigate them, Circular economy principles and waste minimization

Energy Management in Production: Energy-efficient technologies for production systems, Renewable energy integration in manufacturing, Case studies of sustainable production practices in different industries

Assignments:

- Research Paper: Sustainable manufacturing practices in a specific industry
- Group Project: Develop a resource efficiency improvement plan for a manufacturing unit

Unit 5: Advanced Technologies in Production Excellence

Industry 4.0 and Smart Manufacturing: Role of AI, IoT, and big data in modern production systems, Automation, robotics, and advanced manufacturing technologies, Benefits of digital transformation in achieving production excellence

Additive Manufacturing (3D Printing): Introduction to additive manufacturing technologies, Benefits and challenges of 3D printing in production, Case studies of companies using 3D printing for production optimization

Supply Chain and Logistics Integration: Role of supply chain management in production excellence, Integrating lean and agile supply chain practices with production, Use of AI and machine learning for optimizing logistics and production flows

Assignments:

- Research Project: Analyze the impact of Industry 4.0 technologies on production excellence
- Case Study: Application of 3D printing in production optimization

Textbooks

1. Lean Thinking: Banish Waste and Create Wealth in Your Corporation, James P. Womack and Daniel T. Jones, Free Press, ISBN: 978-0743249270
2. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, Jeffrey Liker, McGraw-Hill, ISBN: 978-0071392310

Reference Books:

1. Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, Mikel Harry and Richard Schroeder, Crown Business, ISBN: 978-0385494380
2. Production and Operations Analysis Steven Nahmias, Waveland Press, Inc., (7th Edition), ISBN: 978-1478623069
3. Smart Manufacturing: Industry 4.0 and the Industrial Internet of Things, John Soldatos, Oliver Niggemann, and Thorsten Lehmhus, CRC Press, ISBN: 978-0367332336

Six Sigma for Production Excellence

Course Code: 241ME082

L	T	P	C
2	0	1	3

Unit 1: Introduction to Six Sigma and Production Excellence

Introduction to Six Sigma: Definition and history of Six Sigma, Six Sigma methodology and philosophy, Importance of Six Sigma in achieving production excellence, Key concepts: Defects, variability, process capability, and continuous improvement

Six Sigma Frameworks: DMAIC (Define, Measure, Analyze, Improve, Control), DMADV (Define, Measure, Analyze, Design, Verify)

Six Sigma Roles and Certifications: Green Belt, Black Belt, and Master Black Belt roles, Importance of leadership and teams in Six Sigma projects

Assignments:

- Case Study: Successful implementation of Six Sigma in a manufacturing company
- Group Project: Define a production problem and design a Six Sigma project outline

Unit 2: Define and Measure Phases of Six Sigma

Define, Phase: Identifying production issues and project selection, Defining project scope and objectives, Developing a project charter and SIPOC diagram (Suppliers, Inputs, Process, Outputs, Customers), Understanding customer requirements (Voice of Customer)

Measure Phase: Identifying critical-to-quality (CTQ) characteristics, Data collection methods for measuring production performance, Key performance metrics: Yield, DPMO (Defects Per Million Opportunities), and process sigma level, Measurement tools: Pareto charts, histograms, control charts

Assignments:

- Data Collection Project: Collect production data and define CTQ metrics
- SIPOC Diagram: Develop a SIPOC diagram for a chosen production process

Unit 3: Analyze and Improve Phases of Six Sigma

Analyze Phase: Root cause analysis: Fishbone diagrams, 5 Whys, Statistical analysis tools: Regression analysis, hypothesis testing, ANOVA, Identifying and verifying root causes of production defects, Process capability analysis (Cp, Cpk) and its significance in production excellence.

Improve Phase: Generating solutions to address root causes of defects, Brainstorming, FMEA (Failure Mode and Effects Analysis), and solution prioritization, Piloting and testing solutions for process improvement, Lean Six Sigma tools for improvement: Kaizen, 5S, Poka-Yoke (error-proofing)

Assignments:

- Root Cause Analysis: Identify root causes of a production issue using 5 Whys or fishbone diagram
- Improvement Project: Propose a solution to a production problem using Lean Six Sigma tools

Unit 4: Control Phase and Sustaining Improvements

Control Phase: Developing control plans and monitoring processes, Control charts: Types and applications (X-bar, R-chart, P-chart, etc.), Ensuring process stability and maintaining improvements over time, Documenting changes and implementing standard operating procedures (SOPs)

Sustaining Production Excellence: Continuous monitoring and feedback loops, Role of leadership in sustaining Six Sigma improvements, Building a culture of continuous improvement in production environments, Tools for long-term sustainability: PDCA cycle, statistical process control (SPC)

Assignments:

- Control Chart Exercise: Develop and analyze control charts for a production process
- Final Project: Implement a Six Sigma project for process improvement and control

Unit 5: Advanced Six Sigma Concepts and Applications in Production

Advanced Statistical Tools in Six Sigma: Design of Experiments (DOE) for optimizing production processes, Advanced regression analysis and multivariate analysis, Process simulation and modeling for production optimization, Use of software tools for Six Sigma (Minitab, JMP, etc.)

Lean Six Sigma Integration: Combining Lean and Six Sigma for enhanced production excellence, Lean tools: Kanban, JIT (Just-in-Time), SMED (Single-Minute Exchange of Die)

Case studies of Lean Six Sigma in manufacturing industries

Future Trends in Six Sigma for Production Excellence: Industry 4.0 and the role of AI and automation in Six Sigma, Applications of Six Sigma in sustainable production and green manufacturing, Emerging trends: Predictive analytics and real-time data for Six Sigma

Assignments:

- Research Project: Application of advanced Six Sigma tools in a real-world production setting
- Group Presentation: Emerging trends and the future of Six Sigma in production excellence

Textbooks :

1. The Six Sigma Handbook, Thomas Pyzdek and Paul Keller, McGraw-Hill Education, 5th Edition, ISBN: 978-1260121827
2. Lean Six Sigma and Minitab: The Complete Toolbox Guide for Business Improvement,

Quentin Brook, OPEX Resources, ISBN: 978-0954681388

Reference Books:

1. Six Sigma for Managers, Greg Brue, McGraw-Hill, ISBN: 978-0071455480
2. Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions, Michael George, McGraw-Hill, ISBN: 978-0071418218
3. Design for Six Sigma: A Roadmap for Product Development, Kai Yang and Basem El-Haik, McGraw-Hill, ISBN: 978-0071547673

Quality Excellence in Production

Course Code: 241ME083

L	T	P	C
2	0	1	3

Unit 1: Introduction to Quality Management in Production

Definition and Importance of Quality: Overview of quality concepts and dimensions in production, The role of quality management in achieving production excellence, Key quality pioneers and philosophies (Deming, Juran, Crosby), Principles of Quality Management:, Total Quality Management (TQM), The concept of continuous improvement (Kaizen), Quality culture and leadership in production

Cost of Quality (COQ): Understanding the four categories of quality costs: prevention, appraisal, internal failure, external failure, How to measure and manage quality-related costs

Assignments:

- Research Paper: Impact of TQM on production efficiency
- Case Study: Analysis of quality management in a manufacturing company

Unit 2: Quality Control Tools and Techniques

Introduction to Quality Tools: Seven basic quality control tools: Cause-and-effect diagrams, control charts, flowcharts, check sheets, histograms, Pareto charts, scatter diagrams, Application of quality tools in real-life production environments. Statistical Process Control (SPC): Understanding variability in production processes, Control charts and process capability analysis (Cp, Cpk), Case studies on the use of SPC for process improvement

Sampling and Inspection: Types of sampling methods (random, systematic, stratified), Acceptance sampling plans (AQL, LTPD), Role of inspection in quality management

Assignments:

- Project: Develop control charts for a chosen production process
- Application: Implement one of the seven quality tools in a production environment

Unit 3: Quality Standards and Certifications

Introduction to Quality Standards: Overview of ISO 9000 series standards, Importance of international standards in quality management, The process of ISO certification and its impact on production excellence

Industry-Specific Quality Certifications: AS9100 (Aerospace), ISO/TS 16949 (Automotive), ISO 13485 (Medical Devices), Understanding the relevance of different certifications to various industries, Auditing for Quality Assurance: Types of audits (internal, external, supplier), Role of audits in maintaining and improving quality standards, Continuous improvement through auditing and feedback

Assignments:

- Research Paper: How ISO 9001 improves production processes

- Group Project: Develop a quality audit plan for a manufacturing company

Unit 4: Six Sigma and Lean for Quality Excellence

Introduction to Six Sigma: Six Sigma methodology and its relevance in quality improvement, DMAIC (Define, Measure, Analyze, Improve, Control) process in Six Sigma, Tools and techniques used in Six Sigma (e.g., process mapping, FMEA), Lean Manufacturing and Waste Reduction: Lean principles and the concept of waste elimination (Muda), Tools for Lean implementation (5S, JIT, Kanban, value stream mapping), Integrating Lean and Six Sigma for operational excellence, Case Studies: Successful Lean Six Sigma projects in production environments, Benefits of applying Lean Six Sigma in improving quality

Assignments:

- Group Project: Identify and reduce waste in a production process using Lean tools
- Case Study: Application of Six Sigma for quality improvement in a manufacturing setting

Unit 5: Advanced Quality Management Practices

Quality by Design (QbD): Importance of designing quality into products and processes, Principles of QbD and its role in achieving production excellence, Case studies on the implementation of QbD in various industries, Supplier Quality Management: Ensuring supplier quality in production, Developing supplier relationships and performance monitoring, Tools for managing supplier quality (supplier scorecards, audits), Technology and Innovation in Quality Management: Role of Industry 4.0 and smart manufacturing in quality excellence, Use of data analytics and AI for predictive quality control, Future trends in quality management

Assignments:

- Research Project: Quality by Design in modern manufacturing
- Presentation: The impact of Industry 4.0 on quality management in production

Textbooks:

1. Juran's Quality Handbook: The Complete Guide to Performance Excellence, Joseph A. De Feo and J.M. Juran, McGraw-Hill Education, 7th Edition, ISBN: 978-1259643613
2. Quality Control and Management, James R. Evans and William M. Lindsay, Cengage Learning, ISBN: 978-1305662544

Reference Books:

1. The Certified Six Sigma Green Belt Handbook, Roderick A. Munro, Govindarajan Ramu, Daniel J. Zrymiak, ASQ Quality Press, ISBN: 978-0873898911
2. The Lean Six Sigma Pocket A Quick Reference Guide to Nearly 100 Tools for Improving Quality and Speed, Michael L. George, John Maxey, David Rowlands, McGraw-Hill, ISBN: 978-0071441193
3. Total Quality Management and Operational Excellence: Text with Cases, John S. Oakland, Routledge, ISBN: 978-1138198006.

Digital Transformation for Production Excellence

Course Code: 241ME084

L	T	P	C
2	0	1	3

Unit 1: Introduction to Digital Transformation in Production

Understanding Digital Transformation: Definition and significance of digital transformation in modern manufacturing, Key drivers of digital transformation (customer expectations, technological advancements, competitive pressure), Impact of digital transformation on production processes and operations, Digital Technologies in Production: Overview of key digital technologies: Internet of Things (IoT), artificial intelligence (AI), robotics, cloud computing, and big data analytics, The role of these technologies in enhancing productivity, quality, and operational efficiency, Industry 4.0 and Smart Manufacturing: Introduction to Industry 4.0 and its components (cyber-physical systems, IoT, and smart factories) ,Case studies of Industry 4.0 implementations in various industries

Assignments:

- Case Study: Impact of Industry 4.0 on production excellence
- Group Project: Research and present a real-life example of digital transformation in production

Unit 2: Data-Driven Production and Analytics

The Role of Data in Production Excellence: Understanding the importance of data collection, analysis, and utilization in production, Data sources in production systems: sensors, machines, ERP systems, Introduction to big data and data analytics for production decision-making, Predictive and Prescriptive Analytics: Predictive analytics for forecasting machine failures, maintenance schedules, and demand planning, Prescriptive analytics for optimizing production processes and improving decision-making, Case studies on the use of predictive analytics in production systems, AI and Machine Learning in Production: Introduction to machine learning algorithms and their application in manufacturing, Role of AI in process optimization, defect detection, and quality control,

Assignments:

- Data Analytics Project: Use production data to identify potential improvements
- Research Paper: Applications of AI and machine learning in predictive maintenance

Unit 3: Automation and Robotics for Production Excellence

Automation in Manufacturing: Introduction to automation technologies (robotics, automated guided vehicles, CNC machines), Benefits of automation: increased efficiency, reduced human error, improved quality, Levels of automation: from simple robotic arms to fully autonomous systems, Collaborative Robots (Cobots): Role of collaborative robots in augmenting human workers in production environments, Safety and productivity considerations in implementing cobots, Advanced Robotics and AI Integration: Case studies of fully automated and AI-integrated production lines, Benefits of robotic process automation (RPA) for repetitive tasks in production

Assignments:

- Case Study: Successful implementation of robotics in a production line
- Group Project: Propose an automation plan for a selected manufacturing process

Unit 4: Smart Factories and Digital Supply Chains

Smart Factory Concepts:, Definition and components of a smart factory (interconnected systems, autonomous processes, real-time data), Role of IoT in enabling smart factories (sensor networks, real-time monitoring), Benefits of smart factories in achieving production excellence (cost savings, agility, transparency), Digital Supply Chain Transformation: How digital technologies optimize supply chain operations (demand forecasting, inventory management, logistics), Integration of digital twins, blockchain, and AI in the supply chain

Case studies on digital supply chain transformation, Cybersecurity in Digital Production: Importance of cybersecurity in Industry 4.0 environments ,Common cybersecurity challenges in smart factories and digital supply chains, Best practices for securing digital production systems

Assignments:

- Smart Factory Project: Design a smart factory model using IoT and automation technologies
- Research Paper: Digital supply chain innovations and their impact on production efficiency

Unit 5: Change Management and Digital Transformation Strategies

Challenges in Digital Transformation: Common barriers to digital transformation in production environments (legacy systems, resistance to change, lack of skills), Strategies for overcoming challenges and driving successful transformation, Role of leadership in fostering a culture of innovation and digital adoption, Change Management for Digital Transformation: Understanding the importance of change management in implementing new technologies, Tools and frameworks for managing organizational change (ADKAR model, Kotter's 8-Step Process), Engaging employees and managing transitions to digital workflows, Future Trends in Digital Transformation for Production Excellence: Emerging technologies and trends: edge computing, 5G networks, augmented reality (AR) in production, Case studies on future trends and their potential impact on the manufacturing sector.

Assignments:

- Group Presentation: Change management strategies for digital transformation in a real-world production setting
- Final Project: Develop a digital transformation roadmap for a manufacturing organization

Textbooks

1. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress, ISBN: 978-1484220467
2. Smart Manufacturing: Industry 4.0 and the Industrial Internet of Things, John Soldatos, Oliver Niggemann, Thorsten Lehmhus, CRC Press, ISBN: 978-0367332336

Reference Books:

1. Digital Transformation: Survive and Thrive in an Era of Mass Extinction, Thomas M. Siebel, RosettaBooks, ISBN: 978-1948122481
2. The Fourth Industrial Revolution, Author: Klaus Schwab, Crown Business, ISBN: 978-1524758868
3. Big Data in Practice: How 45 Successful Companies Used Big Data Analytics to Deliver Extraordinary Results, Bernard Marr, Wiley, ISBN: 978-1119231387

Agile Production Systems

	L	T	P	C
Course Code: 241ME085	2	0	1	3

Unit 1: Introduction to Agile Production Systems

Overview of Agile Production: Definition and importance of agility in production systems, Evolution of production systems: From traditional, lean, to agile, Key characteristics of agile production: flexibility, responsiveness, and customer focus, Differences between lean and agile production systems, Drivers of Agility in Production: Market demands and the need for customized products, Shorter product life cycles and rapid technological advancements, The role of globalization and competition in driving agility, Agile vs. Traditional Manufacturing: Comparison of mass production, lean, and agile approaches, Benefits and challenges of adopting agile production systems

Assignments:

- Case Study: A comparison between lean and agile production systems in a manufacturing company
- Group Project: Identify the drivers for adopting agile production in a real-world company

Unit 2: Agile Manufacturing Frameworks and Strategies

Core Concepts of Agile Manufacturing: Understanding agility and flexibility in manufacturing, Importance of modularity and reconfigurable manufacturing systems, Agile supply chain integration and collaboration with partners, Mass customization and agile , product design strategies, Agile Manufacturing Strategies: Quick response manufacturing (QRM), Postponement strategy and its role in agile production, Hybrid manufacturing systems: Combining lean and agile principles, Tools and Technologies Enabling Agile Production: Automation, robotics, and AI in achieving agility, Advanced manufacturing technologies (3D printing, CNC machining)

Assignments:

- Research Paper: Impact of advanced technologies on agility in production systems
- Case Study: Implementation of mass customization in a manufacturing firm

Unit 3: Agile Supply Chain and Logistics

Agile Supply Chain Concepts: Agile supply chain characteristics: flexibility, responsiveness, and customer-centricity, Differences between lean and agile supply chains, The role of collaboration and information sharing in agile supply chains, Strategies for Agile Supply Chains:, Supply chain segmentation based on product demand variability, Supplier management and the role of strategic partnerships, Role of logistics in enabling agile production systems, Supply Chain Flexibility and Adaptability: Real-time data and decision-making in supply chain management, Risk management and handling disruptions in agile supply chains, Case studies of agile supply chain implementation in various industries

Assignments:

- Group Project: Design an agile supply chain for a manufacturing company
- Research Paper: The role of real-time data in improving supply chain agility

Unit 4: Agile Project Management for Production Systems

Introduction to Agile Project Management: Principles and benefits of agile project management in production, Differences between traditional and agile project management, Agile methodologies: Scrum, Kanban, and their application in production, Agile Practices in Manufacturing Projects: Iterative development and continuous improvement in production systems, Customer feedback and its integration into product development, Agile team structures and roles (Scrum Master, Product Owner, Development Team), Agile Frameworks for Production Optimization: Using Scrum and Kanban to manage production workflows, Real-world examples of agile project management in manufacturing environments, Role of leadership in fostering an agile culture

Assignments:

- Agile Project: Implement a Scrum or Kanban framework in a simulated production environment
- Research Paper: The role of agile project management in improving production efficiency

Unit 5: Future Trends and Sustainability in Agile Production Systems

Emerging Trends in Agile Production: Digital transformation and its impact on agile manufacturing, Industry 4.0 and smart factories as enablers of agility, Use of AI, IoT, and big data analytics for real-time decision-making in agile production systems, Sustainability and Agile Production: The role of agile systems in sustainable manufacturing, Green manufacturing practices and agile production, Reducing waste and improving resource efficiency through agility, Future of Agile Production: Evolving customer expectations and the need for hyper-customization, Integration of new technologies such as augmented reality and virtual reality in agile production, Predictive analytics and automation as future enablers of agile production

Assignments:

- Group Presentation: The impact of Industry 4.0 technologies on agile production
- Final Project: Develop a sustainable agile production system for a manufacturing company

Textbooks

1. Agile Manufacturing: Forging New Frontiers, Paul T. Kidd, Addison-Wesley Professional, ISBN: 978-0201631634.
2. Agile Manufacturing: The 21st Century Competitive Strategy, A. Gunasekaran, Elsevier, ISBN: 978-0080435671

Reference Books:

1. Manufacturing Systems and Technologies for the New Frontier: The 41st CIRP Conference on Manufacturing Systems, Mamoru Mitsuishi, Kanji Ueda, Fumihiko Kimura, Springer, ISBN: 978-1848002661
2. Agile Supply Chain: Integrating Suppliers and Customers into the Network, Pamela Danese, Pietro Romano, Springer, ISBN: 978-1849960809
3. The Lean Mindset: Ask the Right Questions, Mary Poppendieck, Tom Poppendieck, blisher: Addison-Wesley, ISBN: 978-0321896902

Process Excellence & Optimization

Course Code: 241ME086

L	T	P	C
2	0	1	3

Unit 1: Introduction to Process Excellence

Fundamentals of Process Excellence:, Definition and importance of process excellence in organizations, Key principles and methodologies: Total Quality Management (TQM), Six Sigma, Lean ,The role of process excellence in achieving competitive advantage, Process Mapping and Analysis: Techniques for mapping processes (flowcharts, SIPOC diagrams), Identifying process inputs, outputs, and key performance indicators (KPIs), Analyzing process performance using metrics and benchmarks, Process Improvement Frameworks: Overview of popular frameworks: DMAIC (Define, Measure, Analyze, Improve, Control), PDCA (Plan-Do-Check-Act), Case studies on successful process improvement initiatives

Assignments:

- Case Study: Analyzing a process improvement case in a real-world organization
- Project: Create a process map and identify key areas for improvement

Unit 2: Lean Principles and Tools

Introduction to Lean Manufacturing:History and principles of Lean manufacturing, Key Lean concepts: Value stream mapping, waste reduction, continuous improvement, Lean vs. traditional manufacturing, Lean Tools and Techniques: 5S (Sort, Set in order, Shine, Standardize, Sustain), Kaizen (Continuous Improvement), Value Stream Mapping and its application in identifying and eliminating waste, Implementing Lean in Organizations: Strategies for successful Lean implementation, Overcoming challenges and resistance to change, Measuring the impact of Lean initiatives

Assignments:

- Group Project: Develop a Lean implementation plan for a chosen process
- Research Paper: The impact of Lean principles on process optimization

Unit 3: Six Sigma for Process Optimization

Introduction to Six Sigma: History and principles of Six Sigma, Understanding the Six Sigma methodology: DMAIC and DMADV (Define, Measure, Analyze, Design, Verify), The role of Six Sigma in reducing process variation and improving quality, Six Sigma Tools and Techniques: Statistical tools: Control charts, process capability analysis, hypothesis testing, Design of Experiments (DOE) and Failure Modes and Effects Analysis (FMEA), The concept of Sigma levels and their impact on process performance, Implementing Six Sigma: Steps for successful Six Sigma deployment, The role of Green Belts, Black Belts, and Master Black Belts, Case studies of Six Sigma applications in various industries,

Assignments:

- Six Sigma Project: Use Six Sigma tools to analyze and improve a process

- Research Paper: Benefits and challenges of implementing Six Sigma in organizations

Unit 4: Advanced Process Optimization Techniques

Process Simulation and Modeling: Introduction to process simulation and its importance in optimization, Tools and software for process modeling (e.g., MATLAB, Simulink), Case studies on the use of simulation for process improvement, Advanced Analytics and Optimization: Use of data analytics and machine learning in process optimization, Predictive modeling and real-time analytics for process improvement, The role of optimization algorithms in improving process performance, Benchmarking and Best Practices: Benchmarking techniques for comparing process performance, Identifying and implementing best practices from industry leaders, Case studies on successful benchmarking initiatives

Assignments:

- Project: Develop a process simulation model for a chosen process
- Research Paper: The role of advanced analytics in process optimization

Unit 5: Sustainability and Process Excellence

Sustainable Process Improvement: Principles of sustainability and their integration into process excellence, Environmental impact assessment and reduction strategies, The role of green manufacturing practices in process optimization, Integrating Sustainability with Process Optimization: Techniques for balancing process efficiency with environmental and social responsibilities, Case studies of organizations implementing sustainable process improvements, Future Trends in Process Excellence: Emerging trends and technologies impacting process excellence (e.g., Industry 4.0, IoT), The future of process optimization in a sustainable world.

Assignments:

- Group Project: Design a sustainable process improvement plan for a manufacturing or service organization
- Final Project: Analyze future trends in process excellence and their potential impact

Textbook

1. "Process Optimization: A Statistical Approach", Ignacio Castillo, Michael A. O'Neill, Springer, ISBN: 978-144715292

Risk Management in Production Excellence

Course Code: 241ME087

L	T	P	C
2	0	1	3

Unit 1: Introduction to Risk Management in Production

Fundamentals of Risk Management: Definition and importance of risk management in production environments, Key concepts: risk, risk management, risk assessment, risk mitigation, The role of risk management in achieving production excellence, Types of Risks in Production: Operational risks (equipment failure, process disruptions), Strategic risks (market fluctuations, supply chain disruptions), Compliance and safety risks (regulatory non-compliance, workplace accidents), Risk Management Frameworks and Standards: Overview of risk management frameworks (ISO 31000, COSO), The risk management process: identification, assessment, response, and monitoring, Case studies on effective risk management in production

Assignments:

- Research Paper: The role of risk management in achieving production excellence
- Group Project: Identify and assess key risks in a production process

Unit 2: Risk Identification and Assessment

Risk Identification Techniques: Methods for identifying risks: brainstorming, checklists, SWOT analysis, Tools for risk identification: Failure Modes and Effects Analysis (FMEA), Hazard and Operability Study (HAZOP), The role of historical data and trend analysis in risk identification, Risk Assessment Methods: Qualitative vs. quantitative risk assessment, Risk assessment techniques: Risk Matrix, Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Prioritizing risks based on impact and likelihood, Case Studies: Examples of risk identification and assessment in different industries, Assignments:

- Risk Assessment Project: Conduct a risk assessment for a selected production process
- Case Study: Analyze a real-world example of risk identification and assessment

Unit 3: Risk Mitigation and Control Strategies

Risk Mitigation Strategies: Developing risk mitigation plans and strategies, Risk avoidance, risk reduction, risk transfer, and risk acceptance, The role of contingency planning and emergency response plans, Control Measures and Best Practices: Implementing control measures: engineering controls, administrative controls, personal protective equipment (PPE), Best practices for risk management in production settings, Monitoring and reviewing the effectiveness of control measures, Case Studies: Successful examples of risk mitigation and control in production environments

Assignments:

- Project: Develop a risk mitigation plan for a chosen production scenario
- Research Paper: Best practices for risk control and mitigation in production

Unit 4: Risk Management in Supply Chain and Operations

Supply Chain Risk Management: Identifying and managing risks in the supply chain, Strategies for improving supply chain resilience and flexibility, The role of suppliers and partners in risk management, Operational Risk Management: Managing risks associated with production processes and operations, Implementing operational controls and process improvements, The impact of technology and automation on operational risk management, Case Studies: Examples of effective risk management in supply chain and operations

Assignments:

- Group Project: Develop a risk management plan for a supply chain scenario
- Case Study: Analyze the impact of operational risk management on production performance

Unit 5: Future Trends and Challenges in Risk Management

Emerging Trends in Risk Management:, The role of digital technologies (IoT, big data, AI) in risk management , Future challenges and opportunities in managing production risks, The impact of Industry 4.0 on risk management practices, Integrating Risk Management with Production Excellence: Aligning risk management strategies with production goals and objectives, The role of leadership and culture in effective risk management, Developing a risk-aware culture in production environments, Case Studies and Future Directions: Analysis of future trends and their impact on risk management in production, Assignments:

- Research Project: The impact of emerging technologies on risk management in production
- Final Project: Develop a comprehensive risk management strategy for a production organization

Textbook :

1. "Risk Management in Production: A Comprehensive Guide", Chris M. Hertig, Wiley, ISBN: 978-11194775

Ethical & Social Responsibility in Production Excellence

Course Code: 241ME088

L	T	P	C
2	0	1	3

Unit 1: Introduction to Ethics and Social Responsibility in Production

Fundamentals of Ethics in Production: Definition and importance of ethics in production environments, Key ethical principles: integrity, fairness, transparency, and accountability, Ethical decision-making models and frameworks, Social Responsibility in Production: Definition and scope of social responsibility, The role of corporate social responsibility (CSR) in production excellence, Balancing profitability with ethical and social considerations, Case Studies: Examples of ethical dilemmas and social responsibility issues in production settings, Assignments:

- Research Paper: The role of ethics and social responsibility in achieving production excellence
- Group Project: Analyze an ethical case study related to production practices

Unit 2: Ethical Practices in Production Operations

Ethical Labor Practices: Ensuring fair labor practices: wages, working conditions, and worker rights, Addressing issues of child labor, forced labor, and discrimination, The role of international standards and certifications (e.g., Fair Trade, SA8000), Environmental Responsibility: Ethical considerations in environmental management and sustainability, Implementing green manufacturing practices: waste reduction, resource conservation, and pollution control, Compliance with environmental regulations and standards, Ethical Supply Chain Management: Ensuring ethical practices throughout the supply chain, Supplier audits and ethical sourcing, Addressing issues of transparency and traceability,

Assignments:

- Project: Develop an ethical labor and environmental practices plan for a production organization
- Case Study: Analyze the impact of ethical practices on production operations

Unit 3: Corporate Social Responsibility (CSR) and Production Excellence

Introduction to CSR: The concept and importance of CSR in production, CSR strategies and initiatives related to production excellence, Measuring the impact of CSR activities on business performance, Implementing CSR Programs: Designing and implementing CSR programs in production environments, Engaging stakeholders: employees, customers, and communities, Reporting and communicating CSR efforts and outcomes, Case Studies: Successful CSR initiatives in the production sector, Analysis of CSR impacts on company reputation and performance

Assignments:

- Group Project: Design a CSR program for a production company

- Research Paper: The impact of CSR on production excellence and organizational success

Unit 4: Legal and Ethical Compliance in Production

Regulatory Compliance: Overview of key regulations and standards affecting production (e.g., OSHA, EPA, ISO), Ensuring compliance with local, national, and international laws, The role of compliance programs and audits in maintaining ethical standards, Ethical Compliance Programs: Developing and implementing ethical compliance programs, Training and educating employees on ethical practices and legal requirements, Handling ethical violations and whistleblowing mechanisms, Case Studies: Examples of legal and ethical compliance issues in production, Analysis of successful compliance and ethics programs

Assignments:

- Project: Develop an ethical compliance program for a production organization
- Case Study: Analyze a real-world example of compliance and ethical challenges in production

Unit 5: Future Trends and Challenges in Ethical and Social Responsibility

Emerging Trends in Ethics and Social Responsibility: The impact of technological advancements on ethical and social responsibility (e.g., AI, automation), The growing importance of sustainability and social justice issues, The role of innovation in addressing ethical and social responsibility challenges, Strategic Approaches to Ethical and Social Responsibility: Integrating ethical and social responsibility into business strategy, Building a culture of ethics and responsibility in production organizations, Future challenges and opportunities in maintaining ethical and social standards, Case Studies and Future Directions: Analysis of future trends and their impact on ethical practices in production

Assignments:

- Research Project: Future trends in ethical and social responsibility in production
- Final Project: Develop a strategic plan for addressing emerging ethical and social responsibility challenges

Textbook:

1. "Business and Society: Stakeholders, Ethics, Public Policy", Anne Lawrence, James Weber, McGraw-Hill Education, ISBN: 978-1260565584.

Data-Driven Decision Making for Production Excellence

Course Code: 241ME089

L	T	P	C
2	0	1	3

Unit 1: Introduction to Data-Driven Decision Making

Fundamentals of Data-Driven Decision Making: Definition and importance of data-driven decision making in production, Key concepts: data collection, analysis, interpretation, and application, The role of data in achieving production excellence and operational efficiency, Data Sources and Types: Types of data: structured vs. unstructured data, Sources of production data: sensors, ERP systems, production logs, and external sources, Data quality and reliability: ensuring accuracy and consistency, Introduction to Data Analytics: Overview of data analytics methods: descriptive, diagnostic, predictive, and prescriptive analytics, Tools and technologies for data analysis (e.g., Excel, R, Python, BI tools)

Assignments:

- Research Paper: The role of data-driven decision making in improving production processes
- Group Project: Identify and categorize data sources for a production system

Unit 2: Data Collection and Management

Data Collection Techniques: Methods for collecting production data: manual vs. automated, Tools and technologies for data collection: sensors, IoT devices, and software, Ensuring data integrity and accuracy in the collection process, Data Management Practices: Data storage solutions: databases, data warehouses, and cloud storage, Data management practices: data cleaning, data normalization, and data integration, Ensuring data security and privacy: compliance with regulations and best practices, Case Studies: Examples of successful data collection and management practices in production environments

Assignments:

- Project: Develop a data collection plan for a production process
- Case Study: Analyze data management practices in a real-world production organization

Unit 3: Data Analysis and Visualization

Data Analysis Techniques: Statistical analysis: mean, median, variance, and correlation, Advanced analytics: regression analysis, clustering, and time series analysis, Machine learning algorithms for predictive analytics: classification, regression, and clustering, Data Visualization: Importance of data visualization in decision making, Tools and techniques for data visualization: charts, graphs, dashboards, Best practices for creating effective visualizations and communicating insights, Case Studies: Examples of data analysis and visualization used to solve production problems

Assignments:

- Data Analysis Project: Analyze a dataset from a production process and draw insights

- Visualization Project: Create a dashboard to visualize key production metrics

Unit 4: Data-Driven Decision Making in Production Processes

Applying Data Insights to Production: Using data to optimize production processes: scheduling, quality control, and resource allocation, Decision-making frameworks: using data to support decision making and problem solving, Real-time decision making and its impact on production efficiency, Case Studies in Data-Driven Decision Making: Examples of organizations that have successfully implemented data-driven decision making, Analysis of the impact of data-driven decisions on production performance and outcomes, Challenges and Solutions: Common challenges in implementing data-driven decision making, Strategies for overcoming barriers and integrating data-driven approaches into production

Assignments:

- Group Project: Develop a data-driven decision-making strategy for a production scenario
- Research Paper: Challenges and solutions in implementing data-driven decision making in production

Unit 5: Future Trends and Innovations in Data-Driven Production

Emerging Technologies: The impact of Industry 4.0 and smart manufacturing on data-driven decision making ,Advances in data analytics technologies: artificial intelligence, machine learning, and big data, The role of IoT and real-time data in enhancing production excellence, Future Directions: Trends in data-driven decision making: automation, predictive maintenance, and adaptive systems, The future of data analytics in production: new tools, techniques, and best practices, Case Studies and Innovations: Analysis of cutting-edge innovations and their impact on production decision making, Future scenarios and their implications for production excellence

Assignments:

- Research Project: Explore future trends and innovations in data-driven decision making for production
- Final Project: Develop a forward-looking data strategy for a production organization considering emerging technologies

Textbook:

1. "Data-Driven Production: How to Use Data Analytics for Production Excellence", John F. McDonald, Emily A. Voss, Wiley, ISBN: 978-1119632348

Industry 5.0 for Engineers

Course Code: 241ME058

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the basic concept of Industry 5.0.
- CO2:** Explain the concepts of Industrial IOT, IOS and Predictive Analytics
- CO3:** Explain the cyber physical systems and AI technologies
- CO4:** Analyse the applications of Industry 5.0 in various sectors
- CO5:** Analyse case studies on automation and healthcare services

Mapping of Course Outcomes with Program Outcomes :

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1										
CO2	1	1	1		2						
CO3	1	1	1		2						
CO4	1	3	1		2						
CO5	1	3	1		2						

UNIT – I

Introduction to Industry 5.0

Introduction of Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 5.0, Comparison of Industry 5.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Automation and Transformation Processes.

UNIT – II

Importance of Internet of Things (IOTs)

Introduction to Internet of Things (IoT), Industrial Internet of Things (IIoT), Internet of Services, Fundamental of Predictive Analytics, Smart Logistics, Smart Devices and Products.

UNIT – IV

Technology Implementation and Case Studies

3D printing, Solar energy sector, Healthcare sector, Maintain records related to education, finance, clean bioenergy generation and Intelligent NextG Wireless Networks.

UNIT – V

Case studies on CNC/NC automation - Benefits, challenges, and industry applications., In-house, Healthcare services-Examples of innovations improving patient care and operational efficiency.

Text Books:

1. Uthayan Elangovan, Industry 5.0, “The Future of the Industrial Economy”, First Edition, Taylor & Francis, ISBN: 978-1-032-04127-8, 2022.
2. Alessandro Massaro, “Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances”, Wiley-IEEE Press, 2021, ISBN: 2021028944.

Reference Books:

1. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016.
2. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
3. Hans Bernhard Kief, Helmut Roschiwal, Karsten Schwarz, “The CNC Handbook: Digital Manufacturing and Automation from CNC to Industry 4.0”, Industrial Press Inc., U.S. ISBN 0831136367, Nov 2021.
4. Janya Chanchaichujit, Albert Tan, Fanwen Meng, Sarayoot Eaimkhong, “Healthcare 4.0 Next Generation Processes with the Latest Technologies”, Palgrave Pivot, 2019, ISBN 978-981-13-8113-3.

Web Links:

1. <http://www.mqtt.org/>
2. <https://opcfoundation.org/about/opc-technologies/opc-ua/>
3. <https://www.ethercat.org/default.htm>

Cost Excellence in Production

Course Code: 241ME090

L	T	P	C
2	0	1	3

Unit 1: Introduction to Cost Management in Production

Fundamentals of Cost Management: Definition and importance of cost management in production, Key concepts: cost types (fixed, variable, direct, indirect), cost behavior, and cost allocation, The role of cost management in achieving production excellence ,Cost Analysis Techniques: Methods for cost analysis: cost-volume-profit analysis, break-even analysis, Tools for cost estimation: cost forecasting, budgeting, and variance analysis, Case Studies: Examples of cost management practices in different production environments

Assignments:

- Research Paper: The importance of cost management in achieving production excellence
- Group Project: Perform a cost analysis for a production process and identify cost-saving opportunities

Unit 2: Cost Control and Reduction Strategies

Cost Control Techniques: Techniques for controlling production costs: standard costing, budgetary control, and cost monitoring, Implementing cost control measures: process improvements, lean manufacturing, Identifying and managing cost variances ,Cost Reduction Strategies: Strategies for reducing production costs: waste reduction, process optimization, and supplier management, Tools for cost reduction: value analysis, activity-based costing (ABC), Measuring the impact of cost reduction initiatives, Case Studies: Successful examples of cost control and reduction in production settings

Assignments:

- Project: Develop a cost control plan for a production process
- Case Study: Analyze a real-world example of successful cost reduction in production

Unit 3: Advanced Cost Management Techniques

Activity-Based Costing (ABC): Principles and implementation of ABC, Analyzing and allocating overhead costs using ABC, Comparing ABC with traditional costing methods, Total Cost of Ownership (TCO): Understanding TCO and its components, Applying TCO in supplier selection and procurement decisions, Case studies on the application of TCO in production environments, Cost Benchmarking: Techniques for cost benchmarking and performance measurement, Identifying cost benchmarks and best practices, Using benchmarking data to drive cost improvement

Assignments:

- Group Project: Implement ABC in a production scenario and compare results with traditional costing

- Research Paper: The role of TCO and benchmarking in cost excellence

Unit 4: Financial Analysis and Decision-Making

Financial Metrics and Analysis: Key financial metrics: return on investment (ROI), return on assets (ROA), and profit margins Analyzing financial statements and performance reports , Using financial data to make informed production decisions , Cost-Benefit Analysis: Conducting cost-benefit analysis for production projects and investments, Evaluating the financial viability of cost-saving initiatives, Tools and techniques for effective cost-benefit analysis, Case Studies: Examples of financial analysis and decision-making in production settings

Assignments:

- Project: Conduct a cost-benefit analysis for a proposed production investment
- Case Study: Analyze financial metrics and their impact on production decisions

Unit 5: Future Trends and Challenges in Cost Management

Emerging Trends in Cost Management: Impact of Industry 4.0 and digital transformation on cost management, Advances in cost management technologies: big data analytics, AI, and automation, Challenges and Opportunities: Common challenges in cost management: global competition, supply chain disruptions ,Opportunities for innovation and improvement in cost management practices ,Strategic Planning for Cost Excellence: Developing a strategic plan for cost excellence in a dynamic production environment, Measuring and evaluating the impact of cost management strategies

Assignments:

- Research Project: Future trends and challenges in cost management for production
- Final Project: Develop a comprehensive cost management strategy for a production organization

Textbook :

1. Cost Management: A Strategic Emphasis, Edward J. Blocher, David E. Stout, J. Fred Weston, McGraw-Hill Education, ISBN: 978-1260247737

Supply Chain Management											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241MB017	Introduction to Supply Chain Management	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241MB018	Logistics & Distribution Management	FC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB019	Supply Chain Project Management	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB020	Supply Chain Innovation & Trends	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB021	Supply Chain Analytics	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB022	Demand Planning & Forecasting	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB023	Supply Chain Risk Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM

241MB024	Inventory Management & Control	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB025	E-Commerce & Supply Chain Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB026	Operations Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
241MB027	Supply Chain Ethics & Corporate Social Responsibility (CSR)	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
Total			22		10	32					

Introduction to Supply Chain Management

Course Code: 241MB017

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Analyse the interdependencies between logistics and other business functions (e.g., marketing, production, finance).
- CO2:** Explore the different logistical activities.
- CO3:** Identify the development of supply chain strategy
- CO4:** Examine the logistical operational integration and supply chain relationships
- CO5:** Assess the role of Supply Chain in e-business and b2b practices

UNIT – I

Logistics management and Supply Chain management - Definition, Evolution, Importance. The concepts of logistics. Logistics relationships. Functional applications – HR, Marketing, Operations, Finance, IT. Logistics Organization - Logistics in different industries

UNIT – II

Logistics Activities: – functions, objectives, solution. Customer Service, Warehousing and Material Storage, Material Handling, order processing, information handling and procurement Transportation and Packaging. Third party and fourth party logistics - Reverse Logistics - Global Logistics

UNIT – III

Fundamentals of Supply Chain and Importance: Development of SCM concepts and Definitions Supply chain strategy, Strategic Supply Chain Management and Key components. Drivers of Supply Chain Performance – key decision areas – External Drivers of Change.

UNIT – IV

Modelling logistics systems - Simulation of logistic systems - Dimensions of Logistics & SCM – The Macro perspective and the macro dimension – Logistic system analysis strategy, Logistical Operations Integration, Customer service – Supply Chain Relationships

UNIT – V

Framework and Role of Supply Chain in e-business and b2b practices: Value of information in logistics & SCM - E-logistics, E-Supply Chains - International and global issues in logistics - Role of government in international logistics and Principal characteristics of logistics in various countries and regions

Text Books:

1. Supply Chain Logistics Management, Bowersox, Closs, Cooper, McGraw Hill. 5th Edition, (9th reprint), 2021, ISBN-0078096642
2. World Class Supply Management, Burt, Dobbler, Starling, TMH., 2019, ISBN-0070499330.

Reference Books:

1. Logistical Management, Donald J Bowersox, David J Closs, TMH, 9th Edition, ISBN-9780070435544
2. Reguram G, Rangaraj N., Logistics and Supply Chain Management Cases and Concepts: Macmillan India Ltd., New Delhi, ISBN-9780070221635.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105141/>
2. <https://www.youtube.com/watch?v=Nrl0CtS1m8Y>

Logistics & Distribution Management

Course Code: 241MB018

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the history and importance of Logistics
- CO2:** Explore the role of Logistics Management and its process.
- CO3:** Identify the need and scope of Distribution Management.
- CO4:** Examine different channels and policies of Distribution
- CO5:** Assess the strategies for Logistics and Distribution in global economy.

Unit I Logistics: Definition - History and Evolution- Objectives – Elements- Activities Importance- The work of logistics-Logistics interface with marketing- Retails logistics- Emerging concept in logistics.

Unit 2 Logistics Management: Definition, Achievement of competitive advantage through logistics Framework-Role of Logistics management Integrated Logistics Management - Model – Flow of process activities (in brief).

Unit-3: Distribution Management: Introduction, need and scope of distribution management, marketing channels strategy, levels of channels, functions of channel partners, channel flows, Channel Intensity, classification of distribution channels, types of channel intermediaries, designing distribution channel strategy, factors affecting the design of marketing channels, Factors affecting selection of channel partners

Unit-4: Distribution Channel Systems: Designing channel systems, Channel Intensity, Selecting Channel Partners, Channel Management Channel Policies, Power Bases in managing channel partners, conflict management Channel Institutions - retailing &wholesaling.

Unit-5: Logistics and Distribution in global economy: Logistics vs Distribution, Importance of Logistics and Supply chain in global economy, distribution strategies by using logistic channels, Logistics and Distribution planning and control in global perspectives.

Reference Books:

1. Donald J. Bowersox & David J. Closs : Logistical Management, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004
2. Krishna K. Havaladar, Vasant M. Cavale Sales & Distribution Management McGraw Hill Latest Edition

Supply Chain Project Management

Course Code: 241MB019

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the types project selection models
- CO2:** Describe project planning and organization
- CO3:** Apply the networking techniques
- CO4:** Examine the project control processes
- CO5:** Assess the role of project auditing

UNIT I

Introduction – Project life cycle – Project selection – Types of project selection models – Project manager – Selection of Project Manager.

UNIT II

Project Organization – types – Project planning. Sorting out the project – Work breakdown structure and Linear Responsibility charts – Conflict and Negotiation – Conflict and Project life cycle – some requirements and principles of negotiation.

UNIT III

Budgeting and cost estimation – Scheduling – Network techniques: PERT and CPM –Gantt charts – Resource allocation – Resource loading – Resource Leveling.

UNIT IV

Monitoring and Information Systems – Project Control – Types of control processes – Control as a function of Management.

UNIT V

Project auditing – Purposes of evaluation – Project Audit Life Cycle – Project termination – Termination process.

References:

1. Jack R. Meredith & Samuel J. Mantel, PROJECT MANAGEMENT – A MANAGERIAL APPROACH
2. Prasanna Chandra, PROJECTS PLANNING, ANALYSIS, SELECTION, IMPLEMENTATION AND REVIEW
3. P. Gopalakrishnan & V.E. Ramamoorthy, TEXTBOOK OF PROJECT MANAGEMENT
4. Richard B. Chase et al, OPERATIONS AND SUPPLY CHAIN MANAGEMENT, Tata McGraw Hill education Pvt. Ltd, New delhi2010

Supply Chain Innovation & Trends

Course Code: 241MB020

L	T	P	C
3	0	0	3

UNIT I

Introduction & Managerial aspects of Innovation function Introduction, Components of Innovation, Types of Innovations, Models of Innovation Processes, Evolution and characteristics of Innovation Management, Key drivers of Innovation, Factors influencing Innovation, Organizing for Innovation, Factors influencing organizational design, Developing Innovation Strategy, Characteristics of creative of creative organization.

UNIT II

Research and Development Management Introduction, Meaning, Objectives, Significance, Classification of R&D according to R&D type, process phase, measurement level, purpose of measurement and measurement perspective. Technology development approaches, Performance of R&D management in Indian scenario.

UNIT III

Financial Evaluation of R&D Projects Introduction, Cost effectiveness of R&D, R&D financial forecasts, Project selection, Evaluating R&D ventures, Conflicting views of managers. Allocation of resources, R&D programme planning and control. Project management, Project Planning and Control Techniques.

UNIT IV

Organization R&D and innovation, HRM issues in innovation and R&D, Leadership and R&D management, Organization Design and structure of R&D, R&D Project Management, Measurement, Evaluation and assessment of R&D

UNIT V

National R&D infrastructure and Institutional Framework, Fiscal and other incentives and Promotional /Support measures, Industry, Institutions and government cooperations. Other important issues in R&D management, Commercialization of R&D.

Text books:

1. White, THE MANAGEMENT OF TECHNOLOGY AND INNOVATION-A STRATEGIC APPROACH, Cengage Publication
2. S Moikal, INNOVATION MANAGEMENT, Sage Publication

Reference Books:

1. C.K Prahalad & M.S. Krishnan, THE NEW AGE OF INNOVATION, Tata McGraw Hill Education Pvt. Ltd. New Delhi 2008.

Supply Chain Analytics

Course Code: 241MB021

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain different of supply chain management by developing different strategies.
- CO2:** Apply analytical tools to solve supply chain design and planning problems
- CO3:** Identify the use of algorithms to solve partitioning and routing problems
- CO4:** Analyze various applications and techniques of supply chain systems
- CO5:** Be familiar with the broader trends in the area of supply chain analytics

UNIT - I

Basics of Supply Chain Management: Introduction to Supply Chain Management – Evolution Different Views of Supply Chain – Supply Chain Strategy – Supply Chain Drivers – Developing Supply Chain Strategy- Strategic Fit in Supply Chain. Analytics in Supply Chain Management.

UNIT – II

Supply Chain Analysis - Types of Supply Chains - Advanced Planning - Structure of Advanced - Planning Systems-Strategic Network Planning - Demand Planning - Master Planning - Demand Fulfilment and ATP - Production Planning and Scheduling Purchasing and Material Requirements Planning Distribution and Transport – Planning - Coordination and Integration - Collaborative Planning.

UNIT – III

Set Covering and Set Partitioning Problems, Travelling Salesman Algorithms, Advanced Vehicle Routing Problem Heuristics, Scheduling Algorithms-Deficit Function Approach and Linking Algorithms.

UNIT- IV

Fuzzy Logic and Techniques-Application in SCM - Recent Issues in SCM: Role of Computer/ IT in Supply Chain Management, CRM vs SCM, Benchmarking Concept, Features and Implementation, Outsourcing – Basic Concepts, Value Addition in SCM – Concept of Demand Chain Management.

UNIT- V

Inventory Management in Supply Chain- Network Design in Supply Chain- Alternative Channels of Distribution- Location Decisions in Supply Chain-Implementing Advanced Planning Systems - The Definition of a Supply - Chain Project -The Implementation Process SCM in a Pharmaceutical – Company Food and Beverages - Computer Assembly Semiconductor – Manufacturing.

Reference Books:

1. Supply Chain Management: Strategy, Planning and Operations by Sunil Chopra and Peter Meindl, Prentice Hall; 6th Edition (2015). ISBN: 0133800202
2. Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain by Michael Watson, Sara Lewis, Peter Cacciopi, Jay Jayaraman. 1st Edition. ISBN: 0133017370

Demand Planning & Forecasting

Course Code: 241MB022

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the concept of Demand Planning and how does it work.
- CO2:** Identify different steps involved in Demand Planning.
- CO3:** Analyze the different factors that influence Demand Forecasting.
- CO4:** Interpret various methods of Demand Forecasting.
- CO5:** Differentiate Demand Planning and Demand Forecasting.

Unit- 1 – Introduction to Demand planning: Concept of Demand Planning, Objectives of Demand Planning, Need for Demand Planning, importance of Demand Planning, how does Demand Planning work,

Unit- 2 – Process of Demand Planning: Elements of Demand Planning, key steps involved in Demand Planning, best practices for Demand Planning, benefits of Demand Planning in E-Commerce, Future Demand Planning.

Unit- 3 – Demand Forecasting: Concept of Demand Forecasting, objectives and Factors influencing Demand Forecasting, different types of Demand Forecasting, advantages and disadvantages of Demand Forecasting.

Unit- 4 – Methods of Demand Forecasting: Need for Demand Forecasting, types of Demand Forecasting, different methods of Demand Forecasting.

Unit- 5 – Demand Planning and Demand Forecasting: Characteristics of A Good Demand Planning and Forecasting Methods, Demand Planning vs Demand Forecasting, best tools for Demand Planning and Forecasting.

Reference Books:

1. Demand Forecasting Best Practices: Stories Beyond Boundaries
2. Fundamentals of Demand Planning and Forecasting, by Chaman L. Jain

Supply Chain Risk Management

Course Code: 241MB023

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Identify and assess potential risks in a supply chain, including operational, financial, and reputational risks.
- CO2:** Design and implement a supply chain risk management framework that aligns with industry best practices.
- CO3:** Assess the effects of natural disasters, pandemics, and climate change on supply chain operations.
- CO4:** Explain key risk management concepts, including risk assessment, mitigation, and transfer, with relevant examples.
- CO5:** Apply the key principles of designing a resilient supply chain, including flexibility, agility, and adaptability.

UNIT – I

Introduction of Risks Management: Concept and Process, An Action-Based Framework for Supply Chain Risk, Identification of Operational Hazards, Risk Assessment and Valuation, Tactical Risk Decisions and Crisis Management, Strategic Risk Mitigation, Four Operational Hedging Strategies.

UNIT – II

Operational Strategy for Managing Supply Chain Risks: Introduction, Stockpile Inventory, Diversify Supply, Backup Supply, Manage Demand, Ambiguity in Risks. Decentralized Risks Management Strategy. Shared risks; Achieving an integrated approach; Identifying risks, Analyzing and responding to risks

UNIT – III

Managing Supply Chain Disruption: Economic Risks to Supply Chain-Demand Shock, Currency Fluctuation, Supply Shock, Industrial Unrest, Impacts of Natural Disasters, pandemics and Climate Change, Societal Risks to Supply chain, Risks and Security in Air Cargo Supply chain, Time-Based Risk Management-Response Time and Impacts, Risk and Reward Considerations.

UNIT – IV

Approaches to Risk Management: Identifying Risks and its Types, Tools for Analysing Past Events, Tools to Collect Opinions, Tools to Analyse Operations, Problems with Risks Identification, Conceptual Explanations with Examples, Development of Risk Management Techniques, Supply Chain Risk Management (SCRM) and aims of SCRM.

UNIT – V

Creating Resilient Supply Chains: Concept of Resilient Supply Chain, Principles of Designing a Resilient Supply Chain, Physical Features of a Resilient Supply Chain, relationships within a Resilient Supply Chain, Risk Compensation and Business Continuity. Latest updates in Resilient Supply Chain.

Text Books:

1. Supply Chain Risks Management, Donald Water, (Kogan Pages), ISBN-970749448547.
2. Handbook for Supply Chain and Risks Management (MeriPustak), Omra Khan & George Zsidisn, ISBN-9788131521878

Reference Books:

1. Supply Chain Risk Management: Advanced Tools, Models, and Developments, YacobKhojasteh, (Springer), ISBN-13:978-9811041051
2. Managing Supply Chain Risk: Integrating with Risk Management , Bret Wagner, SimeCurkovic, and Thomas Scannell, ISBN:9781040084625.

Web Links:

1. http://ndl.iitkgp.ac.in/he_document/nptel/nptel/courses_110_108_110108056_video_lec9
2. http://ndl.iitkgp.ac.in/he_document/nptel/nptel/courses_110_108_110108056_video_lec11

Inventory Management & Control

Course Code: 241MB024

L	T	P	C
3	0	0	3

At the end of the Course, Student will be able to:

- CO1:** Apply the role of purchasing and materials planning in push and pull system.
- CO2:** Simplify pricing models, negotiation techniques, and cost analysis.
- CO3:** Analyze the purpose and significance of inventory within organizations.
- CO4:** Explore the objectives and types of materials handling.
- CO5:** Differentiate between packing and packaging.

UNIT – I

Role of Purchasing and Materials Management- objectives, organization and Inter relationships, Determination and Description of material Quantity, Material planning in push and pull system, MRP and JIT.

UNIT – II

Purchase system and procedures: - objectives, Purchasing function, Purchasing policies and decisions, make or Buy vendor selection and Rating, Timing of purchase, price determination, purchase procedures and system public purchasing and tendering.

UNIT – III

Inventory Management – Introduction of inventory system, Function of Inventory and Relevant cost concept, classification of Inventory systems, Inventory Models: Deterministic Discount, EOQ, EBQ, MRP – I, selective Inventory Management ABC, VED, FSN, PQR.

UNIT – IV

Materials Handling: Materials handling systems and objectives; Types of handling equipment; Selection of the most appropriate equipment in specific situations, Traffic and Transportation, Disposal of Scrap, waste management waste reduction approach, waste collection, Recycling waste disposal system, materials information system.

UNIT – V

Packing and Packaging: Meaning, Functions and Essentials of Packing- Packaging: Meaning, Functions and Essentials of Packaging- Difference between Packing and Packaging-Packing for Storage- Packing for Overseas Shipment- Packing for Inland Transportation- Packaging for Product content Protection - Test of packaging: Mechanical, Climatic & Lab test- International Care labelling code - Packaging cost.

Text Books:

1. Integrated Materials Management, Putta, A.K, New McGraw Hill, ISBN-978-8120300279
2. Handbook of Materials Management, Gopalakrishnan P. and Sanderashan M New Delhi prentice Hall of India, ASIN : B00K7YGKRQ.

Reference Books:

1. Proactive Procurement, Burt, David N, Englewood Cliffs, New Jersey, Prentice Hall Inc, ISBN-0137114656.
2. Purchasing and Material Management, Dobler, D.W. etc., New York, McGraw Hill, ISBN-0070370478

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105095/>
2. https://onlinecourses.nptel.ac.in/noc20_mg17/preview

E-Commerce & Supply Chain Management

	L	T	P	C
Course Code: 241MB025	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Explain the concepts of E commerce and internet terminology
- CO2:** Examine the benefits and issues related to EDI
- CO3:** Identify Various network security threats
- CO4:** Apply the process and functions of supply chain management
- CO5:** Analyse design and network in supply chain management

UNIT – I

Introduction to E-Commerce: Framework-Classification of electronic commerce - Anatomy of E-Commerce Applications- Components of the I way- Network Access Equipment-Internet Terminology.

UNIT – II

Electronic Data Interchange- Benefits-EDI Legal, Security & privacy issues- EDI software implementation- Value added networks-Internal Information Systems- automization of Work flow and Coordination-Customization and Internal Commerce.

UNIT – III

Network security and firewalls- Client Server Network Security- Emerging client server security threats- Firewalls and network security- Data and message security- Encrypted documents and electronic mail- Hypertext publishing- Technology behind the web- Security and the web.

UNIT – IV

Introduction to Supply Chain Management- Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing – pricing.

UNIT – V

Designing the Supply Chain Network- Designing the distribution network – role of distribution – factors influencing distribution – design options – e-business and its impact – distribution networks in practice – network design in the supply chain – role of network – factors affecting the network design decisions – modeling for supply chain.

Text Books:

- 1 Ravi Kalakota & Andrew b. Whinston , “Frontiers of Electronic Commerce”, Dorling Kindersley (India) Pvt.Ltd. *ISBN*, 8177583921, 9788177583922.
- 2 Sunil Chopra and Peter Meindl, SUPPLY CHAIN MANAGEMENT – STRATEGY, PLANNING AND OPERATION, PHI, 4th Edition

Reference Books:

- 1 Daniel Minoli, Emma Minoli “Web Commerce Technology Handbook”, Tata McGraw Hill Publishing, New Delhi. *ISBN*-13: 978-0074637425 *ISBN*-10: 0074637428.
- 2 Wisner, Keong Leong and Keah-Choon Tan, PRINCIPLES OF SUPPLY CHAIN MANAGEMENT A BALANCED APPROACH, Thomson Press

Operations Management

Course Code: 241MB026

L	T	P	C
3	0	0	3

At the end of the Course, Student will be able to:

- CO1:** Explain the Relationship of Operations management with other functional areas and different types of Production Systems.
- CO2:** Analyze the stages of the product design process, value analysis techniques, and facility location and layout decisions
- CO3:** Apply the methods of forecasting, operation planning strategies, and capacity planning techniques including MRP and scheduling
- CO4:** Analyze the factors affecting productivity, job design principles, and process flow charts and methods study
- CO5:** Apply the techniques of Statistical Quality Control and Total Quality Management.

UNIT – I

Introduction to Operation Management: Nature & Scope of Operation/ Production Management, Relationship with other functional areas, Recent trend in Operation Management, Manufacturing & Theory of Constraint, Types of Production System, Just in Time (JIT) & lean system.

UNIT – II

Product Design & Process Selection: Stages in Product Design process, Value Analysis, Facility location & Layout: Types, Characteristics, Advantages and Disadvantages, Work measurement, Job design.

UNIT – III

Forecasting & Capacity Planning: Methods of Forecasting, Overview of Operation Planning, Aggregate Production Planning, Production strategies, Capacity Requirement Planning, MRP, Scheduling, Supply Chain Management, Purchase Management, Inventory Management.

UNIT – IV

Productivity: Factors, Affecting Productivity – Job Design – Process Flow Charts – Methods Study – Work Measurement – Engineering and Behavioral Approaches.

UNIT – V

Quality Management: Quality- Definition, Dimension, Cost of Quality, Quality Circles Continuous improvement (Kaizen), ISO (9000&14000 Series), Statistical Quality Control: Variable & Attribute, Process Control, Control Charts -Acceptance Sampling Operating Characteristic Curve (AQL , LTPD, Alpha & Beta risk), Total Quality Management (TQM).

Text Books:

- 1 Krajewski & Ritzman. Operation Management -Strategy and Analysis. Prentice Hall of India, ISBN-9780201331189.
- 2 Panner Selvem, Production and Operation Management, Prentice Hall of India, ISBN-978-8120345553.

Reference Books:

- 1 Charry, S.N. Production and Operation Management- Concepts, Methods Strategy,. MCGraw-hill education(india) pvt limited, ISBN-9780070583559 .
- 2 K Aswathappa& Sridhar Bhatt, Production & Operations Management, Himalaya, Mumbai, ISBN-13: 978-9350971888.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_me30/preview
- 2 <https://archive.nptel.ac.in/courses/110/107/110107141/>

Supply Chain Ethics & Corporate Social Responsibility (CSR)

Course Code: 241MB027

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the concept of Business Ethics to provide best practices of business ethics.
- CO2:** Develop adequate knowledge in ethical issues in corporate governance.
- CO3:** Analyze the concepts of ethical decision making in business.
- CO4:** Evaluate the factors facilitating globalization.
- CO5:** Interpret various corporate social responsibilities and practice in professional life.

UNIT – I

Introduction to Business Ethics: Definition – Principles of Personal Ethics – Principles of Professional Ethics – The Development of Business Ethics – Importance and Need for Business Ethics – Significance of Business Ethics – Values and Ethics in Business.

UNIT – II

Corporate Governance – Definitions – Historical Perspective of Corporate Governance – Significance of Corporate Governance in Developing Countries – Issues in Corporate Governance – Major thrust areas of Corporate Governance – Indian model of Corporate Governance.

UNIT – III

Ethical Decision making in Business – Ethical Decision making with Cross – holder conflicts and competition – Applying Moral philosophy to Ethical decision making – Kohlberg’s Model of Cognitive Moral development – Influences on Ethical Decision making

UNIT – IV

Globalization and Business Ethics – Growth of Global Corporations – Factors Facilitating Globalization – Role of Multinational Corporations – International Business Issues – International Codes of Business conduct – Challenges of Globalization in the context of Growing market economies – Key Global issues for Business – Corporate Governance is a pre-requisite for Globalization.

UNIT – V

Corporate social responsibility: Definitions of CSR – Models for implementation of CSR – CSR as a business strategy for sustainable development – Advantages of CSR – Scope of CSR – Understanding Social Responsibility of Business – Protecting and Promoting stake holder’s interests.

Text Books:

1. M.G. Velasquez, Business Ethics, Prentice Hall India Limited, New Delhi. *ISBN*-10. 8120346475. *ISBN*-13. 978-8120346475.
2. Andrew Crane and Diark Matten, Business Ethics, Oxford Publication, New Delhi. *ISBN*-10. 0198755961 · *ISBN*-13. 978-0198755968.

Reference Books:

1. Business Ethics – A Case perspective – O.C. Ferrell, John Fraedrich and Linda Ferrell Cengage Leachery *ISBN*-10. 8131511197 ; *ISBN*-13. 978-8131511190.
2. Business Ethics – An Indian Perspective – A.C. Fernando. Pearson *ISBN* 9789353437442.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105079/>
2. https://onlinecourses.swayam2.ac.in/cec19_mg24/preview

Sustainability											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requi site
241CE074	Introduction to Sustainable Development	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE079	Natural Disaster Management & Mitigation	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE081	Waste Water Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE082	Integrated Solid Waste Management for a Smart City	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE083	Watershed Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EE033	Energy Audit, Conservation & Management	IC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EE006	Electric Power Generation, Transmission & Distribution Systems	AC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241CE075	Sustainable Agriculture & Food Systems	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE076	Sustainable Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241CE077	Sustainable Production Excellence	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-

241CE078	AI in Environmental Science and Sustainability	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
Total			32			32					

Introduction to Sustainable Development

Course Code: 241CE074

L	T	P	C
2	0	0	2

Unit 1:

Introduction to sustainable development Concept, nature and scope of Sustainable development. Globalisation and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty.

Unit 2:

Social Development Diversity and social exclusion: Concept and implications, human development of the socio-cultural and other ethnic groups of the society. Contemporary Issues of Development — Bottom of the pyramid approach; understanding the importance of social capital and social mobilization. Social security: Systems and role in development. People's participatory processes in development. Millennium Development Goals, Sustainable development Goals

Unit 3:

Individual, change and development Human development across the life span: Context and impact of deprivation. Conception and birth: issues of genetics and environment; birth processes; socio-cultural influences. Infancy, childhood, school years and middle childhood: Milestones of development, childhood deprivation and children at risk. Adolescence and adulthood: cultural construction and development deprivations. Old age: needs and impact of deprivation.

Unit 4:

Society, change and development Government to governance: Democracy and development; decentralisation policies in India; local governance; shifting forms of governance in urban and rural regions, linkages between decentralisation, power and poverty

Unit 5:

Emerging of role of CBOs and NGO and human rights institutions. Role of law, education, media and international organisations.

Text Books:

1. Agrawal, A N . Indian Economy: Problems of development and planning. pune: Wishwa Prakashan. ISBN: 978-8122437959
2. Baldev Raj Nayar, Globalization and Nationalism: The Changing Balance Of India's Economic Policy. ISBN : 978-0761995364

Reference Books:

1. Urbanization in Developing Countries Basic Services and community Participation, Bidyut Mohanty , Institute of Social Science, Concept Publishing House. ISBN-10. 8170224756
2. Development Experience in the Indian Economy: Inter-State Perspectives, Brahmananda, P.R. and V.R. Panchmukhi (Eds.), Bookwell, Delhi. ISBN: 81-85040-35-4

Natural Disaster Management & Mitigation

Course Code: 241CE079

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the aspects of disaster management and adopt remedial measures.
- CO2:** Explain disaster risk assessment and coping measures.
- CO3:** Explain the vulnerability conditions.
- CO4:** Assess the impact of hazards on structures.
- CO5:** Adopt the rehabilitation procedures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2								2		
CO2		1					3		2		
CO3		1							2		
CO4	2						3		2		
CO5	2						3		2		

UNIT – I

Introduction:

Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

UNIT – II

Overview of Disaster Situations:

Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS-spread and transmissions -pandemic, endemic and epidemic.

UNIT – III

Flood:

Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management-integrating technology and people.

UNIT – IV

Overview of Disaster Situations:

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

UNIT – V

Cyclone and Fire Disaster:

Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

Text Books

1. Disaster Management, RB Singh (Ed), Rawat Publications. (ISBN: 13- 978-8131600337).
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house. (ISBN: 13- 978-8189866464).

Reference Books:

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill. (ISBN:13-9780074631881).
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose. (ISBN:13- 978-0953614011).
3. Anthropology of Disaster management, Sachindra Narayan, Gyan Publishing house. (ISBN: 13- 978-8121206839).

Web Links:

1. https://www.iare.ac.in/sites/default/files/lecture_notes/dm%20notes.pdf

Waste Water Management

Course Code: 241CE081

L T P C
3 0 0 3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the importance of sanitation and wastewater management.
- CO2:** Explain the various methods of sewage flow estimation and pumping systems.
- CO3:** Identify the various characteristics of sewage and the treatment system.
- CO4:** Outline the various secondary treatment technologies for waste water
- CO5:** Explain the different tertiary and effluent disposal methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3									
CO2	2	3				1					
CO3	3	3	1			2					
CO4	2	2	1	2		2					
CO5	2	2	1			2					

UNIT – I

Introduction:

Introduction to sanitation–systems of sanitation–relative merits and demerits –need for waste water management–basic terminology in waste water–generation of waste water–types – collection and conveyance of waste water– classification of sewerage systems.

UNIT – II

Sewage Flow and Pumping:

Estimation of sewage flow and storm water drainage–fluctuations. Types of sewers–hydraulics of sewers– appurtenances in sewerage. Pumping of waste water:pumping stations–location–components– types of pumps and their suitability with regards to waste waters.

UNIT – III

Sewage Analysis and Treatment Sewage characteristics-sampling and analysis of waste water– physical, chemical, and biological examination– measurement of BOD, COD. Preliminary and primary treatment– screens–grit chambers–grease traps–floatation–sedimentation.

UNIT – IV

Secondary Treatment:

Aerobic and anaerobic treatment process-comparison. Aerobic units: Activated sludge process, principles, modifications of activated sludge processes–Oxidation ponds– Trickling filters– Rotating biological contactors. Anaerobic units: UASB Reactor, principle and working.

UNIT – V

Tertiary Treatment and Disposal:

Removal of Nutrients–Nitrification and Denitrification–Ion exchange–membrane processes –MF, UF, NF, RO. Disposal of sewage–Methods of disposal–Effluent Standards. Need, Scope and demand for waste water recycling.

Text Books:

1. Wastewater Engineering: Treatment and Resource Recovery, Metcalf & Eddy, McGraw-Hill, New York, 5th Edition. (ISBN: 13-978-0073401188).
2. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill, 2018. (ISBN: 13- 978-0070495395).

Reference Books:

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications. (ISBN: 978-81-7409-230-4)
2. Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi. (ISBN:13- 9788120336001)
3. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. New Delhi. (ISBN: 13- 978-8121915472).
4. Wastewater Treatment for pollution control and Reuse, Soli J Areivala, Sham R Asolekar, Mc- GrawHill, New Delhi. (ISBN: 9780070620995).

Web Links:

1. https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf
2. <http://www.civil.iitm.ac.in/dwwm/sites/default/files/presentations>
3. https://www.researchgate.net/publication/221911472_Wastewater_Management

Integrated Solid Waste Management for A Smart City

Course Code: 241CE082

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand Fundamental Concepts of Solid Waste Management
- CO2:** Analyze Municipal Solid Waste Management Practices
- CO3:** Evaluate Disposal Methods and Technologies
- CO4:** Apply Knowledge of Construction and Demolition (C&D) Waste Management
- CO5:** Examine E-Waste and Hazardous Waste Management

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1					3	2				
CO2	1					3	2				
CO3	1					3	2				
CO4	1					3	2				
CO5	1					3	2				

UNIT – I

Introduction:

Solid Waste Management- Definition, Concept of 4Rs (reduce, reuse, recycle and recover) of waste management, Elements of a waste management system, Issues in Solid Waste Management, Integrated Waste Management Hierarchy: Source reduction, Recycling, Waste-to-Energy and Landfilling, Review of waste management under Swachh Bharat Mission and Smart Cities Program.

UNIT – II

Municipal Solid Waste:

Waste Composition and Quantities, Collection, Transportation, Segregation, and Processing.

UNIT – III

Disposal of Municipal Solid Waste:

Landfill, Biochemical Processes and Composting, Energy Recovery from Municipal Solid Waste, Municipal Solid Waste (MSW) Rules 2016, Current Issues in Solid Waste Management and Review of MSW Management

UNIT – IV

Construction and Demolition (C&D) Waste Management:

Overview, Components; C&D Waste Management Rules 2016, Beneficial Reuse of C & D Waste Materials.

UNIT – V

Electronic Waste (E-Waste) Management:

Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges.

Hazardous Wastes:

Definition, Classification, Risk assessment, Transportation of hazardous waste, Current Management Practices: Environmental audit, Containment, Remedial alternatives.

Text Books:

1. Solid Waste Engineering, William A Worrell and P. Aarne Vesilind, Cengage Learning, 2nd Edition (SI Edition). (ISBN: 13- 978-8131520420).
2. Integrated Solid Waste management, George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Tata McGraw Hill. (ISBN: 13- 978-0070632370).

Reference Books:

1. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization (CPHEEO), India.
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website
3. Construction and Demolition Waste Management Rules, 2016, MoEF&CC
4. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.

Web Links:

1. <https://nptel.ac.in/courses/105/105/105105160/>
2. <http://swachhbharatmission.gov.in/sbmcms/index.html>
3. <http://swachhbharaturban.gov.in/>

Watershed Management

Course Code: 241CE083

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the objectives and characteristics of watershed management.
- CO2:** Classify the types of soil erosion and control methods.
- CO3:** Explain different water harvesting techniques.
- CO4:** Organize the land and drought management techniques.
- CO5:** Create hydrological models

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2			2	1	1		1		2	
CO2	1			1	1	1					
CO3	2	1		1	2	2					
CO4	2	1	1	2	1	2		1		2	
CO5	2	2	2	1	2	1					

UNIT – I

Introduction:

Introduction - Concept of watershed development – objectives of watershed development – need for watershed development - integrated and multidisciplinary approach for watershed management. Characteristics of Watershed: Size – shape – physiography – slope – climate – drainage – land use – vegetation – geology and soils – hydrology and hydrogeology – socio-economic characteristics – Application of artificial intelligence technology for identification of watershed characteristics.

UNIT – II

Principles of Erosion: Types and causes of erosion – factors affecting erosion– estimation of soil loss due to erosion- Universal soil loss equation. Measures to Control Erosion: Contour techniques – ploughing – furrowing – trenching – bunding – terracing – gully control – check dams – rock-fill dams – brushwood dam – Gabion.

UNIT – III

Water Harvesting: Techniques of rainwater harvesting – rainwater harvesting from rooftop – surface flow harvesting – subsurface flow harvesting – stop dams – farm ponds and dugout ponds – percolation tanks.

UNIT – IV

Land Management: Land use and Land capability classification – management of forest – agricultural – grassland and wild land land grading operation –reclamation of saline and alkaline soils. Drought Management: Drought assessment and classification – drought analysis techniques – drought mitigation planning.

UNIT – V

Beyond BIM - Emerging Trends

Watershed Modelling: Data of watershed for modelling – application and comparison of watershed models – model calibration and validation – advances of watershed models.

Text Books:

1. Watershed Management, Das MM and M.D Saikia, PHI Learning Pvt. Ltd.(ISBN:13- 978-8120346765).
2. Land and Water Management, Murthy.VVN, Kalyani Publications. (ISBN: 13- 978-9327214659)

Reference Books:

1. Water Resource Engineering, Wurbs R A and James R A, Prentice Hall Publishers. (ISBN: 13- 978-8120321519).
2. Watershed Hydrology, Black P E, Prentice Hall. (ISBN: 13- 978-1575040271).
3. Watershed Management, Murthy J V S, New Age International Publishers. (ISBN:13- 978-8122435184).

Web Links:

1. https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654
2. http://agritech.tnau.ac.in/agriculture/agri_majorareas_watershed_watershedmgt.html
3. <https://yourstory.com/2017/11/watershed-management/>

Energy Audit, Conservation & Management

Course Code: 241EE033

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain energy efficiency, conservation, and various technologies.
- CO2:** Design energy efficient lighting systems.
- CO3:** Calculate power factor of systems and propose suitable compensation techniques.
- CO4:** Explain energy conservation in HVAC systems.
- CO5:** Calculate life cycle costing analysis and return on investment on energy efficient technologies. Calculate the Time value of Money.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2								
CO2	3	1	2								
CO3	2	3	1								
CO4	2	3	1								
CO5	3	2	1								

UNIT – I

Basic Principles of Energy Audit: Energy audit- definitions - concept - types of audit - energy index - cost index - pie charts - Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry - thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017).

UNIT – II

Energy Management: Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.

UNIT – III

Energy Efficient Motors and Lighting Energy efficient motors: factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

UNIT – IV

Power Factor Improvement and Energy Instruments Power factor: methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on power factor – power factor motor controllers – Energy Instruments- watt meter – d.

UNIT – V

Economic Aspects and Their Computation: Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

Text Books:

- 1 Energy management by W.R. Murphy & G. McKay Butter worth - Heinemann publications (ISBN: 9788131207383).
- 2 Energy management hand book by W.C. Turner - John wiley & sons (ISBN: 9781420088700).

Reference Books:

- 1 Energy efficient electric motors by John. C. andreas - Marcel Dekker Inc Ltd-2nd edition (ISBN: 9781489914675).
- 2 Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition (ISBN: 9780077076788).

Web Links:

- 1 <https://nptel.ac.in/courses/108106022/>
- 2 <https://nptel.ac.in/courses/112105221/>
- 3 https://onlinecourses.nptel.ac.in/noc17_mm17/preview

Electric Power Generation, Transmission & Distribution Systems

Course Code: 241EE006

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify the different components of various power plants.
- CO2:** Analyze the performance of short, medium and long transmission lines.
- CO3:** Identify various factors related to sag and corona.
- CO4:** Distinguish between AC/ DC distribution systems and also estimate voltage drops of distribution systems.
- CO5:** Analyze the different economic factors of power generation and tariffs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11
CO1	3	1				2					
CO2	2	3	1								
CO3	2	1	3			1					
CO4	2	3	1			1					
CO5	2	3	1								

UNIT – I

Power Stations: Principle of power generation, site selection and layout of Thermal, Nuclear, Hydro power plant, Components of Thermal and Nuclear power plant

UNIT – II

Performance of Transmission Lines: Classification of Transmission Lines –Short, medium, long and their model representations –End condenser method, Nominal-T–Nominal-Pie, and A, B, C, D Constants, Surge Impedance and SIL of Long Lines.

UNIT – III

Corona and Sag: Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss –Radio Interference. Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor

UNIT – IV

Distribution Systems: Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT – V

Economic Aspects of Power Generation and Tariff Methods: Types of load, Load curve, load duration and integrated load duration curves, Important terms and factors in Load Curve.

Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Characteristics and types of Tariff.

Text Books:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar &, A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd (ISBN: 9788177000207).
2. Generation, Distribution & Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers (ISBN: 9789393159175).

Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 9780070151413).

Web Links:

1. <https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant>
2. <https://www.euronuclear.org/1-information/energy-uses.html>
3. <https://www.slideshare.net/9anku/electrical-distribution-system>

Sustainable Agriculture & Food Systems

Course Code: 241CE075

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Define ‘sustainable agriculture’ from multiple perspectives.
- CO2:** Describe and evaluate scientific evidence for the performance of alternative approaches to improving the sustainability of US agriculture and food systems.
- CO3:** Synthesize evidence from multiple sources to highlight the complexities and tradeoffs associated with efforts to improve the sustainability of agriculture and food systems.

Unit-1

Introduction to sustainable agriculture: understanding the principles, practices, and importance of sustainable agriculture in addressing environmental, social and economic Challenges.

Unit -2

Agroecology: exploring the ecological principles underlying sustainable farming practices and their application.

Unit 3

Soil health and management: learning about soil composition, fertility management, erosion control and the role of soil in sustainable agriculture.

Crop diversity and rotation: understanding the importance of crop diversity, crop rotation, and Intercropping in enhancing soil health ,pest management ,and resilience to climate change

Unit -4

Water management: Examining sustainable water use practices in agriculture, irrigation methods, water conservation and water shed management.

Unit-5

Food systems and supply chains: analysing the inter connectedness of food production, distribution, consumption and waste management.

Text Books:

1. Sieglinde Snapp, Barry Pound (2017). Agricultural Systems: Agroecology and Rural Innovation for Development: Agroecology and Rural Innovation for Development. Elsevier Science

Sustainable Supply Chain Management

Course Code: 241CE076

L	T	P	C
3	0	0	3

Unit 1: Introduction to Sustainable Supply Chain Management (SSCM)

Concepts and Definitions: Definition of Supply Chain Management (SCM), Introduction to Sustainability in SCM, Triple Bottom Line (TBL) in SCM: Economic, Environmental, and Social aspects, Key principles of sustainability in supply chains

Sustainable Supply Chain vs Traditional Supply Chain, Differences between conventional and sustainable supply chains, Benefits of sustainable practices in supply chain management

Drivers and Barriers to SSCM: Internal and external drivers for SSCM, Challenges and barriers in implementing sustainability

Global Trends in SSCM: Case studies of leading companies implementing SSCM, International regulatory frameworks for sustainable supply chains

Assignments:

- Case Study: Analyzing SSCM practices of a global company
- Group Discussion: Barriers to implementing sustainable supply chains in emerging markets

Unit 2: Sustainable Procurement and Sourcing

Green Procurement and Sourcing: Definition and importance of sustainable procurement, Sourcing from environmentally responsible suppliers, Ethical and fair-trade sourcing

Supplier Relationship Management: Collaboration with suppliers for sustainable practices, Supplier selection criteria based on sustainability, Supplier evaluation and monitoring for sustainability compliance

Sustainable Materials and Resource Efficiency: Use of renewable and sustainable materials in the supply chain, Life Cycle Assessment (LCA) in sourcing decisions, Circular economy in sourcing strategies

Regulatory Requirements in Sustainable Sourcing: Overview of regulations such as REACH, RoHS, and Dodd-Frank Act, Compliance and reporting

Assignments:

- Research Project: Evaluate the sustainable procurement strategy of a specific company
- Individual Assignment: Develop a sustainable supplier selection criteria

Unit 3: Sustainable Production and Operations

Eco-friendly Production: Green manufacturing and lean operations, Reduction of environmental impacts in production processes, Energy efficiency and waste reduction techniques in production

Closed-Loop Supply Chains: Definition and importance of closed-loop supply chains, Reverse logistics and remanufacturing, Design for Environment (DfE) and end-of-life product management,

Sustainable Facility Management: Green buildings and eco-friendly warehousing, Environmental Management Systems (EMS) like ISO 14001, Water and energy conservation practices

Carbon Footprint in Production: Measuring and reducing carbon footprints, Carbon accounting and management,

Assignments:

- Case Study: Analyze the closed-loop supply chain of a company
- Group Activity: Propose a sustainable production improvement for a manufacturing plant

Unit 4: Sustainable Distribution and Logistics

Green Logistics: Role of transportation in sustainability, Strategies for reducing environmental impact in logistics, Use of alternative fuels and electric vehicles in logistics

Sustainable Packaging: Eco-friendly packaging materials and design, Reducing packaging waste in the supply chain, Innovations in sustainable packaging (e.g., biodegradable packaging)

Warehousing and Distribution Center Sustainability: Energy-efficient warehousing, Waste management in distribution centers, Sustainable inventory management practices

Urban Logistics and Last-Mile Delivery: Challenges and solutions for sustainable urban logistics, Sustainable practices in last-mile delivery

Assignments:

- Research Paper: Sustainable packaging trends in a specific industry
- Case Study: Evaluate the green logistics strategy of a company

Unit 5: Performance Measurement and Future Trends in SSCM

Key Performance Indicators (KPIs) for SSCM: Metrics for evaluating supply chain sustainability, Environmental, social, and economic KPIs, Sustainability scorecards and dashboards

Supply Chain Transparency and Traceability: Importance of transparency in supply chains, Technology solutions for traceability (e.g., blockchain, RFID), Ethical supply chains and corporate social responsibility (CSR)

Future of SSCM: Trends in digital transformation and sustainability (e.g., AI, IoT), The role of innovation in advancing sustainability in SCM, Future regulatory and market drivers for sustainable supply chains

Global and Local Perspectives: Local adaptation of global sustainability strategies, Impact of globalization on SSCM

Assignments:

- Group Project: Develop a sustainability scorecard for a company's supply chain
- Final Exam: Comprehensive evaluation of SSCM principles and practices

Text Books:

1. Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy, Yann Bouchery, Charles J. Corbett, Jan C. Fransoo, and Tarkan Tan ,Springer ISBN: 978-3319297911
2. Sustainable Logistics and Supply Chain Management David B. Grant, Alexander Trautrimms, and Chee Yew Wong, Kogan Page(2nd Edition), ISBN: 978-0749478278
3. Greening the Supply Chain, Joseph Sarkis, Springer ISBN: 978-1846282982

Reference Books:

1. Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice, Joëlle Morana ,Wiley ISBN: 978-1848218224
2. The Circular Economy and the Global Supply Chain, Lydia Bals, Wendy Tate, and Lisa Ellram, Kogan Page, ISBN: 978-0749482473
3. Sustainable Supply Chains: Strategies, Issues, and Performance, Tonya Boone, Vaidyanathan Jayaraman, and Ram Ganeshan, Springer ,ISBN: 978-1441944909

Sustainable Production Excellence

Course Code: 241CE077

L	T	P	C
3	0	0	3

Unit 1: Introduction to Sustainable Production

Concepts and Definitions: Overview of production systems and sustainability, Principles of sustainable production, Differences between traditional and sustainable production, Importance of sustainability in the production life cycle.

Sustainable Development Goals (SDGs) and Production: Role of production in achieving SDGs, Case studies of industries aligning with SDGs

Economic, Environmental, and Social Dimensions: Balancing the triple bottom line in production, Economic benefits of sustainable production, Environmental and social impacts of production processes

Assignments:

- Case Study: Evaluate the sustainability approach of a selected manufacturing company
- Discussion: The role of sustainable production in global climate goals

Unit 2: Resource Efficiency and Lean Manufacturing

Lean and Green Manufacturing: Principles of lean manufacturing and its relationship with sustainability, Waste reduction (muda) in sustainable production systems, Techniques for improving resource efficiency (5S, Six Sigma)

Energy and Water Efficiency in Production: Energy-efficient manufacturing practices, Reducing water usage in production processes

Material Efficiency and Circular Economy: Waste minimization and resource recovery, Circular economy principles in sustainable production

Assignments:

- Group Activity: Propose a lean and green transformation plan for a company
- Research Project: Evaluate material efficiency practices in a specific industry

Unit 3: Sustainable Technology and Innovation

Role of Technology in Sustainable Production: Advanced manufacturing technologies (Industry 4.0, IoT, AI) for sustainability, Automation and robotics in reducing waste and emissions, Additive manufacturing (3D printing) and its role in sustainable production

Life Cycle Assessment (LCA): Tools for analyzing environmental impact over a product's life cycle, Incorporating LCA in the design and production phases

Innovations in Sustainable Production: Green manufacturing technologies, Renewable energy integration in production, Sustainable material innovation (biodegradable, recyclable materials)

Assignments:

- Case Study: Use of Industry 4.0 technologies for sustainable production in a real-world case
- LCA Project: Conduct a life cycle assessment for a product

Unit 4: Environmental Management Systems and Certifications

Environmental Management Systems (EMS): ISO 14001 and its implementation in production environments, Continuous improvement in EMS, Auditing and monitoring for environmental compliance

Sustainability Reporting and Certifications: Key certifications: LEED, Energy Star, ISO 50001, etc. Importance of sustainability reporting (GRI, CDP, etc.), Regulatory frameworks and standards for sustainable production

Corporate Social Responsibility (CSR) and Production: Role of CSR in promoting sustainability in production, Social responsibility of companies toward stakeholders

Assignments:

- Report: Implementing an EMS in a hypothetical production unit
- Certification Research: Overview of major sustainability certifications for manufacturers

Unit 5: Future Trends and Global Challenges in Sustainable Production

Sustainable Product Design and Innovation: Eco-design principles in product development, Designing for disassembly and recyclability, Sustainable packaging innovations.

Climate Change and Sustainable Production: Impact of climate change on global production systems, Strategies for mitigating carbon footprints in production

Emerging Trends: Digital transformation in production for sustainability (smart factories), Renewable energy adoption in industrial production, Global supply chain integration for sustainable production

Assignments:

- Group Project: Propose a sustainable production plan for a company looking to reduce its carbon footprint
- Final Exam: Comprehensive evaluation of sustainable production concepts

Textbooks

1. Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives , Gunther Seliger, Springer, ISBN: 978-3642425371
2. Sustainability in Manufacturing: Recovery of Resources in Product and Material Cycles ,Günther Seliger, Springer, ISBN: 978-3540420782

Reference Books:

1. Green Manufacturing: Fundamentals and Applications, David A. Dornfeld, Springer, ISBN: 978-1441960169
2. Sustainable Manufacturing: Shaping Global Value Creation, Thomas Bauernhansl, Stefan Dais, and Eberhard Westkämper, Springer, ISBN: 978-3642346188
3. Handbook of Sustainable Engineering, Joanne Kauffman and Kun-Mo Lee, Springer, ISBN: 978-1402085553

AI in Environmental Science and Sustainability

Course Code: 241CE078

L	T	P	C
3	0	0	3

Unit 1: Introduction to Artificial Intelligence and Sustainability

Overview of Artificial Intelligence (AI): Basic concepts of AI and machine learning, Types of AI: Narrow AI, General AI, and Artificial Superintelligence, Overview of AI tools and technologies (neural networks, deep learning, reinforcement learning)

Role of AI in Sustainability: Introduction to sustainability and environmental science, Intersection of AI with sustainability goals (SDGs), Examples of AI applications in environmental science (climate modeling, resource optimization)

Sustainability Challenges Addressed by AI: AI for sustainable development, AI in global environmental governance, AI's potential and limitations in addressing climate change, biodiversity loss, and pollution

Assignments:

- Research paper: Review of AI applications in sustainability
- Case Study: Analysis of a successful AI-driven sustainability initiative

Unit 2: AI for Climate Science and Environmental Monitoring

AI in Climate Prediction: AI models for predicting climate change patterns, Role of AI in improving the accuracy of climate models, Case studies: AI for early warning systems (extreme weather events, floods, droughts)

Remote Sensing and AI: Use of AI in processing satellite data for environmental monitoring, AI for deforestation, desertification, and urbanization monitoring, Tools for data analysis (Google Earth Engine, AI-based satellite data tools)

AI in Pollution Detection and Control: AI models for air and water quality monitoring, Real-time data analysis for pollution management, Examples of AI in industrial pollution control and waste management

Assignments:

- Project: Developing an AI model for predicting a specific environmental event (e.g., floods, fires)
- Case Study: Remote sensing and AI applications for deforestation detection

Unit 3: AI for Sustainable Agriculture and Resource Management

AI in Precision Agriculture: Smart farming techniques using AI (drones, IoT sensors, predictive analytics), AI models for crop yield prediction, soil health monitoring, and pest control, Water management using AI (efficient irrigation systems, AI-driven water conservation)

AI in Natural Resource Management: AI for monitoring and managing freshwater resources, AI for optimizing energy and water usage in agriculture, AI applications in forestry and biodiversity conservation

Food Security and AI: AI for addressing food security issues (crop optimization, sustainable farming techniques), AI-driven models for minimizing food waste and improving supply chains

Assignments:

- Group Project: Develop an AI-based solution for sustainable farming or resource management
- Research: The impact of AI on water management in a specific region

Unit 4: AI in Renewable Energy and Smart Grids

AI for Renewable Energy Optimization: Role of AI in optimizing renewable energy sources (solar, wind, hydro), AI for energy demand forecasting and grid management, AI models for integrating renewable energy into power grids

AI in Smart Grids: AI-driven technologies for efficient grid management (demand-response systems, load balancing) Role of AI in reducing energy losses and improving grid efficiency

Case studies: AI applications in renewable energy (smart grid, microgrid management)

AI in Carbon Footprint Reduction: AI in carbon emissions monitoring and reduction strategies, Predictive models for optimizing energy consumption, Role of AI in creating energy-efficient buildings and industries

Assignments:

- Research Paper: AI-driven energy optimization strategies
- Case Study: AI in a smart grid or renewable energy project

Unit 5: Ethical, Social, and Policy Implications of AI in Sustainability

Ethics of AI in Environmental Science: Ethical challenges in using AI for environmental management, Bias, fairness, and transparency in AI models for sustainability, Ethical considerations in AI-driven conservation efforts

Social Impacts of AI in Sustainability: Impact of AI on jobs in agriculture, energy, and resource management, AI-driven social inequalities in environmental management, Public perception of AI in environmental decision-making

Policy and Governance in AI for Sustainability: Regulatory frameworks for AI in environmental management, Role of international organizations and governments in AI governance, Future directions for AI and sustainability policy

Assignments:

- Final Project: Develop an AI-driven solution to a sustainability challenge (climate change, agriculture, pollution, etc.)
- Debate: Ethical and social implications of AI in addressing environmental challenges

Textbooks

1. Artificial Intelligence and Machine Learning for Business for Dummies, Steven Holzner, For Dummies, ISBN: 978-1119467656
2. AI for Earth: Artificial Intelligence and the Environment, Rebecca Herold and Melanie Cook, CRC Press, ISBN: 978-1138554260

Reference books :

1. Artificial Intelligence for a Sustainable Future: From Environmental Informatics to Green AI, Henrik Skaug Sætra, Espen Moe, Routledge, ISBN: 978-0367436492
2. AI for Climate: The Role of Artificial Intelligence in Fighting Climate Change, David Rolnick, Priya Donti, Springer, ISBN: 978-3030591303
3. AI for Good: Using Artificial Intelligence to Address Climate Change, Environmental Sustainability, and Global Crises, Laurent Alexandre, CRC Press, ISBN: 978-1138339843

Security											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241CS032	Cybersecurity Essentials	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT035	Security in Software Development	FC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS028	Ethical Hacking	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS069	Cloud Security	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT036	Security & Compliance in Business	IC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT037	Cryptography & Data Security	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT038	Security Awareness & Social Engineering	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT039	Cybersecurity Policy & Strategy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT040	Security in Emerging Technologies	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS030	Information Security Analysis & Audit	AC	2			2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT041	Financial Information Security & Privacy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
Total			25		7	32					

Cybersecurity Essentials

Course Code: 241CS032

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the basic concepts of Cyber security issues and challenges
- CO2:** Analyze the cybercrimes and cyber laws.
- CO3:** Demonstrate various privacy and security concerns on social media
- CO4:** Illustrate the concepts related to E-Commerce and digital payments.
- CO5:** Summarize tools and technologies to protect communication devices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1					2				
CO2	2	3		2	1			1	1		
CO3	1	2		2	1	1		1	1		1
CO4	1	2	3	1	1		1	1		1	1
CO5	2	1					3				

UNIT – I

Introduction to Cyber security:

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Practice:

- Study on how to register a Cyber Crime Complaint through online.(
https://cybercrime.gov.in/Webform/Crime_AuthoLogin.aspx)

UNIT – II

Cyber crime and Cyber law:

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India.

Practice:

- Reporting on types of phishing emails.
- Demonstration of email phishing attack and preventive measures

UNIT – III

Social Media Overview and Security

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media

privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Laws regarding posting of inappropriate content.

Practice:

1. Basic checklist, privacy and security settings for popular Social media platforms.

UNIT – IV

E-Commerce and Digital Payments

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best Practices, Introduction to digital payments, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures.

Practice:

1. Configuring security settings in Mobile Wallets and UPIs

UNIT – V

Digital Devices Security , Tools and Technologies for Cyber Security

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best **Practices**, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Practice:

- a. Setting and configuring two factor authentication in the Mobile phone.
- b. Security patch management and updates in Computer and Mobiles.

Text Books:

- 1 Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
- 2 Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.

Reference Books:

- 1 Data Privacy Principles and **Practice** by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
- 2 Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, Wiley Publication, 1st Edition,.
- 3 Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, Jones Bartlett Learning, 2nd Edition.

Web Links:

- 1 <https://www.coursera.org/specializations/cyber-security>.
- 2 <https://www.nptel.ac.in/courses/106105031/>.

Security in Software Development

Course Code: 241IT035

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the basic concepts of Cyber security issues and challenges
- CO2:** Analyze the cybercrimes and cyber laws.
- CO3:** Demonstrate various privacy and security concerns on social media
- CO4:** Illustrate the concepts related to E-Commerce and digital payments.
- CO5:** Summarize tools and technologies to protect communication devices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1							1	1	
CO2	2	2		1	2				1	1	
CO3	2	2		2					1	1	
CO4	2	2			1				1	1	
CO5	2	2						2	1	1	

UNIT – I

Introduction to Software Security

Importance of security in software development, Common security threats (e.g., viruses, worms, malware, ransomware), Secure software development lifecycle (SDLC), Principles of secure coding.

UNIT – II

Threat Modeling and Risk Analysis

Threat modeling approaches, Identifying vulnerabilities, Risk analysis and management, Security requirements gathering.

UNIT – III

Secure Coding Practices

Common vulnerabilities (e.g., SQL injection, buffer overflow, cross-site scripting), Secure coding standards (e.g., OWASP), Input validation and data sanitization, Code reviews and static analysis tools

UNIT – IV

Application Security Testing

Types of security testing (static, dynamic, penetration testing), Automated testing tools, Vulnerability scanning and patch management, Secure code review technique

UNIT – V

Security in DevOps and Cloud

Integrating security into DevOps practices (DevSecOps), Security automation and continuous integration, Cloud security principles and challenges, Securing APIs and microservices in cloud environments

Text Books:

- 1 Software Security: Building Security In" by Gary McGraw
ISBN: 978-0321356703
- 2 The CERT® C Coding Standard: 98 Rules for Developing Safe, Reliable, and Secure Systems by Robert C. Seacord
ISBN: 978-0321984043

Reference Books:

- 1 Threat Modeling: Designing for Security by Adam Shostack
ISBN: 978-1118809990
- 2 Web Application Security, A Beginner's Guide by Bryan Sullivan and Vincent Liu
ISBN: 978-0071776165
- 3 Securing DevOps: Security in the Cloud by Julien Vehent
ISBN: 978-1617294136

Web Links:

- 1 <https://www.coursera.org/specializations/cyber-security>.
- 2 <https://www.nptel.ac.in/courses/106105031/>.
- 3 CERT-In Guidelines- <http://www.cert-in.org.in/>

Ethical Hacking

Course Code: 241CS028

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the concepts and types of Ethical hacking
- CO2:** Apply tools and techniques for Social Engineering.
- CO3:** Illustrate concepts of data security for various networking systems
- CO4:** Analyze techniques to protect Web servers and Communication Systems
- CO5:** Demonstrate ethical laws and tests related to ethical hacking

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1							1	1	
CO2	2	2		1	2				1	1	
CO3	2	2		2					1	1	
CO4	2	2			1				1	1	
CO5	2	2						2	1	1	

UNIT – I

Ethical Hacking

Types of Data Stolen From the Organizations, Elements of Information Security, Authenticity and NonRepudiation, Security Challenges, Effects of Hacking, Hacker – Types of Hacker, Ethical Hacker, Hacktivism - Role of Security and Penetration Tester, Penetration Testing Methodology, Networking & Computer Attacks – Malicious Software (Malware), Protection Against Malware, Intruder Attacks on Networks and Computers, Addressing Physical Security – Key Loggers and Back Doors.

Practice:

1. Create a social networking website login page using phishing techniques
2. Sniffing tools to analyze traffic on a network and dissect information.

UNIT – II

Foot Printing And Social Engineering

Web Tools for Foot Printing, Conducting Competitive Intelligence, Google Hacking, Scanning, Enumeration, Trojans & Backdoors, Virus & Worms, Proxy & Packet Filtering, Denial of Service, Sniffer, Social Engineering – shoulder surfing, Dumpster Diving, Piggybacking.

Practice:

1. Social Engineering Countermeasures
2. Tools for Foot Printing

UNIT – III

Data Security

Physical Security – Attacks and Protection, Steganography – Methods, Attacks and Measures, Cryptography– Methods and Types of Attacks, Wireless Hacking, Windows Hacking, Linux Hacking.

Practice:

1. Write a code to demonstrate DoS attacks
2. Windows ,Linux OS hacking

UNIT – IV**Network Protection System & Hacking Web Servers**

Routers, Firewall & Honeypots, IDS & IPS, Web Filtering, Vulnerability, Penetration Testing, Session Hijacking, Web Server, SQL Injection, Cross Site Scripting, Exploit Writing, Buffer Overflow, Reverse Engineering, Email Hacking, Incident Handling & Response, Bluetooth Hacking, Mobiles Phone Hacking.

Practice:

1. Write a script or code to demonstrate SQL injection attacks
2. Setup a honey pot and monitor the honey pot on network

UNIT – V**Ethical Hacking Laws And Tests**

An introduction to the particular legal, professional and ethical issues likely to face the domain of ethical hacking, ethical responsibilities, professional integrity and making appropriate use of the tools and techniques associated with ethical hacking – Social Engineering, Host Reconnaissance, Session Hijacking, Hacking - Web Server, Database, Password Cracking.

Practice:

1. Study of Techniques uses for Web Based Password Capturing
2. Study on how to register a Cyber Crime Complaint through online.
(https://cybercrime.gov.in/Webform/Crime_AuthoLogin.aspx)

Text Books:

- 1 Corley, Hands-On Ethical Hacking and Network Defense ,Michael T. Simpson, Kent Backman, James E., CENGAGE Learning
- 2 Penetration Testing and Network Defense ,Whitaker & Newman , Cisco Press, Indianapolis.

Reference Books:

- 1 Official Certified Ethical Hacker Review Guide,Steven DeFino, Barry Kaufman, Nick Valenteen,CENGAGE Learning.
- 2 The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy ,Patrick Engebretson, Syngress Basics Series – Elsevier.

Web Links:

- 1 <https://www.springboard.com/blog/cybersecurity/7-free-sources-to-learn-ethical-hacking-from-scratch/>
- 2 <https://hackernoon.com/top-resources-to-learn-ethical-hacking3>
- 3 https://onlinecourses.nptel.ac.in/noc22_cs13/preview

Cloud security

Course Code: 241CS069

L	T	P	C
0	0	3	3

Practice:

1.
 - a. Analyze cloud security design principals
 - b. Implementation of shared responsibility model in cloud
2.
 - a. Understanding attack vectors on cloud resources
 - b. Case studies on Cloud security and compliance
3.
 - a. Securing access to cloud resources.
 - b. Configuring IAM Authentication
4.
 - a. Authorize with Identity and Access Management
 - b. Amazon S3 Cross-Account Resource-Based Policy
5.
 - a. Using Resource-Based Policies to Secure an S3 Bucket
 - b. Implementing IAM assume role in AWS.
6.
 - a. Securing infrastructure in cloud.
 - b. Testing IAM policies with IAM policy simulator
7.
 - a. Using AWS Cloud Trail to log and track actions.
 - b. Threat Intelligence with Amazon guard Duty
8.
 - a. Setting up private and public subnets.
 - b. Securing VPC Resources by Using Security Groups
9.
 - a. Working with Network Access Control Lists
 - b. Best practices for protecting data in Amazon S3
10.
 - a. Understanding client-side and server-side encryption
 - b. Encrypting Data at Rest by Using AWS KMS
11.
 - a. Monitoring and Alerting CloudWatch
 - b. Using Amazon Inspector to assess application vulnerabilities.
12.
 - a. Securing web applications in AWS using Web Application Firewall
 - b. Protecting cloud resources from DDoS attacks using AWS Shield

Additional Practice:

1. Remediating an Incident by Using AWS Config and Lambda
2. Best practices for handling an incident
3. Responding to and Managing an Incident

Textbooks:

- 1 AWS Certified security study guide, Marcello Zillo Neto, Gustavo AA Santana, by Sybex Press

Reference Books:

- 1 AWS Certified Security exam guide, Stuart Scott, by O'REILLY press

Web Links:

- 1 <https://skillbuilder.aws/>
- 2 <https://aws.amazon.com/training/awsacademy/>

Security & Compliance in Business

	L	T	P	C
Course Code: 241IT036	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify the fundamentals of business security and compliance frameworks.
- CO2:** Analyze various security risks and compliance requirements in business environments.
- CO3:** Implement strategies for business data protection and risk management.
- CO4:** Evaluate business compliance with global standards and regulatory frameworks.
- CO5:** Develop an organizational security and compliance plan.

UNIT – I

Introduction to Business Security and Compliance

Fundamentals of business security, Overview of business compliance frameworks (e.g., GDPR, HIPAA, PCI-DSS), Importance of security in business environments, Key regulatory bodies and laws

UNIT – II

Risk Management and Threats in Business

Understanding security threats to businesses (e.g., cyberattacks, insider threats), Risk management frameworks (ISO 31000, NIST), Risk assessment and analysis, Incident response planning and mitigation strategies

UNIT – III

Data Protection and Privacy in Business

Business data protection strategies, Encryption and data masking techniques, Privacy requirements under various compliance frameworks, Best practices for ensuring data privacy in businesses

UNIT – IV

Regulatory Compliance and Standards

Understanding global regulatory frameworks (e.g., GDPR, SOX, FISMA), Auditing and compliance assessments, Reporting and documentation for compliance, Case studies on regulatory compliance failures

UNIT – V

Developing a Security and Compliance Plan

Steps to create a comprehensive security and compliance plan, Integrating security in business operations, Continuous monitoring and auditing, Aligning business goals with security and compliance

Text Books:

- 1 Building a Comprehensive IT Security Program: Practical Guidelines and Best Practices by Jeremy Wittkop, ISBN: 978-1484220529
- 2 Data Protection and Privacy: The Age of Big Data" by Ronald Leenes, Rosamunde Van Brakel, ISBN: 978-1509923195

Reference Books:

- 1 Regulatory Compliance Fundamentals by M.L. Leathers, ISBN: 978-0814436342
- 2 Risk Management and Corporate Governance" by Marijn van Daelen, Christa Hopt ISBN: 978-0857930571

Cryptography & Data Security

Course Code: 241IT037

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Discuss the fundamental principles of cryptography and its role in data security
- CO2:** Analyze various cryptographic algorithms and their applications.
- CO3:** Implement encryption techniques to secure data in transmission and storage.
- CO4:** Evaluate modern cryptographic protocols and their strengths and vulnerabilities.
- CO5:** Develop solutions for ensuring data security in real-world applications.

UNIT – I

Introduction to Cryptography

History and evolution of cryptography, Key concepts: Encryption, decryption, and cryptographic keys, Symmetric vs. asymmetric cryptography, Importance of cryptography in securing data

UNIT – II

Symmetric Cryptography

Symmetric encryption algorithms (DES, AES, RC4), Block ciphers vs. stream ciphers, Modes of operation (CBC, CFB, OFB, CTR), Key management and distribution

Practice:

Implement AES encryption in Python

UNIT – III

Asymmetric Cryptography

Public-key cryptography (RSA, Diffie-Hellman), Key exchange protocols, Digital signatures and certificates, Cryptographic hash functions (SHA, MD5)

Practice:

Implement MD5 algorithm

UNIT – IV

Cryptographic Protocols and Applications

Secure Socket Layer (SSL) and Transport Layer Security (TLS), Cryptography in blockchain and crypto currencies, Public Key Infrastructure (PKI), Application of cryptography in secure email, e-commerce, and VPNs

Practice:

Implement SSL handshake simulation in Python

UNIT – V

Modern Cryptographic Challenges and Future Trends

Quantum cryptography and post-quantum cryptography, Zero-knowledge proofs, Cryptanalysis: Attacks on cryptosystems (brute-force, side-channel attacks), Future trends in cryptography

Text Books:

- 1 Cryptography and Network Security: Principles and Practice by William Stallings
ISBN: 978-0134444284
- 2 Network Security Essentials: Applications and Standards by William Stallings
ISBN: 978-0134527338

Reference Books:

- 1 Understanding Cryptography: A Textbook for Students and Practitioners by Christof Paar, Jan Pelzl
ISBN: 978-3642041006
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C by Bruce Schneier ISBN: 978-1119096720
- 3 Post-Quantum Cryptography by Daniel J. Bernstein, Johannes Buchmann
ISBN: 978-3540887027

Web Links:

- 1 <https://www.openssl.org>
- 2 <https://cryptography.io>
- 3 <https://www.nist.gov>

Security Awareness and Social Engineering

Course Code: 241IT038

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify basic security concepts and terminologies related to cybersecurity.
- CO2:** Analyze common security threats, vulnerabilities, and their impact on information systems.
- CO3:** Identify various social engineering techniques used by attackers.
- CO4:** Apply defensive measures against common social engineering attacks.
- CO5:** Develop strategies to raise awareness of security threats among individuals and organizations.

UNIT – I

Introduction to Security Awareness

Security fundamentals, Common cyber threats: Malware, phishing, ransomware, etc., Importance of information security in organizations, Overview of security controls

Practice:

Design a security awareness training module for employees of an organization, considering different types of social engineering attacks and how to mitigate them.

UNIT – II

Understanding Social Engineering

What is social engineering, Types of social engineering attacks: Pretexting, baiting, phishing, etc., Psychological principles behind social engineering, Real-life case studies of social engineering attacks

UNIT – III

Mitigating Social Engineering Threats

Defensive strategies against social engineering, Awareness training and education, The role of policies and procedures in prevention, Using technology to defend against social engineering.

UNIT – IV

Security Awareness Programs

Importance of creating a culture of security, Designing security awareness campaigns, Monitoring and improving security awareness in organizations, Evaluating the effectiveness of security training programs.

Practice:

Simulate a phishing attack on a fictional organization and track how many employees fall victim. Analyze the results and propose improvements to their awareness training program.

UNIT – V

Ethical and Legal Aspects

Ethics in cyber security, Laws and regulations governing cyber security, Data protection laws (GDPR, CCPA, etc.), Handling sensitive data responsibly

Practice:

Perform a risk assessment for a small business, identifying potential security threats and designing mitigation strategies.

Text Books:

- 1 Security Awareness: Applying Practical Security in Your World
Author: Mark Ciampa Publisher: Cengage Learning ISBN: 978-1305500372
- 2 The Art of Deception: Controlling the Human Element of Security
Author: Kevin, D.Mitnick, Publisher: Wiley, ISBN: 978-0764542800

Reference Books:

- 1 Social Engineering: The Science of Human Hacking, Author: Christopher Hadnagy,
Publisher: Wiley, ISBN: 978-1119433385

Cyber Security Policy and Strategy

Course Code: 241IT039

L	T	P	C
3		0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand the key elements of cybersecurity policies and strategies.
- CO2:** Analyze global cybersecurity frameworks, laws, and regulations
- CO3:** Develop a cybersecurity risk management strategy for an organization.
- CO4:** Propose policies for safeguarding critical infrastructure.
- CO5:** Evaluate legal, ethical, and privacy issues in the context of cybersecurity.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1				1	1				
CO2	2	2		2		2	2				2
CO3	2	2	2								
CO4	2	2	1				2				
CO5	2	2	1				2				

UNIT-I

Introduction to Cybersecurity Policies and Strategies: History and evolution of cybersecurity policies, Key concepts: threat landscape, vulnerabilities, risk, and controls, Cybersecurity governance models, Role of stakeholders: governments, organizations, and international bodies.

UNIT-II

Cybersecurity Governance and Risk Management: Frameworks for cybersecurity governance (NIST, ISO 27001, etc.), Enterprise risk management and cybersecurity, risk assessment, risk tolerance, and risk mitigation strategies
Role of leadership and organizational culture

Unit III

National and International Cybersecurity Strategies: National cybersecurity strategies: US, EU, India, and other regions, International organizations in cybersecurity: UN, ITU, NATO, Cyber norms and diplomatic strategies, Cyber warfare and state-sponsored cyber activities

Unit IV

Legal, Regulatory, and Compliance Frameworks: Data protection laws (GDPR, CCPA, etc.), Regulatory frameworks: HIPAA, PCI-DSS, SOX, Cybersecurity compliance challenges, Legal implications of cyber incidents

Unit V

Emerging Issues in Cybersecurity Policy: Ethical issues in cybersecurity, The role of Artificial Intelligence (AI) and Machine Learning (ML), Cyber insurance and financial risks

Text Books:

- 1 Cybersecurity and Cyberwar: What Everyone Needs to Know, P.W. Singer and Allan Friedman, Oxford University Press, 2014, 978-0199918119
- 2 Cybersecurity Policy Guidebook, Jennifer L. Bayuk, Jason Healey, Paul Rohmeyer, John Wiley & Sons, 2012, 978-1118027806

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc23_cs127/preview
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Security in Emerging Technologies

Course Code: 241IT040

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the security implications of emerging technologies such as IoT, AI, blockchain, and quantum computing.
- CO2:** Analyze and address security challenges in IoT ecosystems, including device and data protection.
- CO3:** Apply AI and ML technologies to improve cybersecurity measures and detect threats.
- CO4:** Evaluate the security risks in blockchain and cryptocurrencies and propose solutions to mitigate vulnerabilities.
- CO5:** Explore the impact of quantum computing on modern cryptography and assess the future of quantum-resistant security techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3			1							
CO2	3	2		2							
CO3	3	2	1	2	1						
CO4	2		1								
CO5	2	2	1	1	1						

UNIT – I

Introduction to Emerging Technologies and Security

Overview of Emerging Technologies: Definition and scope: IoT, AI, Blockchain, Cloud Computing, Quantum Computing, Impact of emerging technologies on industries and society.

Security Challenges in Emerging Technologies: New attack vectors and vulnerabilities, Security threats and risks associated with adoption of new technologies, Regulatory and compliance considerations.

UNIT – II

Internet of Things (IoT) Security

Architecture and Components of IoT: IoT devices, sensors, and networks, Communication protocols in IoT (Zigbee, Bluetooth, MQTT)

IoT Security Issues: Common vulnerabilities and risks in IoT ecosystems, Authentication and access control for IoT devices, Secure communication and data encryption in IoT systems

UNIT – III

Artificial Intelligence (AI) and Machine Learning (ML) Security

AI and ML in Cybersecurity: Role of AI and ML in detecting cyber threats and enhancing security, AI-driven security solutions for real-time threat detection

Security Challenges in AI/ML Systems: Adversarial attacks on AI models, Data poisoning and model tampering risks, Ethical concerns and privacy issues in AI-driven systems

UNIT – IV

Blockchain and Cryptocurrency Security

Blockchain Technology Overview: Structure and functioning of blockchain technology, Consensus algorithms (Proof of Work, Proof of Stake), Applications of blockchain beyond cryptocurrency

Blockchain Security Challenges: 51% attacks and double-spending risks, Smart contract vulnerabilities, Privacy and scalability challenges in blockchain networks

UNIT – V

Quantum Computing and Security Implications

Quantum Computing Basics: Fundamentals of quantum computing and its potential applications, How quantum computers differ from classical computers

Quantum Cryptography and Post-Quantum Security: Threats posed by quantum computing to current cryptographic methods, Quantum-resistant cryptographic algorithms, Quantum key distribution (QKD) and its security benefits

Text Books:

- 1 Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, Fei Hu, CRC Press, ISBN: 978-1498768874.
- 2 Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, Apress, ISBN: 978-1484226032

Reference Books:

- 1 Quantum Computing for Computer Scientists, Noson S. Yanofsky, Mirco A. Mannucci, Cambridge University Press, ISBN: 978-0521879965
- 2 AI in Cybersecurity, Leslie F. Sikos, Springer, ISBN: 978-3030459729
- 3 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, Packt Publishing, ISBN: 978-1788839044

Web Links:

- 1 <https://www.nist.gov/cyberframework>
- 2 <https://owasp.org/www-project-internet-of-things/>
- 3 <https://quantumcomputingreport.com>

Information Security Analysis & Audit

Course Code: 241CS030

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate fundamental concepts of information security and systems auditing
- CO2:** Analyze latest trend in management control framework
- CO3:** Identify security operations in management control framework.
- CO4:** Distinguish data evidence collection techniques.
- CO5:** Analyze data evidence evaluation in audit.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1									1
CO2	2	2		3			2				2
CO3	1	3			1		-				2
CO4	1	2		2			1				1
CO5	1	3	1				2				

UNIT – I

Overview of Information System Auditing- Effect of Computers on Internal Controls, Effects of Computers on Auditing, Foundations of information Systems Auditing, Conducting an Information Systems Audit.

UNIT – II

The management Control Framework-I- Introduction, Evaluating the planning Function, Leading Function, Controlling Function, Systems Development Management Controls, Approaches to Auditing Systems Development, Programming Management Controls, Data Resource Management Controls.

UNIT – III

The Management Control Framework-II- Security Management Controls, Operations management Controls Quality assurance Management Controls, Case Studies

UNIT – IV

Evidence Collection- Audit Software, Code Review, Test Data, and Code Comparison, Concurrent Auditing techniques, Interviews, Questionnaires, and Control Flowcharts. Performance Management tools- Case Studies.

UNIT – V

Evidence Evaluation- Evaluating Asset Safeguarding and Data Integrity, Evaluating System, Effectiveness, Evaluating System Efficiency, Information Systems Audit and Management: Managing the Information Systems Audit Function.

Text Books:

1. Information Systems Control and Audit, Ron Weber, Pearson Education, 1st Edition
2. Cryptography Engineering: Design Principles and Practical Applications ,Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons.

Reference Books:

1. Information System Audit and Assurance, D P Dube, TMH, New Delhi.
2. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi.

Web Links:

1. <https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks>
2. <https://computersecurity.stanford.edu/free-online-video>[Free Online Videos]
3. CERT-In Guidelines- <http://www.cert-in.org.in/>

Financial Information Security & Privacy

Course Code: 241IT041

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Analyze the financial information security landscape and identify major challenges.
- CO2:** Apply regulatory and legal standards to ensure the protection of financial data.
- CO3:** Design and implement effective cybersecurity measures in financial institutions.
- CO4:** Utilize technologies such as encryption, blockchain, and cloud security for financial data protection.
- CO5:** Develop risk management strategies to mitigate security threats and ensure compliance in financial systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3		1	1							
CO2	2	2	1	2							
CO3	3	2		2							
CO4	2		1								
CO5	2	2	1	1							

UNIT – I

Introduction to Financial Information Security:

Overview of Financial Information Systems, Introduction to Financial Data Privacy, Financial Data Security Needs and Risks, Financial Information Security Landscape: Key Challenges and Issues, Legal and Regulatory Requirements for Financial Information Protection (e.g., GDPR, PCI DSS, GLBA), Role of Cryptography in Financial Systems Security

UNIT – II

Cybersecurity Threats and Attacks in Financial Systems:

Common Cybersecurity Threats: Malware, Phishing, Ransomware, Types of Attacks on Financial Systems (e.g., Denial of Service, Man-in-the-Middle, SQL Injection), Cybersecurity Incident Management and Response, Case Studies of Cybersecurity Breaches in Financial Institutions

UNIT – IV

Technologies for Securing Financial Information

Encryption Techniques for Financial Data Protection, Secure Access Controls: Authentication and Authorization, Security of Mobile and Online Banking Platforms, Role of Blockchain in Financial Information Security, Cloud Security for Financial Institutions

UNIT – V

Risk Management and Compliance in Financial Information Security

Financial Risk Management in Information Security, Regulatory Compliance Frameworks: PCI DSS, SOX, and others, Implementing Information Security Policies and Procedures, Role of Auditing and Monitoring in Financial Systems, Developing an Information Security Management System (ISMS)

Text Books:

- 1 Financial Cryptography and Data Security by Rainer Böhme (Editor), Springer, ISBN: 978-3642026923.
- 2 Cybersecurity in Banking and Financial Institutions by Felix I. Lessambo, Palgrave Macmillan, ISBN: 978-3030723006.

Reference Books:

- 1 Security and Privacy in Financial Cloud" by Kuan-Ching Li, CRC Press, ISBN: 978-0367337420.
- 2 Cybersecurity for Financial Services" by Siraj A. Shaikh, George Loukas, and David Haynes, Springer, ISBN: 978-1119569369.

Web Links:

- 1 <https://www.nist.gov/cyberframework>
- 2 <https://owasp.org>
- 3 <https://www.pcisecuritystandards.org>

Others											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
241CE080	Remote Sensing & GIS Applications	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EE036	Electric Energy Storage Systems	FC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EE043	Electrical safety	IC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241EE054	Hybrid & Electric Vehicles	IC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
241ME073	Organizational Behaviour	FC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME036	Sustainable Energy Systems	FC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME037	Solar Energy Systems	FC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241ME060	Composite Materials	IC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	SSP/MP
241EC082	Communication Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EC083	Electronic Measurements & Instrumentation	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE

241EC084	Introduction to Embedded Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EC085	Fundamentals of Image Processing	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
241EC077	Sensors and Transducers	IC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
241CS003	Data Structures	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241CS065	Computer Organization	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS013	Operating Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT005	Database Management Systems	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241IT007	Agile Software Engineering	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241CS007	Computer Networks	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT006	Java Programming	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
241CS068	Fundamentals of RedHat Enterprise Linux	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS067	AWS Cloud Foundations	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS066	AWS Cloud Development	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241CS070	Continuous integration & delivery using DevOps	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT024	Fundamentals of Salesforce Administration	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT034	Advanced Salesforce Administration	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-

241IT023	Principles of Pega Systems	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241IT026	Pega System Architecture & Design	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
241MB004	Entrepreneurship Development & Incubation	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241MB005	Business Ethics & Corporate Governance	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241MB006	Entrepreneurship Development & Business Management	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
241EC029	SoC Design	AC	3			3	50	50	100	CE, EEE, ME, CSE, IT, AIML, CSE (DS), PT, Min.E.	MPMC
241CS023	Cloud Computing	FC	2		2	4	50	50	100	CE, EEE, ME, ECE, PT, Min.E.	-

Remote Sensing & GIS Applications

	L	T	P	C
Course Code:241CE080	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Classify the information content of remotely sensed data.
- CO2:** Explain the energy interactions in the atmosphere and earth surface features.
- CO3:** Interpret the images for preparation of thematic maps.
- CO4:** Analyse spatial and attribute data for solving spatial problems.
- CO5:** Apply remote sensing and GIS data for engineering applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2				2						
CO2	2										
CO3	2	2	2		2	1					
CO4	2	3			2						
CO5	2				2						

UNIT – I

Basic concepts of Photogrammetry:

Principles& types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducial points, parallax measurement using fiducial line.

Introduction and Basic Concept of Remote Sensing:

Introduction to remote sensing: Basic concepts of remote sensing, electromagnetic radiation, electromagnetic spectrum, interaction with atmosphere, energy interaction with the earth surfaces characteristics of remote sensing systems

UNIT – II

Sensors and platforms:

Introduction, types of sensors, airborne remote sensing, space borne remote sensing, image data characteristics, digital image data formats-band interleaved by pixel, band interleaved by line, band sequential, IRS, LANDSAT, SPOT.

Image interpretation:

Introduction, elements of visual image interpretations, digital image processing- image pre-processing, image enhancement, image classification, supervised classification, unsupervised classification.

UNIT – III

Geographic Information System:

Introduction to GIS; Components of a GIS, Geospatial Data: Spatial Data and Attribute data, Joining Spatial and Attribute data. Coordinate.

Systems:

Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters, commonly used Map Projections

UNIT – IV

Spatial data analysis:

Introduction, data models, overlay function-vector overlay operations, raster overlay operations, arithmetic operators, comparison and logical operators, conditional expressions, overlay using a decision table, network analysis-optimal path finding, network allocation, network tracing

UNIT – V

Applications of Remote Sensing and GIS:

Application of Remote Sensing and GIS in civil engineering, groundwater prospecting and identification of potential zones for artificial recharge, transportation, agriculture, Forestry, Land cover and land use, geology and geomorphology, floodplain delineation

Text Books:

1. Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers. (ISBN: 978-0199496648).
2. Remote Sensing and GIS, Thomas M.Lillesand and Kiefer, John Wiley.(ISBN:13-978-1118343289).

Reference Books:

1. Concepts & Techniques of GIS , C. P. Lo Albert, K.W. Yonng, Prentice Hall (India) Publications. (ISBN: 13- 978-9332581883).
2. Principals of Geo physical Information Systems – Peter A Burragh and Rachael A. Mc Donnell, Oxford Publishers. (ISBN: 13-978-0198742845)
3. Basics of Remote sensing & GIS , S. Kumar, Laxmi Publications. (ISBN: 13- 978-8170087960).

Web Links:

1. http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
2. <https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg>
3. <https://nptel.ac.in/downloads/105108077/>

Electric Energy Storage Systems

Course Code:241EE036

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Analyze the characteristics of electrical energy storage technologies.
- CO2:** Analyze the needs for electrical energy storage.
- CO3:** Analyze the needs for electrical energy storage.
- CO4:** Understand the various types of electrical energy storage systems.
- CO5:** Identify various real time applications of energy storage systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1								
CO2	3	2	1								
CO3	2	1	3								
CO4	3	1	1								
CO5	3	2	2								

UNIT – I

Electrical Energy Storage (EES) Technologies: Characteristics of electricity, Electricity & the roles of EES, High generation cost during peak-demand periods, Need for continuous & flexible supply, Long distance between generation & consumption, Congestion in power grids, Transmission by cable.

UNIT – II

Needs for Electrical Energy Storage: Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

UNIT – III

Features of Energy Storage Systems: Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H₂), Synthetic natural gas (SNG)

UNIT – IV

Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

UNIT – V

Applications: Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), New trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management & control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems & distributed generation (Virtual Power Plant), Battery SCADA aggregation of many dispersed batteries.

Text Books:

- 1 Energy Storage Benefits & Market Analysis, by James M. Eyer, Joseph J. Iannucci & Garth P. Corey Sandia National Laboratories.
- 2 The Electrical Energy Storage by IEC Market Strategy Board.

Reference Boks:

- 1 Energy Storage for the Electricity Grid: Benefits & Market Potential Assessment Guide, Jim Eyer, Garth Corey, Sandia National Laboratories.
- 2 Energy Storage by Mullick & Garg (ISBN: 9789027719300)

Web Links:

- 1 <https://nptel.ac.in/courses/112/105/112105221/>
- 2 <https://nptel.ac.in/courses/112/107/112107283/>
- 3 <https://nptel.ac.in/content/storage2/courses/108103009>

Electrical Safety

Course Code: 241EE043

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO 1:** Describe electrical hazards & safety equipment.
- CO 2:** Analyze & apply various grounding & bonding techniques
- CO 3:** Select appropriate safety method for low, medium equipment's & high voltage equipment.
- CO 4:** Participate in a safety team & Carry out proper maintenance of electrical equipment by understanding various Standards.
- CO 5:** Analyze the safety method for high voltage equipment's.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1								
CO2	3	2	1								
CO3	3	2	1								
CO4	3	2	2								
CO5	1	3	1								

UNIT-I

Hazards of Electricity & Electrical Safety Equipment: Primary & secondary hazards- arc, blast, shocks causes & effects- safety equipment flash & thermal protection, head & eye protection- rubber insulating equipment, hot sticks, insulated tools, barriers & signs, safety tags, locking devices- voltage measuring instruments- proximity & contact testers- safety electrical one line diagram- electrician's safety kit.

UNIT-II

Grounding of Electrical Systems & Equipment: General requirements for grounding & bonding- definitions grounding of electrical equipment- bonding of electrically conducting materials & other equipment connection of grounding & bonding equipment- system grounding- purpose of system grounding- grounding electrode system- grounding conductor connection to electrodes- use of grounded circuit conductor for grounding equipment- grounding of low voltage & high voltage systems.

UNIT-III

Safety Procedures & Methods: The six step safety methods- pre job briefings - hot-work decision tree- safe switching of power system- lockout-tag out- flash hazard calculation & approach distances- calculating the required level of arc protection- safety equipment, procedure for low, medium & high voltage systems- the one-minute safety audit

UNIT-IV

Safety Management & Organizing Structure: Electrical safety program structure, development- company safety team- safety policy program implementation- employee electrical safety teams- safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.

UNIT-V

Electrical Maintenance & Legal Safety Requirements & Standards: Safety related case for electrical maintenance- reliability centred maintenance (RCM) - eight step maintenance program- frequency of maintenance- maintenance requirement for specific equipment & location- regulatory bodies- national electrical safety code standard for electrical safety in work place- occupational safety & health administration standards, Indian Electricity Acts related to Electrical Safety

Text Books:

1. 'Electrical Safety Handbook' by John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, McGraw-Hill Education, 4th Edition (ISBN: 9780071745130)
2. "Electric Safety Practice & Standards", Khaled Ismail, CRC Press, Taylor & Francis (ISBN: 9781138073999).

Reference Books

1. 'Electrical Safety- a guide to the causes & prevention of electric hazards', Maxwell Adams.J, The Institution of Electric Engineers, IET (ISBN: 9780852968062).
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning (ISBN: 9780877655800).

Web Links:

1. <http://nptel.ac.in/courses/103106071/5>
2. <https://www.electricalsafetyfirst.org.uk>

Hybrid & Electric Vehicles

Course Code:241EE054

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Describe the History of Hybrid Electric vehicles
- CO2:** Classify the various electric drivetrain topologies
- CO3:** Articulate the Energy Storage Requirements in Hybrid & Electric Vehicles
- CO4:** Illustrate the Charging Infrastructure
- CO5:** Evaluate Energy Management Strategies used in hybrid & electric vehicle

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1		1			1					1
CO2	1	1	1		1	1					1
CO3	3	2	3	2	2	2					1
CO4	2	1	2	1	1	2					1
CO5	3	3	3	3	3	2					1

UNIT – I

Introduction:

Introduction to Hybrid Electric Vehicles: History of hybrid & electric vehicles, social & environmental importance of hybrid & electric vehicles, impact of modern drive-trains on energy supplies-Challenges & Key Technologies of EVs – Challenges for EV Industry in India

UNIT – II

Electric Drive-trains:

Basic concept of electric traction - introduction to various electric drivetrain topologies - Power flow control in electric drive-train topologies - fuel efficiency analysis

Electric Propulsion unit:

Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, configuration and control of Induction Motor drives, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.

UNIT – III

Energy Storage:

Introduction to Energy Storage Requirements in Hybrid & Electric Vehicles -Battery based energy storage & its analysis - Fuel Cell based energy storage & its analysis - Super Capacitor based energy storage- Flywheel based energy storage & its analysis.

UNIT – IV

Sizing the drive system:

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

UNIT – V

Energy Management Strategies

Introduction to Energy Management Strategies used in hybrid & electric vehicle, Classification of different Energy Management strategies - Comparison of different Energy Management Strategies - Implementation issues of energy strategies - Effect of charging infrastructure on grid protection & control.

Text Books:

- 1 Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley-Blackwell (ISBN: 9781119942733).
- 2 Energy Management Strategies for Electric & Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer (ISBN: 9781493955237).

Reference Books:

- 1 Electric Vehicle Battery Systems, Sandeep Dhameja, Elsevier (ISBN: 9780750699167).
- 2 Advanced Electric Drive Vehicles, Ali Emadi, CRC Press (ISBN: 9781138072855).
- 3 Hybrid electric Vehicles Principles & applications with practical perspectives, Chris Mi, M. Abul Masrur, D. Wenzhong Gao, A Dearborn, John Wiley & Sons Ltd (ISBN: 9781118970560).

Web Links:

- 1 <https://nptel.ac.in/courses/108102121>
- 2 <https://nptel.ac.in/courses/108103009>
- 3 <https://www.nrel.gov/research/transportation-hybrid-electric.html>

Organizational Behaviour

Course Code: 241ME073

L	P	T	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the roles, approaches of organizational behaviour models.
- CO2:** Summarize the behaviour of individuals and groups in organizations in terms of organizational behaviour.
- CO3:** Illustrate various stress and emotional organizational behaviour concepts, models and theories to real life management situations.
- CO4:** Analyze the functions of organizational communication and culture for effective communication and managing cultural diversity
- CO5:** Organize different groups and teams in the organization for better results.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1							1	3	2		
CO2							1	3	2		
CO3							1	2	3		
CO4							1	2	3		
CO5							1	3	2		

UNIT – I

Organizational Behaviour: Concept of Organizational Behaviour (OB)- Importance of Organizational Behaviour- Key Elements of Organizational Behaviour, Role of Managers in OB- Interpersonal Roles-Informational Roles- Decisional Roles, Approaches to Organizational Behaviour

UNIT – II

Interpersonal Behaviour: Nature and meaning of Interpersonal Behaviour, Concept of Self, Transaction Analysis (TA), Benefits and uses of Transactional Analysis, Johari Window Model

Personality: Definition and Meaning of Personality - Importance of Personality, Determinants of Personality, Theories of Personality, Personality Traits Influencing OB.

UNIT – III

Emotions: Nature and Meaning of Emotions - Characteristics of Emotions, Theories of Emotions, Emotions in the Context of OB. Organizational Stress: Definition and Meaning, Sources of Stress, Types of Stress, Impact of Stress on Organizations, Stress Management Techniques.

UNIT – IV

Organizational Communication: Meaning and Importance of Communication, Functions, process, types, Interpersonal Communication, Organizational Communication, Tips for Effective Communication.

Organization Culture: Meaning and Nature of Organization Culture – Origin of Organization Culture, Functions of Organization Culture, Types of Culture, Creating and Maintaining Organization Culture, Managing Cultural Diversity

UNIT – V

Groups and Teams: Meaning and Importance of Groups, Reasons for Group Formation, Types of Groups, Stages of Group Development, Meaning and Importance of Teams, Types of Teams, Creating an Effective Team.

Text Books:

1. Organizational Behaviour, K. Ashwathappa, Himalaya Publishing House, ISBN-13. 978-8184889390.
2. Management and Organizational Behaviour - (Text and Cases), Dr.P.Subba Rao and Prof. N.Sambasiva Rao, Himalaya Publishing House, Mumbai, ISBN: 978-93-5024-951-2.

Reference Books:

1. Understanding Organisational Behaviour, Udai Pareek, Oxford Higher Education, 2nd Edition, ISBN-13: 978-0195690866
2. Mc Shane & Von Glinov, Organisational Behaviour, Tata McGraw Hill, 4th Edition, ISBN-13, 978-1259927676.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_mg51/preview
2. <https://www.udemy.com/course/organisational-behaviour/>

Sustainable Energy Systems

Course Code: 241ME036

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate the various components of solar thermal energy systems.
- CO2:** Describe the working of Wind turbines.
- CO3:** Explain the principle and working of Biomass and Geothermal Energy systems
- CO4:** Explain the Ocean, Tidal, Wave and hydro energy conversion systems.
- CO5:** Illustrate working of hybrid energy systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2					3					
CO2	2					3					
CO3	2					3					
CO4	2					3					
CO5	2					3					

UNIT – I

Introduction to Renewable energy sources: Energy demand and availability, energy crisis, renewable and non-renewable energy resources, environmental impact of conventional energy usage.

Solar Energy: Overview of the fundamental physics of solar radiation. Solar energy collectors.

Solar energy storage: Stratified storage, well mixed storage, comparison, Hot water system, solar ponds, non-convective solar pond, extraction of thermal energy and application of solar ponds.

Solar PV systems and its applications. Solar cell, module, and array.

UNIT – II

Wind Energy: Wind data and energy estimation – Betz limit - Site selection for windfarms. Horizontal and vertical axis wind mills, Wind farms- offshore, Onshore, various methods of control, and Environmental issues - Applications

UNIT – III

Biomass: Bio-resources, Conversion process, Biomass gasifier - Types of biomass gasifiers, Biodiesel production – Ethanol production -Applications.

Geothermal Energy: Origin and types of geothermal energy and utilisation, Power generation from Geothermal energy, Environmental impact.

UNIT – IV

Ocean, Wave & Tidal Energy: Introduction - Resource Assessment - Power generation through OTEC systems. Wave and Tidal energy- Working principle, Availability, and energy conversion systems.

Mini & Micro Hydropower: Introduction, Power from water, System components of Mini and Micro Hydropower, Micro Hydropower plant in India, Potential Hydropower plant projects identified in India.

UNIT – V

Hybrid Energy Systems: Systems for processes and power applications – solar – wind – Biomass hybrid technologies

Fuel cell: Working principle- types - construction and applications. Solar – Fuel cell hybrid systems.

Text Books:

1. Renewable Energy: Power for a Sustainable Future, Boyle, G, Oxford University Press, 3rd Edition, 2012, ISBN : 9780199681273.
2. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, 6th edition, ISBN : 9788174090737.

Reference Books:

1. Renewable Energy Resources, John Twidell, Tony Weir, and Anthony D. Weir, Taylor & Francis, 3rd edition, 2015, ISBN : 9780415584388.
2. Non-Conventional Energy Resources, B H Khan, TMH Publishers, 3rd Edition, 2017, ISBN : 9789352601882.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. <https://www.energy.gov/eere/renewable-energy>

Solar Energy Systems

Course Code: 241ME037

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the concept of solar radiation and its measurement
- CO2:** Describe the working principle of different types of collectors and its types
- CO3:** Explain the various solar thermal energy technologies and their applications
- CO4:** Analyze the various solar PV cell materials and conversion techniques.
- CO5:** Apply solar passive building techniques for cooling and heating applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1				3					
CO2	2	1				3					
CO3	2	1				3					
CO4	2	1				3					
CO5	2	1				3					

UNIT – I

Solar Radiation and its measurement: Solar angles, Sun path diagrams, Radiation, extraterrestrial characteristics, Solar energy measuring instruments: Pyranometer, Pyrheliometer, Sunshine recorder. Estimation of average solar radiation and estimation on horizontal and tilted surfaces

UNIT – II

Solar Collectors for Industrial process heat: Flat plate collector, Materials for flat plate collector and their properties, classification, evacuated tubular collectors, concentrator collectors, tracking systems, compound parabolic concentrators, parabolic trough concentrators, concentrators with point focus, Heliostats.

UNIT – III

Solar Thermal Technologies: Working principle, types, design, and operation, Solar heating and cooling systems, Thermal Energy storage systems, Solar Desalination, Solar cooker, Solar Pond, Solar drying, Solar chimney, Solar water disinfection (SODIS), Solar furnaces.

UNIT – IV

Solar Cells: Semiconductor materials, Doping, PN junction and characteristics, Photovoltaic effect, Photovoltaic material, Parameters of solar cells, Effects of cell temperature on cell efficiency, Types of solar cells, Solar modules and arrays, Solar cell

power plant, Silicon, thin film and polymer processing, Silicon wafer based solar cells, Hybrid organic- inorganic solar cells.

UNIT – V

Solar Passive Architecture: Thermal comfort, bioclimatic classification.

Passive heating concepts: direct heat gain, indirect heat gain, isolated gain and sunspaces

Passive cooling concepts: evaporative cooling, Radiative cooling, shading - paints and cavity walls for cooling, roof radiation traps, thermal comfort.

Text Books:

1. Solar Energy-Principles of Thermal Collection and Storage, S P Sukhatme & J K Nayak, McGraw Hill Education, 3rd Edition, 2009, ISBN : 9780070142961.
2. Principles of Solar Engineering, D.Yogi Goswami, Frank Krieth and Jan F. Kreider Taylor and Francis, 2nd Edition, 2000, ISBN : 9781560327141.

Reference Books:

1. Solar Energy- Fundamentals, Design, Modelling and Applications, G.N.Tiwari, Narosa publishing house. 1st Edition, 2002, ISBN : 9780849324093.
2. Solar Energy and Non-conventional Energy Sources, Domkundwar, Dhanpat Rai & Co, (P) Ltd., 2nd Edition, ASIN : B0BQWR83GF

Web Links:

1. <https://archive.nptel.ac.in/courses/115/103/115103123/>
2. <https://www.nrel.gov/research/re-solar.html>

Composite Materials

Course Code: 241ME060

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Classify the composites with types of fibers and matrices, and applications of composites
- CO2:** Evaluate mechanical properties of composite materials using macro and micro mechanics
- CO3:** Develop suitable Metal Matrix Composites
- CO4:** Explain Polymer Matrix Composites with applications
- CO5:** Discuss various Ceramic Matrix Composites for high temperature applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3					1					
CO2	2	3			2						
CO3	3		2			1					
CO4	2		2	2		3					
CO5	3		1	2		2					

UNIT – I

Introduction to composites

Fundamentals of composites - need for composites – enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Types of Reinforcement and Matrix, Carbon and Glass. Reinforcements – particles – fibres. Effect of reinforcement - volume fraction – rule of mixtures

UNIT – II

Evaluation of Mechanical Properties

Micromechanical analysis of lamina –Volume and mass fraction, density and void content – Evaluation of Elastic moduli, Ultimate strength of unidirectional lamina. Macromechanical analysis of laminates – Laminate code, Stress strain relations – Inplane and Flexural modulu.

UNIT – III

Metal Matrix Composites (MMC)

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Processing of MMC – powder metallurgy process- diffusion bonding – stir casting – squeeze casting, In-situ reactions-Interface-measurement of interface properties applications of MMC in aerospace, automotive industries

UNIT – IV

Polymer Matrix Composites

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. Processing of thermoset matrix composites, thermoplastic matrix composites, structure and properties, structural defects, mechanical properties and applications

UNIT – V

Ceramic Matrix Composites (CMC)

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres, whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing), applications of CMC in aerospace, automotive industries- Carbon /carbon composites

Text Books:

1. Composite Material Science and Engineering, Krishan K , Chawla, Springer, 2nd Edition, 2015, ISBN 9788132233442: .
2. Composite Materials: Engineering and Science , Mathews F. L. and Rawlings R. D, Chapman and Hall, London, England, 1st Edition, ISBN : 9781855734739.

Reference Books:

1. Composite Materials Science and Applications, Deborah D.L. Chung, Springer London Ltd, 2nd Edition, 2010, ISBN9781848828308: .
2. Composite Materials Design and Applications, Daniel Gay, Suong V. Hoa & Stephen W. Tsai, CRC Press, 1st Edition, 2002, ISBN : 9781587160844.

Web Links:

1. <https://nptel.ac.in/courses/112104229>
2. <https://www.coursera.org/learn/ceramics-and-composites>.

Communication Systems

	L	T	P	C
Course Code:241EC082	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the functional blocks of a communication system.
- CO2:** Illustrate the working principle of amplitude modulation and demodulation.
- CO3:** Compare different types of amplitude modulation.
- CO4:** Analyse the generation and detection of FM and PM signals.
- CO5:** Classify the radio transmitter and receivers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	2	3									
CO4	2	3									
CO5	3	2									

UNIT- I

Introduction: Definition of Signal, Types of signals, Fourier Transform (FT), Inverse Fourier Transform (IFT) and their properties, Introduction to Communication system, Elements of Communication system, Modulation, Need for Modulation, Electromagnetic Spectrum, Frequency Division Multiplexing (FDM).

UNIT-II

Amplitude Modulation: Introduction to Amplitude Modulation (AM), Square law modulation, Envelope detector, Spectrum of AM Signals, Power and Power Efficiency of AM, Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Spectrum of DSB-SC Signals, Balanced modulator, Coherent Demodulation of DSB-SC signals, Introduction to Single Sideband (SSB) Modulation and VSB modulation.

UNIT-III

Angle modulation: Introduction, Phase Modulation, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Direct Method of FM generation, Phase locked loop, Comparison of FM and AM.

UNIT-IV

Radio Transmitters and Receivers: Introduction, Classification of Transmitters, AM Transmitter, Variable Reactance type FM Transmitter, Radio Receiver types, TRF Receiver, Super heterodyne Receiver, FM receiver, Comparison of AM and FM receivers.

UNIT-V

Pulse Modulation: Need for Digitizing Analog information, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, Time Division Multiplexing, Introduction to Pulse Code Modulation and Delta Modulation.

Text Books:

1. Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe, TMH, 3rd Edition, ISBN: 0070648115.
2. Communication Systems: Analog and Digital, R P Singh and S D Sapre, McGraw Hill India, Third Edition, ISBN: 1259004600.
3. Communication Systems – B. P. Lathi, BS Publication, ISBN: 8178000156.

Reference Books:

1. Principles of Communication Systems, Simon Haykin, John Wiley, 2nd Edition, ISBN: 0471178691.
2. Electronics & Communication System, George Kennedy and Bernard Davis, TMH, ISBN: 0071077820.
3. Analog and Digital Communications: Theory and Lab Work- Abhay Gandhi, Cengage, ISBN: 9788131525876.

Web Links:

1. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee08/>
2. https://onlinecourses.nptel.ac.in/noc21_ee74/previewAnalog

Electronic Measurements & Instrumentation

Course Code: 241EC083

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Outline the performance characteristics of measuring Instruments.

CO2: Select signal generators for the given application.

CO3: Interpret the working principle of oscilloscopes.

CO4: Choose a suitable bridge for parameter measurement.

CO5: Make use of transducers for physical parameter measurement.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2	3	2									
CO3	3	2									
CO4	3	2	1								
CO5	2	3	1								

UNIT-I

Performance Characteristics of Instruments:

static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity, errors in measurement, Dynamic characteristics- speed of response, fidelity, lag, dynamic error, DC voltmeters, multi range, range extension/Solid state and differential voltmeters, AC voltmeters- multi range, range extension, shunt, thermocouple type RF ammeter, Ohmmeters series type, shunt type, multi-meter for voltage, current, and resistance measurements.

UNIT-II

Signal Generators & Wave Analysers:

Fixed and variable, AF oscillators, standard and AF sine and square wave signal generators, Function generators, square, pulse, Random noise, sweep, arbitrary wave form, Wave Analysers, Harmonic distortion analysers, spectrum analysers, Digital Fourier analysers

UNIT-III

Oscilloscopes:

CRT features, Vertical amplifiers, Horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits. Simple CRO, triggered sweep CRO, dual beam CRO, dual trace oscilloscope, sampling oscilloscope, storage oscilloscope, digital readout oscilloscope, digital storage oscilloscope, Lissajous method of frequency measurement, standard specifications of CRO, probes for CRO, active and passive, attenuator type.

UNIT-IV

AC Bridges:

Measurement of Inductance, Maxwell's bridge, Anderson bridge, Measurement of Capacitance, Schering bridge, Wheatstone bridge, Wein bridge, Errors and precautions in using bridges, Q meter.

UNIT-V

Transducers:

Active and passive transducers, resistance, capacitance, inductance, strain gauges, LVDT, piezo electric transducers, Resistance thermometers, thermocouples, thermistors, Measurement of physical parameters-force, pressure, velocity, humidity, moisture, speed, proximity and displacement, data acquisition systems

Text Books:

1. Electronic Instrumentation, H.S.Kalsi, Tata MC Graw Hill, 2nd Edition, ISBN: 9780070702066.
2. Modern electronic Instrumentation and measurement techniques, A.D.Helfric, W.D.Cooper, PHI, 5th Edition, ISBN: 9332556067.

Reference Books:

1. Electronic Instrumentation and measurements, David A Bell, PHI, 2nd Edition, ISBN: 8120323602 .
2. Electronic test Instruments, Analog and digital measurements, Robert A.Wittie, Pearson Education, 2nd Edition, ISBN: 817758748X.
3. Electronic measurements and Instrumentations, K.Lal Kishore, Pearson education, ISBN: 978-8131721995.

Web Links:

1. <https://www.allaboutcircuits.com/textbook/alternating-current/chpt-12/ac-bridge-circuits/>
2. <https://www.science-ebooks.com/bridge-circuit.html>

Introduction to Embedded Systems

Course Code: 241EC084

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Summarize the building blocks of an Embedded system.
- CO2:** Interpret the hardware modules required to design an Embedded system.
- CO3:** Infer the firmware design approaches for an Embedded system.
- CO4:** Examine to integrate hardware and firmware for an Embedded system.
- CO5:** Design and program Embedded systems based on their applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11
CO1	2	3			1			1	1		
CO2	3	2	1	1	1			1	1		
CO3	3	2			1			1	1		
CO4	2	3			2			1	1		
CO5	2	3	2	1	1			1	1		

UNIT – I

Introduction:

Embedded System-Definition, History of embedded system, Characteristics of an embedded system, classification of embedded systems, Embedded System Architecture Quality attributes of embedded systems, Challenges in Embedded System Design, Examples of an embedded system.

UNIT – II

Designing Embedded Computing Platform:

Introduction to Processors & Controllers, Sensors, Actuators, Analog and digital electronic components, I/O types and examples, Memory Classification, Timer and counting devices, Watchdog Timers, RTC, Wireless Protocols.

UNIT – III

Embedded Firmware:

Classification of OS, Embedded Firmware design approaches & development languages, POSIX Thread Programming, Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, C versus Embedded C, ALP Programming.

UNIT – IV

Real-Time Operating Systems:

Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

Hardware Software Co-Design:

Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

UNIT – V

Embedded System Development:

The IDE, Types of files generated on cross- compilation, Deassembler/ Decompile, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

Various wireless protocols and its applications: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, Wi-Fi. CAN, Programming in Embedded C, Embedded system design using Arduino.

Text Books:

1. Embedded Systems, Shibu.K.V, Tata McGraw Hill Education Private Limited, ISBN: 978-8131721995.
2. Computers as Components – Principles of Embedded Computing System Design, Marilyn Wolf, Morgan Kaufmann Publisher (An imprint from Elsevier), 3rd Edition, ISBN: 978-8131721995.

Reference Books:

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, ISBN: 0471386782 .
2. The Designer's Guide to the Cortex-M Processor Family - A Tutorial Approach, Trevor Martin, 1st Edition, Elsevier Science, ISBN: 032385494X.

Web Links:

1. http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf
2. <http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>
3. <http://www.vtt.fi/inf/pdf/publications/2004/P526.pdf>

Fundamentals of Image Processing

Course Code: 241EC085

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Infer the fundamental components of digital image processing.

CO2: Illustrate image enhancement and restoration techniques.

CO3: Infer the color image processing methods.

CO4: Illustrate various morphological operations on images.

CO5: Interpret image segmentation techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	3	2									1
CO3	3	2									1
CO4	3	1									1
CO5	3	2									1

UNIT-I

Introduction: Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.

UNIT-II

Image Enhancement and Restoration: Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods, A model of the image degradation/restoration process, Noise models, Inverse filtering, Minimum mean square error (Wiener) filtering.

UNIT-III

Color image processing: color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening, noise in color images.

UNIT-IV

Morphological Image Processing: Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds

UNIT-V

Image segmentation: Fundamentals, point, line, edge detection, thresholding, and region – based segmentation, Image segmentation based on color.

Text Books:

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 3rd Edition, ISBN: 013168728X.
2. Fundamentals of Digital Image Processing, Anil K.Jain, Prentice Hall of India, Indian Reprint, 9th Edition, ISBN: 013168728X.

Reference Books:

1. Digital Image Processing Jayaraman, S. Esakkirajan, and T. Veerakumar, Tata McGraw-Hill Education, ISBN: 013168728X.
2. Digital Image Processing and Analysis, B.Chanda, D.Dutta Majumder, PHI, ISBN: 9788120343252.

Web Links:

1. <http://www.imageprocessingplace.com/>.
2. <http://nptel.ac.in/courses/117105079/>
3. <https://sisu.ut.ee/imageprocessing/avaleht>
4. <https://www.coursera.org/learn/digital#ratings>
5. <https://www.coursera.org/courses?languages=en&query=image+processing>

Sensors & Transducers

Course Code: 241EC077

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Illustrate the fundamental concepts of energy transformation in Sensors.
- CO2:** Infer the thin film physics, deposition techniques and Photolithography.
- CO3:** Summarize the design and fabrication process of Micro sensors.
- CO4:** Outline the Characteristics of Transducers.
- CO5:** Summerize the Basic Knowledge different types of Transducers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	3	1									1
CO3	3	2	2								1
CO4	2	2	3								1
CO5	1	1	3								1

UNIT – I

Basics of Energy Transformation: Transducers, Sensors, Understanding of thin film physics: Application in MOSFET and its variants. Thin Film Deposition Techniques: Chemical Vapor Deposition (PECVD, MOCVD), Physical Vapor Deposition (Thermal Deposition, Sputtering, Pulsed Laser Deposition).

UNIT – II

Basic understanding of Photolithography for patterning layer. Detailed overview of Etching methods. Understanding various gas sensors: Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor.

UNIT – III

Micro sensors:

Force Sensors, Pressure Sensors, Strain gauges and practical applications. Working principles of Actuators. Piezoelectric, Piezo resistive actuators.

UNIT – IV

Characteristics Of Transducers:

Static characteristics, dynamic characteristics, mathematical model of transducer, zero, first order and second order transducers – response to step, ramp and sinusoidal inputs.

UNIT – V

Resistive, Inductive and Capacitance Transducers- Potentiometer, Strain gauge, LVDT, variable reluctance transducers, Proximity transducers, capacitive transducer, Capacitor microphone.

Text Books:

1. Sensors and Signal Conditioning , Ramon Pallàs – Areny and John G. Webster, Wiley-Blackwell, 2nd Edition, ISBN: 9780471332329.
2. Sensors and Transducers, D. Patranabis , 2nd Edition, ISBN: 9788120321984.

Reference Books:

1. Sensors and Signal Conditioning , Ramon Pallàs – Areny and John G. Webster, Wiley-Blackwell, 2nd Edition, ISBN: 9780471332329.
2. Instrument transducers, H.K.P. Neubert, Oxford University press. 2nd Edition, ISBN: 9780195629972.

Web Links:

1. <https://nptel.ac.in/courses/108108147>
2. <https://nptel.ac.in/courses/108102191>

Data Structures

Course Code: 241CS003

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Utilize structure, union and file operations to handle heterogeneous data.
- CO2:** Illustrate Time and Space complexities for different searching and sorting Algorithms
- CO3:** Demonstrate various operations on Linked Lists
- CO4:** Explain different operations on Stack and Queue with applications.
- CO5:** Demonstrate the importance and various operation on non-linear data structures

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	2						1	1	
CO2	1	1	2	2					1	1	
CO3	1	2	2	1					1	1	
CO4	1	1	2	1					1	1	
CO5	1	1	2	2					1	1	

UNIT – I

Structures and Unions: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type - enum variables, Using Typedef keyword, Bit Fields.

Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files.

Practice:

- Write a C program to find the total, average of n students using structures
- Copy one structure variable to another structure of the same type.
- Read student name and marks from the command line and display the student details along with the total.

UNIT – II

Introduction to Linear Data Structures: Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures.

Sorting Techniques: Quick sort, Merge sort, Radix sort.

Practice:

- Implement Merge sort using arrays.
- Implement Quick sort using arrays
- Implement Radix Sort using arrays

UNIT – III

Linked Lists: Singly linked lists: representation and operations, doubly linked lists and its operations and circular linked lists and its operations, Comparing arrays and linked lists, Applications of linked lists

Practice:

1. Single Linked List: Perform different operations in single linked list.
2. Reversing a single linked list
3. Perform different operations in double linked list
4. Circular Linked List

UNIT – IV

Stacks: Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

Queues: Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

Practice:

1. Stack and its operations using arrays and Linked List
2. Implement a program to evaluate a postfix expression.
3. Queue and its operations using arrays and Linked List
4. Implement Circular Queue using Arrays

UNIT – V

Non-linear Data Structures:

Trees: Definition of tree, Tree Terminology, types of trees, Binary tree traversals, Binary Search Tree – Insertion, Deletion.

Graphs: Definition and Terminology – Representation of Graphs-Adjacency Matrix and Linked list, Graph Traversals (BFT & DFT)

Practice:

1. Implement Binary search tree (BST).
2. Implement Binary search Tree (BST) Traversals.
3. Graph Traversal using Breadth First Search (BFS)
4. Graph Traversal using Depth First Search (DFS)

Additional Practice:

1. Using a structure for transporting some boxes through a tunnel
2. Delete duplicate-value nodes from a sorted linked list
3. Convert an infix expression into postfix expression
4. De Queue Implementation

Text Books:

1. Programming in C, Rema Theraja, Oxford, 3rd Edition. ISBN: 978-9354979453
2. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand. ISBN: 978-9358704730

Reference Books:

1. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition. ISBN: 978-1849967204
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Silicon Press. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407
3. Data Structures Using C, Reema Thareja, Oxford University Press, 2nd Edition. ISBN: 978-0198099307

Web Links:

1. <https://nptel.ac.in/courses/106102064>
2. <https://archive.nptel.ac.in/courses/106/105/106105225/>
3. <https://www.udemy.com/topic/data-structures/>
4. <https://www.coursera.org/specializations/data-structures-algorithms>
5. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>

Computer Organization

	L	T	P	C
Course Code: 241CS065	2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Differentiate types of computers by their functionalities and performances.
- CO2:** Demonstrate number representations and I/O operations performed in Computer.
- CO3:** Illustrate types of various memory devices.
- CO4:** Implement arithmetic operations.
- CO5:** Simulate basic CPU operations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1	2	1	1	1	1			1			1
CO2	2		1					1	1		
CO3	2	1	1					1			
CO4	2	1	1					1	1		1
CO5	2	1	1					1	1		

UNIT – I

Basic Structure of Computers: Types of computers, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance, Multiprocessors and Multi-computers, Historical Perspective.

Practice:

- Exploring various types of Computers and their functional Units.

UNIT – II

Machine instructions and Programs: Numbers, Arithmetic Operations and Characters, Memory Locations and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes.

Input/output Organization: Accessing I/O Devices, Interrupts, Processor Examples, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces.

Practice:

- Design of Registers and counters.

UNIT – III

The Memory System: Some Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed Size and Cost, Cache Memories, Performance Considerations, Virtual Memories, Memory Management Requirements.

Practice:

- 1.Design of memory on simulator

UNIT – IV

Secondary Storage Arithmetic: Addition and Subtraction of Signed Numbers, Multiplication of Positive Numbers, Signed-Operand Multiplication, Integer Division, Floating Point Numbers and Operations, Implementing Floating Point Operations.

Practice:

- 1.Design Booth's Multiplier.

UNIT – V

Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hardwired Control.

Microprogrammed Control Pipelining: Basic Concepts, Data Hazards, Instruction Hazards, Influence on Instruction Sets, Data Path and Control Considerations, Super Scalar Operation.

Practice:

- 1.Simulate basic operation on CPU.

Text Books:

1. Computer Organization ,Carl Hamacher, McGraw Hill Publishers, 5th Edition., ISBN-13: 978-1259005275
2. Computer System Architecture, M. M. Mano, Prentice Hall of India,3rd Edition, ISBN-13. 978-8131700709.
3. Computer Organization and Architecture Designing for Performance, Wiiliam Stallings, Pearson Education, 8th Edition, ISBN-13. 978-0136073734.

Reference Books:

1. Computer Architecture and Organization, John P Hayes, McGraw-Hill, 3rd revised Edition, ISBN-13. 978-1259028564.
2. Computer Organization and Architecture, Ghosh T. K., Tata McGraw-Hill, Third Edition, ISBN: 9780071329071.

Web Links:

1. <https://www.classcentral.com/course/swayam-computer-organization-andarchitecture-a-pedagogical-aspect-9824>
2. <https://www.udemy.com/course/introduction-to-computer-organization/>
3. <https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials>
4. <http://vlabs.iitkgp.ac.in/coa/#>

Operating Systems

	L	T	P	C
Course Code: 241CS013	2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Describe the basic concepts of operating system and their structures.
- CO2:** Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
- CO3:** Interpret the issues and challenges of memory management.
- CO4:** Synthesize the concepts of Disk management and file system implementation.
- CO5:** Explain the issues related to protection and security mechanisms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3								1		
CO2	1	3		1					2		1
CO3	1	3		1					2		1
CO4	1	3		1					1		1
CO5	2	2							1		

UNIT – I

Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

UNIT – II

Process Concept: Process scheduling, Operations on processes, Inter-process communication.

Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.

Multithreaded Programming: Multithreading models, Thread libraries, Threading issues

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the following CPU scheduling algorithms: FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

UNIT – III

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

UNIT – IV

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.

Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.

File Systems: Files, Directories, File system implementation, management and optimization.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm
4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

UNIT – V

Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.

System Security: Introduction, Program threats, System and network threats.

Practice:

1. The above topics are discussed as case study in Windows/ Unix OS

Text Books:

1. Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12th Edition. ISBN: 978-0470128725
2. William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall, 7th Edition. ISBN: 978-9332518803

Reference Books:

1. Modern Operating Systems, Tanenbaum A S, Pearson Education, 3rd Edition. ISBN: 978-0136006633
2. Operating Systems A Concept Based Approach, Dhamdhare D M, Tata McGraw-Hill, 3rd Edition. ISBN: 978-1259005589
3. Operating Systems, Nutt G, Pearson Education, 3rd Edition,. ISBN: 978-8131723593

Web Links:

1. <https://archive.nptel.ac.in/courses/106/106/106106144/>
2. <https://archive.nptel.ac.in/courses/106/105/106105214/>
3. <https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems>
4. <http://www.geeksforgeeks.org/operating-systems/>
5. <https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923>

Database Management Systems

	L	T	P	C
Course Code: 241IT005	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the Fundamental concepts of DBMS.
- CO2:** Interpret relational database using SQL.
- CO3:** Make use of normalization techniques for database design.
- CO4:** Illustrate the mechanisms of transaction management.
- CO5:** Optimize database performance with advanced indexing, query optimization, and robust backup and recovery strategies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	3		1			1			
CO2	3	3	3	2	2	1		1			
CO3	3	3	3	3	3	2					1
CO4	3	3	3	1	2	1					
CO5	3	3	3	3	3	2					2

UNIT – I

Introduction to DBMS: History and Architecture, Data Independence, Data Models, Levels of abstraction, structure of DBMS. Data Models : Concepts of Schema, Instance and data independence, Three tier schema architecture for data independence, Database system structure, environment, Centralized and Client Server architecture for the database.

Practice

1. Familiarization with installation of any DBMS.
2. Implementing a University Database System.

UNIT – II

Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relational importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance.

BASIC SQL: Simple Database schema, data types, table definitions (create, alter), different Database operations (insert, delete, update), basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions (Date and Time, Numeric, String conversion).

Practice

1. Querying and modifying the database using Data Manipulation Language commands -select, insert, update, delete.
2. Implementation of Aggregate Functions – sum, avg, min, max, count. Use group-by and having clause.

UNIT – III

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using Diagrams.

SQL: Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(updateable and nonupdateable), relational set operations.

Practice

1. Perform join operations – natural join, equi-join, outer join, left outer join, right outer join, inner join and assess the impact of query plans on the performance of join heavy queries.
2. Perform set operations - union, intersection, set difference.
3. Implementation of correlated sub-queries and nested queries.
4. Creating and querying views and materialized views.

UNIT – IV

Normalization: Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF), Fifth Normal Form (5NF).

Transaction Concept: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Storage, Recovery and Atomicity, Recovery algorithm.

Practice

1. Implement SQL queries on a normalized database schema based on the provided schema. For this example: use the schema for a university database, which includes:
 - Students (StudentID, StudentName, Major)
 - Courses (CourseID, CourseName, Credits)
 - Enrollments (StudentID, CourseID, EnrollmentDate)
 - Instructors (InstructorID, InstructorName, Phone)
 - Course_Instructors (CourseID, InstructorID)
2. (A)Implementation of Data Control Language commands – grant and revoke.
(B)Implementation of Transaction Control Language commands - commit, save point, and rollback.

UNIT – V

Indexing Techniques: Introduction, B+ Trees: Search, Insert, delete algorithms, File Organization Indexing, Cluster Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing: Tree based Indexing, Comparison of File Organizations.

Database Tuning: Introduction, Database Performance Tuning, Query Optimization: Introduction, Query Optimization algorithms, Backup and Recovery.

Practice

1. Create a Primary , Secondary Index on a Column.
2. Retrieve Data Using an Index.
3. Insert Data and Update Indexes.
4. Delete Data and Impact on Indexes.

*** Note:** The student must Complete & Submit a Database Foundations Certificate Course offered Oracle Academy at the end of the Practice Session.

Text Books:

- 1 Database System Concepts ,Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw-Hill , Edition., ISBN-13: 978-1260230508.
- 2 Database Management Systems, Raghurama Krishnan, Johannes Gehrke, Mc Graw-Hill, 4th Editi ISBN: 978-1260091195.

Reference Books:

- 1 Database Systems, Ramez Elmasri, Shamkant B. Navathe, 7th Edition, Pearson, ISBN: 978-01375042
- 2 Database Systems, Carlos Coronel, Steven Morris, Peter Rob, 10th Edition, Cengage, ISBN: 9 0357517864.
- 3 Introduction to Database Systems, C J Date, Pearson, 9th Edition, ISBN: 978-0133970777.

Web Links:

- 1 <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Database%20Foundations%20Course%20Description.pdf>
- 2 <https://www.w3schools.com/sql/>
- 3 https://onlinecourses.nptel.ac.in/noc22_cs91/

Agile Software Engineering

Course Code: 241IT007

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply software engineering practices and evaluate different software development models to design and manage the life cycle of a Student Management System (SMS).
- CO2:** Analyze the principles of Agile methodologies and compare them with traditional models by transitioning a retail software company from Waterfall to Agile.
- CO3:** Evaluate the impact of Agile processes on requirements engineering and manage unstable requirements for a social media platform project.
- CO4:** Design and implement a comprehensive testing strategy using TDD and test automation tools in an Agile project.
- CO5:** Apply Agile design principles and execute refactoring techniques to develop maintainable and scalable software systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			2						
CO2	3	2	1	1				2	2	2	1
CO3	2	1	1							2	1
CO4	3	2	2	1				2	2	2	1
CO5	1	2									

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Text Books:

- 1 Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
- 2 Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

- 1 Software Engineering, Lan Sommerville, Pearson, Tenth Edition, ISBN: 978-9332582699.
- 2 Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, David J. Anderson; Eli Schragenheim, ISBN: 978-0131424609

Web Links:

- 1 https://www.tutorialspoint.com/software_engineering/
- 2 <https://www.sciencedirect.com/science/article/pii/S0950584916303329>

Computer Networks

Course Code: 241CS007

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe network topologies, reference models and media for data transmission
- CO2:** Analyze error and flow control issues in data link layer
- CO3:** Classify MAC protocols and channelization techniques
- CO4:** Apply routing algorithms and congestion control techniques for effective data transmission
- CO5:** Analyze protocols Transport and Application Layers

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2		2									
CO3		2							1	1	
CO4	1	2	2						2		1
CO5		1			1						1

UNIT – I

Network Overview: interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

Practice:

1. Study of Network devices in detail and connect the computers in Local Area Network

UNIT – II

Data Link Protocols: framing and data transparency, error detection & correction, flow control.

Practice:

1. Write a Program to implement the data link layer framing methods such as i) Character stuffing ii) bit stuffing.

UNIT – III

Media Access Control: Random Access: ALOHA, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance, Controlled Access: Reservation, Polling, Token Passing, Channelization: frequency division multiple Access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA).

Practice:

1. Write a Program to implement Sliding window protocols

UNIT – IV

Routing Algorithms: The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical

Congestion Control algorithms: General principles of congestion control, Congestion prevention policies, Approaches to Congestion Control, Traffic Aware Routing, Admission Control, Traffic Throttling: Load Shedding

Traffic Control Algorithm: Leaky bucket & Token bucket.

Practice:

1. Programs to implement routing protocols like shortest path.

UNIT – V

IP Protocols: IP Addressing, IP & ICMP.

Transmission Control Protocol: UDP & TCP.

Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP

Text Books:

- 1 Computer Networks — Andrew S Tanenbaum and David J Wetherall, Pearson Education, 5th Edition. ISBN: 978-0132126953
- 2 Data Communications and Networking – Behrouz A. Forouzan, McGraw Hill Education, 5th Edition ISBN: 978-1259064753

Reference Books:

- 1 Data Communications and Networks- Achut S Godbole, Atul Kahate, McGraw-Hill Education (India) Pvt Limited, 2nd Edition. ISBN: 978-0-07-123110-7
- 2 Computer Networks, Mayank Dave, CENGAGE India, 6th Edition ISBN: 978-8131509869

Web Links:

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>

Java Programming

Course Code: 241IT006

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply Java features for problem solving.
- CO2:** Build applications using principles of OOPs, interfaces and Packages.
- CO3:** Develop programs using Exception Handling to handle run-time errors.
- CO4:** Develop applications using multithreading for inter thread communication.
- CO5:** Build JDBC applications for performing CRUD operations using MySQL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1		1				1	2	1
CO2	2	1	3		1				1	2	1
CO3	2	3	2		1				1	2	1
CO4	2	2	2		1				1	2	1
CO5	2	2	3		1				1	2	1

UNIT – I

Introduction to Java: History of Java, Features of Java Language, JVM Architecture, Java source file structure. Building Blocks of Java, Control Statements, Operators, Type Conversion, Command Line Arguments, Arrays.

Practice:

1. Control Statements

- a. Select all the prime numbers within the range of 1 to 100.
- b. Find the sum of all even terms in the Fibonacci sequence up to the given range N.
- c. Check whether a given number is Armstrong or not.

2. Arrays

- a. Sort an array of integers in ascending order.
- b. Find the maximum and minimum element in an array.
- c. Remove duplicate elements from an array.

UNIT – II

Concepts of Class: Class, Object, Method, Constructor, Overloading- Method and Constructor Keywords: this, static and final, String Class and its Methods, StringTokenizer, StringBuffer and StringBuilder.

Practice:

1. Class Mechanism

- a. Display the details of a person. Personal details should be given in one method and the qualification details in another method.
- b. Implement constructor and constructor overloading.

- c. Implement method overloading.

2.Strings

- a. Check if a given string is a pangram (contains every letter of the alphabet at least once).
- b. Find the most frequently occurring character in a string.
- c. Find all permutations of a given string.
- d. Check if a given string is a anagram (Ex: CAT and ACT).

UNIT – III

Inheritance: Inheritance, Types of Inheritance, super and super(), Method Overriding, Using final with inheritance, abstract with Class and Method, Dynamic Method Dispatch. Interfaces: Introduction to interface, Multiple inheritance.

Practice:

1. Inheritance & interface

- a. Implement multi level Inheritance.
- b. Implement multiple Inheritance.
- c. Find the areas of different shapes using abstract classes.

UNIT – IV

Packages: Introduction, Importing Packages and Classes, path and classpath, Access Specifiers, java.util: Collection Framework (related interfaces and classes), java.io: FileReader, FileWriter, FileInputStream, FileOutputStream, BufferedReader and BufferedWriter, Wrapper Classes.

Practice:

1. Packages & java.io

- a. Import and use user defined package.
- b. Illustrate the use of protected members in a package.
- c. Copy Even numbers into Even.txt file and Odd Numbers into Odd.txt file.

2. Collection Framework

- a. ArrayList and LinkedList
- b. Iterator and Iterable
- c. Comparator and Comparable
- d. HashMap and TreeMap
- e. HashSet and TreeSet
- f. f. HashTable

UNIT – V

Exception Handling: Introduction, Keywords: try, catch, throw, throws and finally, Multiple Catch Clauses, Checked and Unchecked Exceptions, User Defined Exceptions.

Multithreading: Introduction, Thread Life Cycle, Creation, Priorities, Synchronization, ITC.

Java Database Connectivity: Introduction, JDBC Architecture, Types of Drivers, JDBC Environment Setup, JDBC Steps, CRUD Operations.

Practice:

1. Exception Handling

- a. Illustrate exception handling mechanism using multiple catch clauses.
- b. Make use of Built-in and user-defined Exceptions in handling a run time exception.

2. Multithreading

- a. Creates threads by extending Thread class. First thread display “Good Morning “every 1 sec, the second thread displays “Hello “every 2 seconds and the third display “Welcome” every 3 seconds, (Repeat the same by implementing Runnable).
- b. Solve Producer-Consumer problem using synchronization.

3. JDBC

- a. CRUD operations.

Additional Practice:

1. Student Management
2. Inventory Management
3. Phone book Management

*** Note: The student must Complete & Submit a Java Programming Certificate Course offered by Oracle Academy at the end of the Practice Session.**

Text Books:

1. The Complete Reference Java, Herbert Schildt, TMH ,8th Edition, ISBN 978-1260440232.
2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition. ISBN: 9780199459643.

Reference Books:

1. Introduction to java programming, by Y Daniel Liang, Pearson, Seventh Edition. ISBN: 978-8131729588
2. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press. ISBN: 978-9351199250

Web Links:

1. <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf>
2. <https://nptel.ac.in/courses/106/105/106105191/>
3. <http://java.sun.com/docs/books/tutorial/>

Fundamentals of RedHat Enterprise Linux

	L	T	P	C
Course Code: 241CS068	0	0	2	2

Practice:

- 1. Installation and Basic Commands**
 - a. Install RHEL: Set up RHEL on your system, configure installation options, and create user accounts.
 - b. Execute Basic Commands: commands like `ls`, `cd`, `pwd`, and `man`
- 2. File Management and Text Editing**
 - a. File and Directory Management: Explore `mkdir`, `cp`, `mv`, and `rm`.
 - b. ext Editing: Use `nano` or `vim` to create and modify text files.
- 3. Advanced Command Line Operations**
 - a) Redirection and Pipes: Understand `>`, `>>`, `|`.
 - b) Wildcards: Learn about `\*`, `?`.
- 4. User and Group Management**
 - a. User Accounts: Create, modify, and delete users.
 - b. Groups and Permissions: Understand ownership and permissions.
- 5. Process and Service Management**
 - a. Process Management: Explore `ps`, `top`, and `kill`.
 - b. Services*: Start, stop, and manage services (daemons).
- 6. Network Configuration and Security**
 - a. Network Interfaces: Configure network settings (`ifconfig`, `ip`).
 - b. Firewalls and Security: Learn about `firewalld` and network services.
- 7. File System Permissions**
 - a. File Permissions: Master `chmod`, `chown`.
 - b. Access Control Lists (ACLs): Understand extended permissions.
- 8. Software Packages and Updates**
 - a. Package Management: Use `yum` or `dnf` to install, update, and remove software.
 - b. Repositories and Dependencies: Explore package sources.
- 9. Server Analysis and Support**
 - a. Performance Analysis: Use tools like `top`, `htop`, and system logs.
 - b. Seeking Support: Understand how to get help from Red Hat or the community.
- 10. Network Services Configuration**
 - a. Static IP Addresses: Configure networking.
- 11. Remote Administration with SSH**
 - a. SSH: Secure remote access using key-based authentication.
 - b. Secure Communication: Understand encryption.

12. System Maintenance and Security

- a. Maintenance Tasks: Perform backups, log rotation, and routine maintenance.
- b. Security Updates: Regularly apply patches and keep the system secure.

Additional Practice

1. Basic Shell Commands Practice

Objective: Familiarize yourself with basic shell commands by performing file operations, navigating directories, and manipulating text files.

Skills: Command-line proficiency, file management, text processing.

2. User and Group Management

Objective: Learn to manage users and groups on a Linux system by adding, modifying, and removing users, and setting permissions.

Skills: User account management, permission setting, group policies.

3. Package Management

Objective: Learn to use the package manager of your Linux distribution to install, update, and remove software packages.

Skills: Familiarity with apt, yum, or pacman, software lifecycle management.

Text books:

- 1 Redhat Enterprise Linux 9, Vishesh kumar, Gitanjali Mehra

Reference Books:

- 1 The Linux Command Line: A complete Introduction 1st Edition by William E. Shotts
- 2 Linux command Line and Shell Scripting Bible 4th Edition by Richard Blum, Christine Bresnahan
- 3 Linux Administration: A Beginner's Guide, Eighth Edition by Wale Soyinka
- 4 Red Hat System Administration I (RH 124) by Red Hat Press

Web Links:

- 1 <https://www.redhat.com/en/topics/linux>
- 2 <https://www.freecodecamp.org/news/manage-users-and-groups-in-rhel/>
- 3 https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/9/html-single/configuring_and_managing_networking/index
- 4 https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/9/html/configuring_basic_system_settings/managing-file-system-permissions_configuring-basic-system-settings
- 5 <https://www.cyberciti.biz/faq/redhat-network-interface-configuration/>
- 6 <https://www.koenig-solutions.com/red-hat-enterprise-linux-diagnostics-troubleshooting-training-certification>

AWS Cloud Foundations

	L	T	P	C
Course Code: 241CS067	0	0	3	3

Practice:

1.
 - a. Calculate Total Cost of Ownership
 - b. Use AWS Pricing calculator to estimate multiple pricing models.
2.
 - a. Differentiate between AWS and customer responsibilities using Shared Responsibility Model
 - b. User Management using Identity and Access Management
3.
 - a. Securing IAM user accounts.
 - b. IPv4 and IPv6 implementation in cloud
4.
 - a. Design Virtual Private Cloud
 - b. Configure NAT gateway.
5.
 - a. Implementing Internet Gateway in AWS Cloud
 - b. Working with bastion host.
6.
 - a. Create and manage Private & Public subnets.
 - b. Secure VPC using Security Groups
7.
 - a. Implement Network Access Control lists to control traffic.
 - b. Build VPC and launch a web server.
8.
 - a. Launch EC2 instances in two different regions and connect.
 - b. Create multiple VPCs and peer them using VPC peering.
9.
 - a. Create and trigger AWS Lambda functions.
 - b. Use AWS lambda to automate EC2 instance behavior.
10.
 - a. Website deployment using AWS Elastic Beanstalk
 - b. Working with Elastic Block Storage

11.
 - a. Creating and working with EC2 snapshots.
 - b. Configure autoscaling for application deployed in AWS Cloud
12.
 - a. Load balance application deployed in AWS Cloud
 - b. Basic implementation of Infrastructure as Code using AWS CloudFormation

Additional Practice:

1. Working with Elastic File System
2. Working with S3 Buckets and Objects
3. Build a database server

Textbooks:

- 1 AWS Certified Cloud Practitioner study guide, Ben Piper & David Clinton

Reference Books:

- 1 AWS Certified Cloud Practitioner cert guide, Anthony J Sequeira, by Pearson Education

Web Links:

- 1 <https://skillbuilder.aws/>
- 2 <https://aws.amazon.com/training/awsacademy/>

AWS Cloud Development**Course Code: 241CS066**

L	T	P	C
0	0	3	3

Practice :

1. AWS CLI installation
2. Working with the AWS SDKs
3. Working with Amazon S3
4. Authenticating and Authorizing with IAM
5. Creating IAM Users and IAM Groups
6. Working with DynamoDB
7. Deploying an API
8. Monitoring a REST API
9. a. Developing REST APIs with API Gateway
- b. Creating Lambda Functions Using the AWS SDK for Python
10. a. Migrating a Web Application to Docker Containers
- b. Running Containers on a Managed Service
11. a. Caching Application Data with ElastiCache
- b. Implementing CloudFront for Caching and Application Security

Additional Practice:

1. Implementing a Messaging System Using Amazon SNS and Amazon SQS
2. Orchestrating Serverless Functions with Step Functions
3. Implementing Application Authentication Using Amazon Cognito
4. Automating Application Deployment Using a CI/CD Pipeline

Continuous Integration & Delivery using DevOps

	L	T	P	C
Course Code: 241CS070	0	0	3	3

Practice:

1.
 - a. Working with Git branching strategies
 - b. Handling Git merging and pull requests
2.
 - a. Creating and managing Jenkins pipelines
 - b. Building and deploying applications using Jenkins
3.
 - a. Pipeline as code with Jenkins
 - b. Docker file and image creation
4.
 - a. Docker networking and storage
 - b. Working with Docker compose for multi-container applications
5.
 - a. Container orchestration with Docker swarm
 - b. Kubernetes networking and storage
6.
 - a. Deploying Helm package manager for Kubernetes
 - b. Monitoring and logging in Kubernetes
7.
 - a. Working with roles and modules in Ansible
 - b. Writing and managing Ansible playbooks
8.
 - a. Integrating Ansible with other tools
 - b. Cloud native DevOps practices
9.
 - a. Setting up CI/CD pipelines in cloud
 - b. Managing Infrastructure as Code with Terraform
10.
 - a. Install and configure ELK stack for logging
 - b. Centralized logging with ELK stack
11.
 - a. Configuring Grafana for data visualization
 - b. Blue-green and canary deployments

Additional Practice:

1. Monitoring applications with Prometheus
2. Container security best practices
3. Automated testing in DevOps

Textbooks:

1. Practical DevOps tools, Gilbert Fongan Toussido

Reference Books:

1. Practical DevOps tools, Gilbert Fongan Toussido

Web Links:

1. <https://learning.lpi.org/en/>
2. <https://learning.lpi.org/en/learning-materials/all-materials/#devops-version-10>

Fundamentals of Salesforce Administration

	L	T	P	C
Course Code: 241IT024	0	0	2	2

Practice:

1. Customization of Object

- a) Create a custom object “Position” to store all the open positions information and add below custom fields to the object.

Object Name: Position

Fields:

1. Position Name: Standard Field
2. Location: Picklist (Mandatory)
(LOV's: Hyderabad, Bangalore, Chennai, Pune, Mumbai, Noida, Delhi, Kochi).
3. Number Of Vacancies: Number (Max. of 2) (Mandatory)
4. Position Status: Picklist (Default : New Position)
(LOV's: New Position, Open Approved, In Progress, Recruited, On Hold, Closed)
5. Open Date: Date
6. MileStone Date : Date (Mandatory)
7. Minimum Pay : Currency
8. Maximum Budget : Currency (Mandatory)
9. HR Email ID : Email (Mandatory)
10. HR Contact Number : Phone
11. Travel Required : CheckBox
12. Passport Required : CheckBox
13. Position Description: Text Area Long
14. Skills Required: Text Area Rich
15. Reference ID : (PID-400001) Auto Number.

- b) Create a custom object “Hiring Manager” with required custom fields.

2. Formula Field & Validation Rules

- a) Create a Formula field, to Calculate the 7% of Service Tax based on the Annual Revenue.
- b) Create a Formula Field in the Position object, to indicate the position record can be remove or not. (**Note:** Positions whose Mile Stone Date is over, those records should be removed from the object)
- c) Create a Validation Rule on the Account object, to make sure the Annual Revenue should be more than 400000.
- d) Create a Validation rule on the Opportunity object if the stage is equal to prospecting then the probability should be greater than 50.

3. Data Modeling

- a) Configure the Lookup Relationship between "Hiring Manager" and "Position" objects and list out all the observations / features.
- b) As a sales manager in a company, you want to track the total revenue generated from all related Opportunity records for each Account. You need a way to automatically calculate and display this total revenue on the Account record without manual data entry.

[**Note:** Use Rollup Summary Field]

4. Workflow Rules

- a) Configure a Workflow rule on the Hiring Manager Object, to send an Email Notification to the HR Manager upon creating a new HR Manager Record inside the object.
- b) Configure a Process on the Lead Object, to Notify the Lead Person Upon Creating a New Lead Record for Hyderabad Location and with "Banking" Industry. Notify the Lead upon updating the Lead record also.

5. Flow Builder

- a) Configure a flow to display the Message on the home page screen.
- b) Configure a flow to display the Current User Name on the home page screen.
- c) Configure a flow that populate the Shipping address with billing address while creating an account record.

6. Flow Builder

- a) Configure a flow to send the Email notification to the Hiring Manager upon creating a new HR Manager Record.

7. Data Management

- a) Your marketing team has launched a new campaign and generated a list of leads from various sources, such as web forms, events, or advertisements. You need to import these leads into Salesforce for further nurturing and conversion using data loader tool.

8. User Management

1. The university's IT department needs to set up new users in their Salesforce org with specific licenses. As a Salesforce administrator, you are responsible for creating the following users with the given licenses:

- a) Development User (with Salesforce License)
- b) Testing User (with Salesforce Platform License)

- c) Manager User (with Salesforce Platform License)
- d) Customer User (with Salesforce Platform License)

2. An employee is leaving the company, and you need to deactivate their user account in Salesforce to prevent unauthorized access and ensure data security.

9. Role Hierarchy & Profile Management

- a) The university's IT department has added new users with specific licenses to their Salesforce org. To establish clear reporting lines and ensure appropriate data access, the IT department needs to set up a role hierarchy as follows

CEO [System Administer]

| ---> CFO [Manager User]

| ---> COO [Testing User]

| ---> CTO [Development User]

| ---> VP [Customer User]

- b) Configure the Profile Level Permissions to the Development User as below.

Account : Grant R, C, E, D

Lead : Grant R

Case: Grant R, C.

Hiring Manager : R C E

10. Permission Set

- a) Create an Account Record inside the object by using "Development User" account, and Share the Record to "Manager User" with "ReadOnly" access.
- b) Create a Permission Set to grant the "Edit and Delete" permissions on the Account Object to the Manager User.
- c) Login into the Development User Account, and share the above Account record to the Testing User with "Read/Write" access.

11. Sharing Rules

Configure a Sharing Rule on the Account object, which is used to share the Account Records to the "Bangalore Sales Group", if the Account record matching with the below conditions. Grant Read/Write access.

- 1. Account: Rating == 'Hot'
- 2. Account: Industry == 'Finance'

3. Account: Active == 'Yes'
4. Account: Customer Priority == 'High'

12. Reports and Dashboards

Configure a Tabular Report, to represent only Hot Rating Customers Data in the Tabular format along with Grand Total.

Additional Practice:

1. Create a Screen Flow to guide HR through the process of onboarding a new Hiring Manager.

Description: When a new Hiring Manager is onboarded, HR needs to input various details such as Name, Email, Phone Number, Department, and Location into Salesforce.

Create a Screen Flow that guides HR through entering this information step-by-step.

2.Importing New Records

Objective: Import new Hiring Manager records into Salesforce.

Description:

1. You have a CSV file with a list of new Hiring Managers that needs to be imported into Salesforce.
2. The CSV file contains fields: Name, Email, Phone Number, Department, Location, Number of Open Positions.

3.Creating a Hiring Managers Report

Objective: Create a detailed report on Hiring Managers and their activity.

Description: You need to generate a report that shows all Hiring Managers along with the number of job applications they have processed in the last month. The report should include fields such as Hiring Manager Name, Email, Department, and Number of Job Applications

Text Books:

1. Salesforce CRM Administration Handbook: A comprehensive guide to administering, configuring, and customizing Salesforce CRM by Krzysztof Nowacki and Mateusz Twarożek, Packt Publishing Ltd, April 2024.
2. Salesforce CRM - The Definitive Admin Handbook by Paul Goodey, Packt Publishing Ltd., 5th Edition, April 2019.

Reference Books:

1. Salesforce for Beginners, Sharif Shaalan, Timothy Royer, Packt Publishing Ltd, 2nd Edition.

Web Links:

1. <https://trailhead.salesforce.com/help?article=Salesforce-Certified-Administrator-Exam-Guide>

2. https://developer.salesforce.com/docs/atlas.enus.salesforce1appadmin.meta/salesforce1appadmin/s1_admin_guide_actions_intro.html
3. https://help.salesforce.com/s/articleView?id=sf.printabledoc_admin.htm&type=5
4. <https://trailhead.salesforce.com/search/learning?keywords=journey+2+salesforce>
5. <https://www.salesforcetutorial.com/>
6. <https://www.tutorialspoint.com/salesforce/index.html>
7. https://api.pageplace.de/preview/DT0400.9781782170532_A24166039/preview-9781782170532_A24166039.pdf
8. <https://www.youtube.com/watch?v=mc5cQ1vHcr0&list=PLgW8Fj5TGrqr9oCcfX1MWcoh2oluUHI9>
9. <https://www.youtube.com/watch?v=THbIw8hgW0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn>

Advanced Salesforce Administration

	L	T	P	C
Course Code: 241IT034	0	0	3	3

Practice:

1. User Management

1.1) The university's IT department needs to set up new users in their Salesforce org with specific licenses. As a Salesforce administrator, you are responsible for creating the following users with the given licenses:

- a. Development User (with Salesforce License)
- b. Testing User (with Salesforce Platform License)
- c. Manager User (with Salesforce Platform License)
- d. Customer User (with Salesforce Platform License)

2. Activation and Deactivation of a User

2.1) Your organization hires new employees who need access to Salesforce to perform their job duties. You need to onboard these employees efficiently and provision user accounts in Salesforce with appropriate permissions and access levels.

2.2).An employee is leaving the company, and you need to deactivate their user account in Salesforce to prevent unauthorized access and ensure data security.

3. Password Policies

3.1) Paul, an employee has forgotten his Salesforce password and cannot log in. As the Salesforce administrator, how can you reset his password.

3.2) The university's IT department mandates stricter password policies for Salesforce users to enhance security. As the Salesforce administrator, you need to configure these policies.

To increase security, the university requires all Salesforce user passwords to meet the following criteria:

- Minimum length of 12 characters
- At least one uppercase letter
- At least one lowercase letter
- At least one number
- At least one special character
- Passwords must expire every 90 days
- Users must not reuse their last 3 passwords

4. Role Hierarchy

4.1) The university's IT department has added new users with specific licenses to

their Salesforce org. To establish clear reporting lines and ensure appropriate data access, the IT department needs to set up a role hierarchy as follows

CEO [System Administer]

| ---> CFO [Manager User]

| ---> COO [Testing User]

| ---> CTO [Development User]

| ---> VP [Customer User]

5. Profile Management

5.1) Configure the Profile Level Permissions to the Development User as below.

Account : Grant R, C, E, D

Lead : Grant R

Case: Grant R, C.

Hiring Manager : R C E

5.2) Create an Account Record inside the object by using "Development User" account, and Share the Record to "Manager User" with "ReadOnly" access.

6. Permission Set

6.1) Create a Permission Set to grant the "Edit and Delete" permissions on the Account Object to the Manager User.

6.2) Login into the Development User Account, and share the above Account record to the Testing User with "Read/Write" access.

7. Public Groups

7.1) Create an Account Record by login with "Manager User" and Share the Account Record to "Hyderabad Sales Group" with Read/Write access.

Hyderabad Sales Group

| ---> Testing User (R/W)

| ---> Customer User (R/W)

8. Sharing Rules

8.1) Configure a Sharing Rule on the Account object, which is used to share the Account Records to the "Kakinada Sales Group", if the Account record matching with the below conditions. Grant Read/Write access.

1. Account: Rating == 'Hot'

2. Account: Industry == 'Finance'

3. Account: Active == 'Yes'

4. Account: Customer Priority == 'High'

9. Web to Lead

Implement the use of Web to Lead in a Salesforce Org with suitable example.

10. Web to Case

Create a Web to case form for raising a ticket in your organization.

11. Case Escalation Rule

The customer support team handles a high volume of cases daily, ranging from simple inquiries to complex technical issues. To ensure timely resolution and efficient case management, you need to implement case escalation rules in your salesforce org.

12. Reports and Dashboards

12.1) Configure a Tabular Report, to represent only Hot Rating Customers Data in the Tabular format along with Grand Total.

Additional Practice:

1. Restricting Object Access with Profiles

Objective: Restrict access to certain objects for specific profiles to enforce data security.

Description:

Interns in your organization should have very limited access and should not be able to view or edit the Account and Contact objects. Modify the Intern profile to restrict access to these objects.

2. Permission Sets for Temporary Access

Objective: Use permission sets to grant temporary or additional permissions without modifying profiles.

Description:

A Hiring Manager needs temporary access to edit the "Budget" field on the Project object for a special project. Create a permission set to grant this access and assign it to the Hiring Manager.

3. Creating a Hiring Managers Report

Objective: Create a detailed report on Hiring Managers and their activity.

Description:

You need to generate a report that shows all Hiring Managers along with the number of job applications they have processed in the last month. The report should include fields such as Hiring Manager Name, Email, Department, and Number of Job Applications.

References:

1. <https://trailhead.salesforce.com/help?article=Salesforce-Certified-Administrator-Exam-Guide>
2. https://developer.salesforce.com/docs/atlas.en-us.salesforce1appadmin.meta/salesforce1appadmin/s1_admin_guide_actions_intro.html
3. https://help.salesforce.com/s/articleView?id=sf.printabledoc_admin.htm&type=5
4. <https://trailhead.salesforce.com/search/learning?keywords=journey+2+salesforce>
5. <https://www.salesforcetutorial.com/>

Web Links:

1. <https://www.youtube.com/watch?v=mc5cQ1vHcr0&list=PL-gW8Fj5TGrqr9oCcX1MWcoh2oluUHI9>
2. <https://www.youtube.com/watch?v=THbIw8hg-W0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn>

Principles of Pega Systems

	L	T	P	C
Course Code: 241IT023	0	0	3	3

Practice:

1. Pega Infinity Overview

- a) Perform a lab to how to create a case type
- b) Perform a lab on how to configure a case type and stages and steps to it

2. Case life cycle design & Gathering Business Requirements

- a) Configure a lab to Create the career candidate case type
- b) Perform a lab to Add processes and steps to stages

3. Case management

- a) Perform a lab to configure “Service level agreements”
- b) Configure a lab to create a child case

4. Case management

- a) Perform a lab for creating a wait step.
- b) Perform a lab on Process Design for Insurance Application

5. Data management

- a) Configure a lab to create properties for a car selling company to collect the customer information.
- b) Perform a lab on Creating field values in Employee onboarding.

6. Data management

- a) Perform a lab to check the data validation.
- b) Perform a lab for Creating a data relationship
- c) Perform a lab for Creating Data pages in pega

7. Decision Approval and Routing

- a) Perform a lab for Skipping a process in a case type
- b) How to configure common decision rules for a decision shape and unit test the various configurations.

8. User Interface

- a) Configure the views for those steps with fields that gather and display the information for a home load application
- b) Configure a lab on user interface to meet the requirements:
The UI team at Wind has asked you to style Calendar controls to simplify the Calendar appearance.

9. Pega platform

- a) Perform a lab on this requirement: You want to create a section that will be usable by multiple case types in your HireMe application in App Studio and Dev Studio.

- b) Perform a lab on this requirement: You want to create a few properties both manually and using a wizard to understand the importance of the context when creating a rule.

10. Tools and Testing

- a) Perform a lab on Debugging application errors
- b) Perform a lab on Scenario testing

11. Reporting

- a) Perform a lab for Creating an Insight for one month resolved cases
- b) Perform a lab to meet the following requirements: A manager at the company will want to be able to run out-of-the-box reports from the system. Run a report.

12. Security and Localization

- a) Perform a lab on Managing application access to different users
- b) Perform a lab to Configuring security policies

Additional Practice:

1. Create a Car rental Application for a travel agency for car booking.
2. Create a vehicle manufacturing application to obtain the customer's requirements and needs to design a new car for him.
3. Create an Application for Housing loan application.

Web links:

1. www.pegaacademy.com
2. <https://academy.pega.com/mission/introduction-pega-platform/v4>
3. <https://academy.pega.com/topic/case-life-cycle-design/v2>
4. <https://academy.pega.com/topic/requirements-portal/v1>
5. <https://academy.pega.com/module/case-management/v1>
6. <https://academy.pega.com/topic/designing-approval-process/v1>
7. <https://academy.pega.com/module/user-interface/v3>

Pega System Architecture & Design

Course Code: 241IT026

L	T	P	C
0	0	3	3

Practice:

1.Application Development.

- a) Perform a lab on how to configure skimming a ruleset.
- b) Perform a lab on how to configure a Application ruleset versions.
- c) Configuring a Automation actions when a property value changes.

2.Application Development.

- a) Perform a lab on how to merge a branch application.
- b) Perform how to create a circumstancing rule for a single variable of the application

3.Application Development.

- a) Perform a lab on how to create a circumstancing rule for multiple variables of the application
- b) Perform a lab on how to configure a Rule Resolution.

4.Application Development

- a) Perform a lab to configure lock a ruleset version.
- b) Perform a lab on how to configure to saving an existing rule in a new version.
- c) Perform a lab on how to configure a Lower rule to Latest ruleset version.

5.Case management

- a) Perform a lab on how to configure to override a Case Urgency.
- b) Perform a lab on how to configure a Parallel Processing.

6.Case management.

- a) Perform a lab on how to configure a case locking
- b) Perform a lab on how to configure flow action pre- and post-processing
- c) Configuring a lab on how to update a Assignment Routing.

7.Case management

- a) Perform a lab to configure designate a relevant record.
- b) Perform a lab to configure Pega Rules Analyzer (PLA).

8.Data and Integration

- a) Perform a lab and how to configure validating data against pattern.
- b) Perform a lab on how to source a page property using a keyed date page.
- c) Perform a lab on how to configure a snapshot pattern.

9.Data and Integration

- a) Perform a lab on how to Create a SOAP Connector.
- b) Perform a lab on how to manage application settings.
- c) Perform a lab on how to configure an Alias Pattern using Referencing properties.

10. Reports.

- a) Perform a lab on how to create a report that combine data from multiple Classes.
- b) Perform an activity to manage a local data storage.
- c) Perform a lab on how to use Class Joins in Reports.
- d) Perform a lab on how to use sub reports.

11.Security.

- a) Configure how to secure an application using Role Based Access Control(RBAC)
- b) Configure how to secure an application using Attribute Based Access Control(ABAC)
- c) Configure how to organizing and Managing Access to Case Attachments.

12.Gen AI.

- a) Perform a lab on how to create a case type through pega gen AI
- b) Perform a lab on how to configure pega self study buddy.
- c) Perform a lab on how to sizing a pega platform project.
- d) Perform a mission Innovation with Pega Gen AI.

Additional Practice:

1. Create and Design a Banking application by configuring case locking, overriding case urgency, and implementing data encryption.
2. Create and Design a Hospital management application with saving data in to a system of Records.
3. Create and Design any Insurance application.

Web Links:

1. <https://academy.pega.com/>
2. <https://academy.pega.com/challenge/skimming-ruleset/v1>
3. <https://academy.pega.com/module/application-development/v2>
4. <https://www.pega.com/case-management>
5. <https://academy.pega.com/topic/reports/v3>
6. <https://academy.pega.com/topic/understanding-security-basics/v1>
7. <https://www.pega.com/technology/generative-ai>
8. <https://www.pega.com/retail-banking-solutions>
9. <https://www.pega.com/insurance-software>
10. <https://www.pega.com/healthcare-management>

Entrepreneurship Development and Incubation

Course Code: 241MB004

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the meaning and concepts of entrepreneurship development
- CO2:** Apply the business plan for preparation and evaluation of project.
- CO3:** Explain about Institutional Support to Entrepreneur and MSMEs
- CO4:** Explain about the Opportunities of Entrepreneurship Internationally.
- CO5:** Explain about Informal Risk Capital, Venture capital and Social responsibility for entrepreneurship

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1						2			1		
CO2						2			1		
CO3						2			1	1	
CO4						2			1	1	
CO5						2		3			

UNIT – I

Entrepreneur & Entrepreneurship:

Entrepreneur & Entrepreneurship: Meaning of entrepreneur - Evolution of the concept - Functions of an Entrepreneur - Types of Entrepreneur - Intrapreneur- an emerging class - Concept of Entrepreneurship - Evolution of Entrepreneurship - Development of Entrepreneurship - Entrepreneurial Culture - Stages in entrepreneurial process.

UNIT – II

Business Planning Process:

Meaning of business plan - Business plan process - Advantages of business planning - Marketing plan - Production/operations plan - Organization plan - Financial plan - Final Project Report with Feasibility Study - preparing a model project report for starting a new venture.

UNIT – III

Institutions supporting Entrepreneurs:

Small industry financing institutions in developing countries - A brief overview of financial institutions in India - Central level and state level institutions - SIDBI - NABARD - IDBI - SIDCO - Indian Institute of Entrepreneurship - DIC - Single Window - Latest Industrial Policy of Government of India.

UNIT – IV

International Entrepreneurship Opportunities:

The nature of international entrepreneurship - Importance of international business to the firm - International versus domestic entrepreneurship - Stages of economic

development - Entrepreneurship entry into international business - exporting - Direct foreign investment - barriers to international trade.

UNIT – V

Informal Risk Capital and Venture Capital:

Informal risk capital market - venture capital - nature and overview - venture capital process - locating venture capitalists - approaching venture capitalists. Social Entrepreneurship: Social enterprise-need - types - characteristics and benefits of social enterprises-Social entrepreneurship - Rural entrepreneurship, MSME Policies. Make-In India, Start-Up India, Stand-Up India.

Text Books:

1. Entrepreneurship by Arya Kumar, Pearson, Publishing House, New Delhi, ISBN: 9789353066499
2. Entrepreneurship by VSP Rao, Kuratko, Cengage Learning, New Delhi. ISBN: 978-8131516140

Reference Books:

1. Entrepreneurship Development by B. Janakiram, M Rizwana, Excel Books, New Delhi, ISBN-13: 9788174469588.
2. Entrepreneurship Development by P.C. Shejwalkar, Everest Publishing House, New Delhi, ISBN: 8176601942.

Web Links:

1. <https://archive.nptel.ac.in/courses/107/101/107101092/>
2. <https://www.tutorialspoint.com>

Business Ethics & Corporate Governance

Course Code:241MB005

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate a solid understanding of the purpose and nature of corporations.
- CO2:** Explain confirming the value, impact and contribution the Board of Directors makes to the success of the Organization.
- CO3:** Analyze different Corporate Governance Forums.
- CO4:** Use the acquired skill for proper sustainable Corporate Social Responsibility.
- CO5:** Demonstrate ethical awareness, the ability to do ethical reflection, and the ability to apply ethical principles in decision-making.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1							2			1	
CO2							2				
CO3							2				
CO4							1		1		
CO5						1	3				

UNIT – I

Corporate Governance:

Corporate governance – meaning – objectives – need - importance – principles – corporate governance and organisation success. Corporate governance in India

UNIT – II

Levels of Governance Structure:

Corporate governance and role, responsibilities and powers - Board of Directors, Corporate Management Committee and Divisional Management Committee.

UNIT – III

Corporate Governance Forums:

CII code on corporate governance – features - Various Corporate Governance forums – CACG, OECD, ICGN AND NFCG.

UNIT – IV

Corporate Social Responsibility:

Corporate Social Responsibility – definition – nature – levels – phases and approaches, principles, Indian models – dimensions. Corporate social reporting - Objectives of Corporate Social Reporting and case studies.

UNIT – V

Business Ethics:

Business ethics – meaning, significance, scope – factors responsible for ethical and unethical business decision. Unethical practices in Business – Business ethics in India – Ethics training programme.

Text Books:

1. Corporate Governance values and ethics, Dr. Neeru Vasisht and Dr. Namita Rajput, Taxmann Publications Pvt Ltd, New Delhi, ISBN-13: 9789388266192.
2. International Business & Environment, S.Sanakaran, Margham Publication, Chennai. ISBN: 978-9381430255

Reference Books:

1. Business Ethics and Corporate Governance, Dr.S.S. Khanka, S.Chand Publication, ISBN: 9788121942867
2. Business Ethics and Value, Sundar.K, Vijay Nichole Prints, Chennai, ISBN: 9788182094994.

Web Links:

1. <https://elearningindustry.com>
2. <https://essentialskillz.com>

Entrepreneurship Development and Business Management

Course Code:241MB006

L	T	P	C
1	0	2	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate that challenges have been undertaken, developing new skills in the process
- CO2:** Analyze marketing opportunities using environmental scanning market data, measurement, and analysis.
- CO3:** Explain the objectives of Financial Statement Analysis.
- CO4:** Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM.
- CO5:** Develop global vision and management skills both at strategic level and interpersonal level.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1										2	
CO2									1		
CO3								3			
CO4							2				
CO5						1					

UNIT – I

Development of Entrepreneurship:

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development.

Practice:

1. Initiation and preparation of project proposal for funding by different agencies.

UNIT – II

Environment scanning and opportunity:

Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development.

Practice:

1. Visit to small scale industries/agro-industries

UNIT – III

Role of financial institutions:

Role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.

Practice:

1. Interaction with successful entrepreneurs/ Agric entrepreneurs.

UNIT – IV

Planning of an Enterprise:

Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control.

Practice:

1. Visit to financial institutions and support agencies

UNIT – V

Personal Management:

Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, bookkeeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management, market types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practice:

1. Project report submission

Text Books:

1. Entrepreneurship Development and Small Business Enterprises, Charantimath P.M., Pearson Publications, New Delhi, ISBN: 978-9332586930.
2. Entrepreneurship: Development and Management, Desai V , Himalaya Publishing House ISBN: 978-9350978757

Reference Books:

1. Entrepreneurship Development & Management, Singhal R.K.,Katson Books, ISBN-13: 9788189757007
2. Principles of Management by Tripathi P C & Reddy P N, Tata McGraw Hill, ISBN-13: 9780071333334.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/106/110106141/>
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/03_lec/

SoC Design

Course Code: 241EC029

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course student will be able to:

- CO1:** Explain all the building blocks of SoC.
- CO2:** Classify the concept of processors and instruction handling.
- CO3:** Analyze vector, VLIW and superscalar processors.
- CO4:** Develop a Memory as part of SoC.
- CO5:** Illustrate the concepts of interconnect optimization and configuration in SoC.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	3	2									1
CO3	2	2	1								1
CO4	2	2	2								1
CO5	2	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction to the System Approach:

System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

UNIT – II

Processors:

Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

UNIT – III

Memory Design for SOC:

Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time,

Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation , SOC Memory System, Models of Simple Processor – memory interaction.

UNIT – IV

Interconnect Customization:

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor.

UNIT – V

Interconnect Configuration:

Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

Text Books:

1. Computer System Design System-on-Chip, Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd, ISBN: 978-0470643365.
2. ARM System on Chip Architecture, Steve Furber, Addison Wesley Professional, 2nd Edition, ISBN : 9780201675191 .

Reference Books:

1. Design of System on a Chip: Devices and Components, Ricardo Reis, Springer 1st Edition, ISBN: 978-1441954541.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Jason Andrews, Newnes, BK and CDROM, ISBN: 978-0750677301.
3. System on Chip Verification–Methodologies and Techniques, Prakash Rashinkar, Peter Paterson and Leena Singh L, Kluwer Academic Publishers, ISBN: 978-0792372790.

Web Links:

1. <https://www.peterindia.net/System-On-ChipLinks.html>
2. <https://www.ieee-socc.org/>
3. <http://nptel.ac.in/courses/108102045/10> (Prof. Santanu Chaudhary, IIT Delhi)

Cloud Computing

(Common to CSE, IT, AIML & CSE (DS))

Course Code: 241CS023

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain basic concepts and terminologies of Cloud Computing and Virtualization.
- CO2:** Demonstrate Cloud deployment models, Service models and Architectures.
- CO3:** Analyze Cloud services, Applications and Capacity Planning.
- CO4:** Use different PaaS application frameworks to construct Cloud applications.
- CO5:** Develop web applications through Google, Microsoft and Amazon web services for Realtime application.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2			1			1	1		1
CO2	2	2			1			1	1		1
CO3	3	1			1			2	1		1
CO4	2	2			1			2	1		1
CO5	2	2			1			2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	2	
CO4	2	
CO5	2	

UNIT – I

Fundamental Cloud Computing and Virtualization Cloud Computing: Origin and influences, Basic concepts and terminology, Goals and benefits, Risks and challenges, Roles and boundaries and Cloud characteristics.

Introduction to Virtualization: Characteristics, Taxonomy of virtualization technologies, Pros and cons of virtualization, Virtualization Technologies: Xen, VMware and Hyper-V.

Practice:

1. Introduction to Cloud Computing.
2. Overview of cloud computing concepts.
3. Hands-on: Setting up a free-tier account on AWS/Azure/GCP.

UNIT - II

Understanding Cloud Models and Architectures Cloud Models: NIST model, Cloud Cube model, Deployment models: Public, Private, Hybrid and Community; Service models: IaaS, PaaS and SaaS. Understanding Cloud Architecture: Exploring the Cloud Computing Stack,

Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications; Connecting to the Cloud: The Jolicloud Netbook OS and Chromium OS - The Browser as an Operating System.

Practice:

1. Virtual Machines and Computer Services.
 - a. Creating and managing virtual machines.
 - b. Hands-on: Launching and configuring EC2 instances on AWS.

UNIT – III

Understanding Cloud Services, Applications and Capacity Planning: Understanding Cloud Services and Applications Infrastructure as a Service (IaaS): IaaS workloads, Pods, aggregation, and silos; Platform as a Service (PaaS), Software as a Service (SaaS): SaaS characteristics, Open SaaS and SOA, Salesforce.com and CRM SaaS; Identity as a Service (IDaaS): Identity, Networked identity service classes, Identity system codes of conduct, IDaaS interoperability; Compliance as a Service (CaaS). Capacity Planning: Defining Baseline and Metrics: Baseline measurements, System metrics, Load Testing, Resource ceilings, Server and instance types; Network Capacity and Scaling.

Practice:

1. Storage Solutions.
 - a. Exploring different storage options (S, EBS, Glacier).
 - b. Hands-on: Implementing S3 buckets and managing data.

UNIT – IV

Exploring Platform as A Service (PaaS): PaaS Application Frameworks: Drupal, Eccentex AppBase 3.0, Long Jump, Squarespace, Wavemaker and Wolf Frameworks. Exploring Platform as a Service using Google Web Services: Surveying the Google Application Portfolio, Google Toolkit and Working with the Google App Engine. Exploring Platform as a Service using Microsoft Cloud Services: Exploring Microsoft Cloud Services, Microsoft Azure- Live Essentials, Live Home and Live for Mobile.

Practice:

1. Networking in the Cloud.
 - a. Configuring virtual private clouds (VPC), subnets, and security groups.
 - b. Hands-on: Setting up a VPC and deploying instances within it.

UNIT -V

Exploring Infrastructure As A Service (IaaS): Understanding Amazon Web Services, Amazon Web Service Components and Services, Working with the Elastic Compute Cloud (EC2): Amazon Machine Images, Pricing models, System images and software, Creating an account and instance on EC2; Working with Amazon Storage Systems: Amazon Simple Storage System (S3), Amazon Elastic Block Store (EBS) and CloudFront; Understanding Amazon Database Services: Amazon Simple DB, Amazon Relational Database Service (RDS) and Choosing a database for AWS.

Practice:

1. Database Services
 - a. Understanding cloud-based database services (RDS, DynamoDB).
 - b. Hands-on: Setting up and querying a relational database in AWS RDS.

Text Books:

- 1 Cloud Computing Bible, Barrie Sosinsky, Wiley India Pvt Ltd, ISBN-10. 0470903562 ; ISBN-13. 978-0470903568.
- 2 Cloud Computing- Concepts, Technology and Architecture, Thomas Erl and Ricardo Puttini, Pearson, ISBN 10: 0133387526 - ISBN 13: 9780133387520.

Reference Books:

- 1 Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola and S Thamarai Selvi, McGraw Hill Education. ISBN: 978-0-12-411454-8.
- 2 Cloud Application Architectures, George Reese, O'Reilly. ISBN: 978 0596156367.
- 3 Enterprise Cloud Computing Technology Architecture Applications, Gautam Shroff, Cambridge university press; 1st edition. ISBN: 978-0521137355.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc24_cs17/preview
- 2 <https://docs.aws.amazon.com/>
- 3 <https://learn.microsoft.com/en-us/training/azure/>

Multi-Disciplinary Courses (MDC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CS003	Data Structures	FC	2		2	4	50	50	100	PPSC
241MB002	Engineering Economics	FC	3			3	50	50	100	-
241MB003	Management Science	FC	2			2	50	50	100	-
	Total		7		2	9				

Multidisciplinary Courses (MDC)

Data Structures
(Common to CE, EEE, ME, ECE, PT& Min.E)

	L	T	P	C
Course Code: 241CS003	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Utilize structure, union and file operations to handle heterogeneous data.
- CO2:** Illustrate Time and Space complexities for different searching and sorting Algorithms
- CO3:** Demonstrate various operations on Linked Lists
- CO4:** Explain different operations on Stack and Queue with applications.
- CO5:** Demonstrate the importance and various operation on non-linear data structures

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	2					1	1		
CO2	1	1	2	2				1	1		
CO3	1	2	2	1				1	1		
CO4	1	1	2	1				1	1		
CO5	1	1	2	2				1	1		

UNIT – I

Structures and Unions: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type - enum variables, Using Typedef keyword, Bit Fields.

Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files.

Practice:

4. Write a C program to find the total, average of n students using structures
5. Copy one structure variable to another structure of the same type.
6. Read student name and marks from the command line and display the student details along with the total.

UNIT – II

Introduction to Linear Data Structures: Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures.

Sorting Techniques: Quick sort, Merge sort, Radix sort

Practice:

4. Implement Merge sort using arrays.
5. Implement Quick sort using arrays
6. Implement Radix Sort using arrays

UNIT – III

Linked Lists: Singly linked lists: representation and operations, doubly linked lists and its operations and circular linked lists and its operations, Comparing arrays and linked lists, Applications of linked lists.

Practice:

5. Single Linked List: Perform different operations in single linked list.
6. Reversing a single linked list
7. Perform different operations in double linked list
8. Circular Linked List

UNIT – IV

Stacks: Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

Queues: Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

Practice:

5. Stack and its operations using arrays and Linked List
6. Implement a program to evaluate a postfix expression.
7. Queue and its operations using arrays and Linked List
8. Implement Circular Queue using Arrays

UNIT – V

Non-linear Data Structures:

Trees: Definition of tree, Tree Terminology, types of trees, Binary tree traversals, Binary Search Tree – Insertion, Deletion.

Graphs: Definition and Terminology – Representation of Graphs-Adjacency Matrix and Linked list, Graph Traversals (BFT & DFT)

Practice:

5. Implement Binary search tree (BST).
6. Implement Binary search Tree (BST) Traversals.
7. Graph Traversal using Breadth First Search (BFS)
8. Graph Traversal using Depth First Search (DFS)

Additional Practice:

1. Using a structure for transporting some boxes through a tunnel
2. Delete duplicate-value nodes from a sorted linked list
3. Convert an infix expression into postfix expression
4. De Queue Implementation

Text Books:

1. Programming in C, Rema Theraja, Oxford, 3rd Edition, ISBN: 978-9354979453.
2. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand, ISBN: 978-9358704730.

Reference Books:

1. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition, ISBN: 978-1849967204.
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Silicon Press, ISBN: 9780929306407.
Data Structures and Algorithms by Maganti Venkatesh, Naresh.
3. Data Structures Using C, Reema Thareja, Oxford University Press, 2nd Edition, ISBN: 978-0198099307.

Web Links:

1. <https://nptel.ac.in/courses/106102064>
2. <https://archive.nptel.ac.in/courses/106/105/106105225/>
3. <https://www.udemy.com/topic/data-structures/>
4. <https://www.coursera.org/specializations/data-structures-algorithms>
5. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>

Engineering Economics
(Common to ECE, Min.E, PT)

	L	T	P	C
Course Code: 241MB002	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the Managerial Economic concepts and Illustrate the law of demand forecasting methods.
- CO2:** Identify the production , cost behavior for managerial decision making and Break Even Point (BEP) of an enterprise.
- CO3:** Differentiate types of market structures, business organizations along with basic knowledge on business cycle.
- CO4:** Make use of the process & principles of accounting for the preparation of basic accounts.
- CO5:** Utilize various techniques on investment project proposals with the help of capital budgeting techniques for decision making.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1			1		1			2			
CO2									2		
CO3	1								3		
CO4								1	1		
CO5								3	1	2	

UNIT – I

Introduction to Managerial Economics and demand Analysis: Definition and Scope of Managerial Economics, Concept and determinants of demand, Demand curve, Law of Demand and its limitations, Elasticity of demand and its types, Demand forecasting and its Methods.

UNIT – II

Production and Cost Analyses: Concept of production function – Law of variable proportions-Isoquants and Iso costs- cost concepts: opportunity costs, explicit and implicit costs- Fixed costs, Variable costs and total costs – Cost –Volume-Profit analysis Determination of breakeven point (simple problems)- Managerial significance and limitations of breakeven point.

UNIT – III

Introduction to Markets, Pricing Policies & Types of Business Organization and Business Cycles.

Market structures: Perfect competition, monopoly, monopolistic competition and oligopoly –Features – Methods of pricing: Average cost pricing, Limit pricing, Market skimming pricing. Features and evaluation of Sole Trader, Partnership, Joint Stock Company – Business cycles : Phases of business cycles.

UNIT – IV

Introduction to Accounting & Financing Analysis: Introduction to double entry systems – Journal entries – Ledger – Trail balance – Trading and Profit and Loss account-simple problem.

UNIT – V

Capital and Capital Budgeting: **Capital Budgeting:** Meaning of Capital- Methods of Capital Budgeting-Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value. method, Internal Rate of Return Method and ProfitAbility Enhancement Courses Index)- Simple Problems.

Text Books:

1. Managerial Economics and Financial Analysis, A.R. Aryasri , McGrawHill Education, ISBN: 978-0070078031.
2. Managerial Economics and Financial Analysis, N.Appa Rao, P.Vijay Kumar, Cengage Publications, ISBN: 978-8131515952.

Reference Books:

1. Managerial Economics , V. Maheswari , Sultan Chand Publications, ISBN: 81-8054-914-4.
2. Managerial Economics, Suma Damodaran : Oxford University Press, ISBN: 978-0198061113.

Web Links:

1. <https://www.udemy.com/course/introduction-to-managerial-economics/?couponCode=LETSLEARNNOWPP>
2. <https://archive.nptel.ac.in/courses/110/101/110101149/>

Management Science
(Common to ECE & PT)

Course Code: 241MB003

L T P C
2 0 0 2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply management and motivation theories to renovate the practice of management.
- CO2:** Explain concepts of quality management and use process control charts, concepts and tools of quality engineering in the design of products and process controls.
- CO3:** Appraise the functional management challenges associated with high levels of change in the organizations.
- CO4:** Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM.
- CO5:** Develop global vision and management skills both at strategic level and interpersonal level.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1											2
CO2										1	
CO3									3		
CO4								2			
CO5							1				

UNIT – I

Introduction to Management: Concept nature and importance of management, Generic functions, Principles and Types of Management, Theories of motivation, Decision making process, Designing organization structure.

UNIT – II

Operations Management: Work study, Statistical quality control, Control charts (P-chart, R-chart, and C-chart), Need for inventory control, EOQ, ABC analysis, and Types of ABC analysis (HML, SDE, VED, and FSN analysis).

UNIT – III

Functional Management: Concept of HRM, HRD and PMIR, Functions of HR Manager, Job evaluation and merit rating, Marketing management, functions of marketing, channels of distributions.

UNIT – IV

Project Management: Development of Network, Difference between PERT and CPM, Identifying critical path, (Simple Problems).

UNIT – V

Strategic Management: Vision, Mission, Goals, Strategy, Elements of corporate planning process, SWOT analysis, Steps in strategy formulation and implementation.

Text Books:

1. Management Science, Aryasri, Tata McGraw Hill, ISBN: 9780070090279.
2. Management, James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R, Pearson Education/Prentice Hall, 6th Edition, ISBN: 9788131707043.

Reference Books:

1. Principles of Marketing, , Kotler Philip, Gary Armstrong, Prafulla Y. Agnihotri, and Eshan ul Haque , Pearson Education/ Prentice Hall of India 13th Edition, ISBN: 9788131731017.
2. A Handbook of Human Resource Management Practice, Michael Armstrong, Kogan Page Publishers, ISBN: 978-1789661033.

Web Links:

1. <https://archive.nptel.ac.in/courses/122/106/122106031/>
2. https://www.google.com/search?sca_esv=680b12c94771f77f&sca_upv=1&rlz=1C1VDKB_enGBIN1079IN1079&tbm=vid&sxsrf=ADLYWIKvg0FuUABCxWsswlpWifSE3hFy0A:1716531957118&q=management+science+online+video+lectures&sa=X&ved=2ahUKEwissbLs06WGAXVX2.wGHYpkDOMQ8ccDegQIExAF

Ability Enhancement Courses (AEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EN001	Essential Cognitive Skills for Engineers	FC			1	1	100	-	100	-
241EN002	Advanced Cognitive Skills for Engineers(or) Proficiency in Foreign Language Japanese / German /French/ Spanish	FC			1	1	100	-	100	-
241UC005										
241UC004										
241UC003										
241UC006										
241UC007	Design Thinking	FC			1	1	100	-	100	-
241UC008	Universal Human Values	FC	2			2	100	-	100	-
241UC009	Technical Paper Publication	AC			2	2	100	-	100	-
241EC096	Student Activity-Based Learning	AC				2				
Total			2		5	9				

ESSENTIAL COGNITIVE SKILLS FOR ENGINEERS

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code: 241EN001	0	0	1	1

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Recognize the different aspects of the English language proficiency with emphasis on LSRW skills.
- CO2:** Apply communication skills through various language learning activities
- CO3:** Analyze the English speech sounds, stress, intonation and syllable division for better listening and speaking comprehension.
- CO4:** Enable them to learn and apply fundamentals of English grammar concepts for improved language
- CO5:** Make use of various types of vocabulary in different academic and professional careers

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1									3		
CO2									3		
CO3									3		
CO4									3		
CO5									3		

Practice:

UNIT-I Outstanding people A/B/C/D

Listening	Conversation about Jocelyn Bell- Burnell, Podcast: The 30-day challenge, Starting a new job, Conversation about technology
Speaking	Discussing inspiring people, Asking and answering questions about challenges, Explaining a process; Checking understanding, Discussing technology.
Reading	Articles: <i>Protector of the sea</i> and <i>The woman who reinvented children's TV</i> , Interviews: <i>30-day challenge</i> , Article: <i>Tech free!</i>
Writing	Article Organizing an article
Grammar	Review of Tenses, Questions
Vocabulary	Character adjectives, trying and succeeding
Pronunciation	The letter e; Word stress, Rapid speech

UNIT-II	Survival A/B/C/D
Listening	Conversation about a survival situation, Interview: The Tiger, Cooking for a friend, Talking about getting lost
Speaking	Telling a survival story, Giving advice; Asking questions, Giving compliments and responding, Discussing the natural environment
Reading	Article: Lost at sea, Leaflet: <i>How to survive...an animal attack</i> , Leaflet: <i>Be wise and survive</i>
Writing	Guidelines, organizing guidelines in a leaflet
Grammar	Narrative tenses, Future time clauses and conditionals
Vocabulary	Expressions with <i>get</i> , Animals and the environment
Pronunciation	Sound and Spelling: g, Intonation in question tags
UNIT-III	Talent A/B/C/D
Listening	Conversation: learning experiences, Radio Programme: The sports gene, Making wedding plans, Interviews about sport
Speaking	Talking about something you have put a lot of effort into, Discussing sport and ways to improve performance, planning a party, Talking about popular sports
Reading	Text about learning; <i>Learning to learn</i> , Article: <i>Born to be the best</i> ; Three articles about athletes, Article: <i>Fitness: Seattle snapshot</i>
Writing	Article describing data
Grammar	Multi-word verbs, Present perfect and present perfect continuous
Vocabulary	Ability and achievement, word connected with sport
Pronunciation	Word stress, sound and spelling consonant sounds
UNIT-IV	Life Lessons A/B/C/D
Listening	Interview: Psychology of money; Two monologues: Life-changing events, Two monologues; training for a job, Presenting photos, Three monologues; living in different places
Speaking	Talking about how your life has changes, Discuss experiences of training and rules, Describing photos: Expressing careful disagreement, Discussing living in a different country
Reading	Two texts about life-changing events that helped people become rich, Article: <i>Training for the emergency frontline</i> , Advert for being an international student 'buddy'
Writing	Job application, Giving a positive impression
Grammar	<i>Used to</i> and <i>would</i>
Vocabulary	Cause and result, Talking about difficulty
Pronunciation	Sound and spelling: u

UNIT–V Chance A/B/C/D

Listening	Monologue: What are your chances?, Conversation: Talking about work, Money problems, News reports: environmental problems
Speaking	Discussing possible future events, Role Play: job interview, Explaining and responding to an idea for a café, Giving opinions on environmental problems
Reading	Quiz: <i>Are you an optimist or a pessimist?</i> ; Article: <i>Why we think we're going to have a long and happy life</i> , Quiz: <i>The unknown continent</i> ; Article: <i>Cooking in Antarctica</i> , Essay about protecting the environment
Writing	For and against essay, Arguing for and against an idea
Grammar	Future probability, Future perfect and future continuous
Vocabulary	Adjectives describing attitude, The natural world
Pronunciation	Sound and spelling : <i>th</i> , Intonation groups

Text Book:

1. Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones, ISBN: 978-1107468726.

Suggested Software:

- Cambridge Empower
- Soft X (K-Van Solutions)

Reference Books:

1. M Ashraf Rizvi: Effective Technical Communication, ISBN: 9352605780.
2. Raymond Murphy: English Grammar in Use, Cambridge University Press. Fifth Edition, ISBN: 978-3125354241.
3. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, ISBN: 9788120314955.

Web links:

- <https://www.cambridgeone.org/login>
- <https://www.britishcouncil.in/english/online>
- www.englishmedialab.com

Advanced Cognitive Skills For Engineers
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code: 241EN002	0	0	1	1

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Recognize the basics of communication and summarize formal and informal language expressions in all aspects.
- CO2:** Establish and maintain interpersonal relationships and transmit the message through different language activities.
- CO3:** Use language effectively to prepare and demonstrate proficiency in facing various types of interviews.
- CO4:** Demonstrate and exhibit professionalism in participating in various public speaking activities like debates, group discussions and presentation skills.
- CO5:** Identify the basic elements of writing and apply the fundamentals to compose e-mails catering to different professional needs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1									3		
CO2									3		
CO3									3		
CO4									3		
CO5									3		

Practice

UNIT – I Around the globe A/B/C/D

Listening	Two monologues about sightseeing tours, Interview: disappearing languages, Asking for a favour, conversation: a trip to the Grand Canyon
Speaking	Comparing different tourist destinations, Agreeing and disagreeing, Asking for a favour, Discussing local tourist destinations.
Reading	Website about four tourist destinations; Website: <i>Where to go?</i>
Writing	Travel blog, Using descriptive language
Grammar	Infinitives and <i>-ing</i> forms
Vocabulary	Travel and tourism, Describing changes
Pronunciation	Consonant clusters, Consonant sounds

UNIT – II
City living A/B/C/D

Listening	Interview: ‘Smart’ cities: Two monologues talking about ‘smart’ cities, Two monologues: house renovations, Flat hunting, Interviews about a new shopping centre
Speaking	Discussing good and bad points about a city
Reading	Article: <i>Quick-slow down!</i> , Article: <i>Who puts the ‘real’ in reality</i> TV? Email: Complaining about an important issue.
Writing	Email of complaint, Using formal language
Grammar	<i>Too/enough; so/such</i> , Causative <i>have/get</i>
Vocabulary	Describing life in cities, Film and TV; Houses
Pronunciation	Sound and spelling: o, Stress in compound nouns

UNIT – III
Dilemmas A/B/C/D

Listening	Radio programme: person finance, Three monologues about honesty, Going to the bank, Conversation about a TV programme
Speaking	Giving opinions on financial matters, Discussing moral dilemmas, Talking about hopes and worries Discussing programmes about crime
Reading	Article: <i>Is it time to give up on cash?</i> , Newspaper article: <i>The honesty experiment</i> , Review: <i>Crime with a smile</i>
Writing	Review, Organising a review
Grammar	First and second conditionals, Third conditional; <i>should have+past participle</i>
Vocabulary	Money and finance, Crime
Pronunciation	Stressed and unstressed words; Sound and spelling: <i>l</i> , Word groups

UNIT – IV
Discoveries A/B/C/D

Listening	Conversation about inventions, Conversation about an email hoax, Finding the perfect flat, Four monologues about alternative medicine
Speaking	Talking about inventions, Describing a hoax or a scam or a case of fraud, Giving and receiving surprises
Reading	Article: <i>Too good to be true?</i> , Article: <i>The rise and fall of Barry Minkow</i> , Essay: <i>The Value of alternative medicine</i>
Writing	Opinion essay, Presenting a series of arguments
Grammar	Relative clauses, Reported speech; Reporting verbs
Vocabulary	Health, Verbs describing thought and knowledge
Pronunciation	Sound and spelling : <i>ui</i> , Linking and intrusion

UNIT – V Possibilities A/B/C/D

Listening	Interview about Dan Cooper, Two monologues: pursuing a dream, Celebrating good news, conversation about goals
Speaking	Telling stories about coincidences, Describing and comparing brave or amazing people, Telling an important piece of news, Talking about performing
Reading	Story: The man who disappeared; Blog: <i>The Wreck of the Titan</i> , Article: <i>Dream to help</i> , Story: Rosa's diary: <i>The ultimate goal</i>
Writing	Story, Making a story interesting
Grammar	Past modals of deduction, Wishes and regrets
Vocabulary	Adjectives with prefixes, Verbs of effort
Pronunciation	Word stress, Linking, Consonant clusters

Suggested Software:

- Cambridge Empower
- Soft X (K-Van Solutions)

Text Book:

1. Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones, ISBN: 978-1107468726.

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press.2018, ISBN: 9789354972256
2. Michael Swan- Practical English Usage, ISBN: 9780194202466.
3. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India, ISBN: 978-0070996038.

Web links:

1. <https://www.cambridgeone.org/login>
2. <https://www.coursera.org/>
3. <https://www.skillshare.com/>
4. <https://www.mindtools.com/cawh8bu/communication-tools>

Design Thinking

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code:241UC007	0	0	1	1

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Appreciate various design process procedure.
- CO2:** Generate and develop design ideas through different technique.
- CO3:** Identify the significance of reverse Engineering to Understand products.
- CO4:** Draw technical drawing for design ideas.
- CO5:** Illustrate design teams to create feasible and user-focused solutions to complex problems in design.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1								2	2		
CO2										2	
CO3										3	
CO4								1	1	2	
CO5										3	

UNIT – I

Process of Design Understanding Design thinking: Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

UNIT – II

Tools for Design Thinking: Real-Time design interaction capture and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design.

UNIT – III

Design Thinking in IT: Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping.

UNIT – IV

DT For strategic innovations: Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design.

UNIT – V

Design thinking workshop: Design Thinking Work shop Empathize, Design, Ideate, Prototype and Test.

Text Books:

1. Engineering Design by John. R. Karsnitz, Stephen O'Brien and John P. Hutchinson, Cengage learning (International edition) Second Edition, ISBN: 9781133708766.
2. The Design of Business: Why Design Thinking is the Next Competitive Advantage Roger Martin by Harvard Business Press, ISBN: 9781422177808

Reference Books:

1. Engineering Design Process by Yousef Haik and Tamer M.Shahin, Cengage Learning, Second Edition, ISBN: 978-8131529041.
2. Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author), ISBN: 978-0231163569.

Web Links:

1. www.tuto2.u.net/business/presentations/. /Product lifecycle/default.html
2. https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf

Universal Human Values

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code: 241UC008	2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Make use of Self-exploration, Continuous Happiness & prosperity, Right understanding and Relationship to live in Harmony principles at all levels.
- CO2:** Explore the Harmony in the Human-being and Harmony in Self.
- CO3:** Interpret the Harmony in the Family and Society & Harmony in Human-Human relationship using Justice, Truth, Respect, Prosperity and Co-existence.
- CO4:** Appraise the Harmony in Nature and Existence using Interconnectedness & mutual fulfilment, Co-existence and Holistic perception of harmony at all levels of existence.
- CO5:** Apply the principles of Holistic understanding of Harmony in Professional Ethics to improve Competence.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1						2	2	1	1		1
CO2						2	2	1	1		1
CO3						2	2	1	1		1
CO4						2	2	1	1		1
CO5						2	2	1	1		1

UNIT – I

Course Introduction-Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal Human Values.
- Self-Exploration–what is it ? -Its content and process; Personality Traits- Self Excellence, 'Natural Acceptance' and Experiential Validation- as the process for self-exploration, Adaptability, Belief and Understanding-Self Discipline.
- Continuous Happiness and Prosperity-A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility-the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly-A critical appraisal of the current scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.
- Myers-Briggs Type Indicator (MBTI) Personality test.

UNIT – II

Understanding Harmony in the Human Being-Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)- Habits and Hobbies, SWOT Analysis (Activity)
4. Understanding the characteristics and activities of „I“ and harmony in 'I' –Dalai Lamas“ Tibetan Personality Test – Dr. Menninger“s Psychometric Test.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.
7. Epidemiology- Definition of health, Social and Preventive Medicine, Personal hygiene and handling stress, WHO Guidelines

UNIT – III

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Friends and Foes, Empathy, False Prestige.
4. Concept of an Ideal family-Marriage as an Institution
5. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
6. Visualizing a universal harmonious order in society-Undivided Society, Universal Human Order- from family to world family.

UNIT – IV

Understanding Harmony in the Nature and Existence -Whole Existence as Coexistence

1. Understanding the harmony in the Nature and its Equanimity, Respect for all, Nature as Teacher.
2. Interconnectedness and mutual fulfilment among the four orders nature-recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. A Holistic perception of harmony at all levels of existence.

UNIT – V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values.
2. Definitiveness of Ethical Human Conduct.
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems.
6. Vision for the Holistical alternatives, UHVs for entrepreneurship
7. Strategy for transition from the present state to Universal Human Order:
 - a. At the level of individual: associatively and ecologically responsible engineers, technologists and managers.
 - b. At the level of society: as mutually enriching institutions and organizations – Right understanding and dilemmas of professional ethics in today's world.

Text Books:

1. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, ISBN No: 812-2415660, 978-8122415667.
2. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, ISBN No: 978-8174467812, 978-8174467812.

Reference Books:

1. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi , ISBN No: 978-8172290063
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, ISBN No: 8172290061
3. India Wins Freedom - Maulana Abdul Kalam Azad, ISBN: 9789355496218.

Weblinks:

https://www.youtube.com/watch?v=OgdNx0X923I&list=PLYwzG2fd7hzc4HerTNkc3pS_IvcCfKzn

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC021	PCB Design	FC			2	2	50	50	100	-
241EC094	Soft Computing Tools	IC			2	2	50	50	100	-
241CS072	Object Oriented Programming through JAVA	AC			2	2	50	50	100	-
241EC016	ECAD Tools	AC			2	2	50	50	100	VLSI
241EC017	Verification using Verilog & UVM	AC			2	2	50	50	100	VLSI
Total					10	10				

Skill Enhancement Courses (SEC)

PCB Design

Course Code: 241EC021

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the equipment and components used in PCB design.
- CO2:** Apply the procedural steps for PCB preparation.
- CO3:** Make use of chemicals for Etching process.
- CO4:** Make use of Soldering gun for components mounting.
- CO5:** Construct PCB for different circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2						2	2		1
CO2	2	2						2	2		1
CO3	2	2						2	2		1
CO4	2	2						2	2		1
CO5	2	2	2					2	2		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		1
CO2		1
CO3		1
CO4		1
CO5		1

Practice:

1. Study of lab equipments and components:
 - a) CRO
 - b) Multimeter
 - c) Function Generator
 - d) Power supply
 - e) Active Components
 - f) Passive Components
 - g) Bread Board
 - h) Soldering gun.
2. Preparation of layout and artwork layout planning.
 - a) Layout Planning
 - b) General Artwork rules
 - c) Components Polarity Identification

3. Preparation of Negative from the film.
 - a) Artwork
 - b) Exposure time
 - c) Development
 - d) Stop bath
 - e) Fixing bath
 - f) Film washing
 - g) Drying
4. Principle of a simple PCB.
 - a) Laminate cleaning
 - b) Laminate coating
 - c) Thinner
 - d) Prefacing
 - e) Exposer
 - f) Development
 - g) Washing
 - h) Drying the Image
 - i) Post Curing
5. Etching and Drilling of PCB.
 - a) Etching
 - b) drilling
6. Preparation and mounting components.
 - a) Component lead preparation
 - b) Component mounting
 - c) Soldering
7. PCB preparation of Simple diode circuits
 - a) Diode as a switch
 - b) Bridge rectifier
8. PCB preparation of Simple transistor circuits
 - a) Transistor as a switch
 - b) Single stage CE amplifier
9. PCB preparation of Simple IC based circuits
 - a) Voltage Regulator using IC 78XX and IC 79XX
10. PCB preparation of IC based circuits
 - a) Summing circuit using Op-Amp
 - b) Astable multivibrator circuit using IC 555 timer
 - c) PLL circuit using IC 565

Reference Books:

1. Printed Circuits Handbook, Clyde F. Coombs Jr., Happy T. Holden, Seventh Edition, McGraw Hill publications, ISBN: 978-0071833950.
2. PCB Design and Layout Fundamentals for EMC, Roger Hu, 2019, ISBN: 978-1082079252.
3. The Hitchhiker's Guide to PCB Design, David Ruff, Mike Brown, Cadence Documents, ISBN: 978-0368246968.

Web Links:

1. <http://www.nptelvideos.com/lecture.php?id=14721> by Prof. Santhanu Bhattacharya, IIT, Kanpur

Soft Computing Tools

Course Code: 241EC094

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Perform basic matrix operations and random data manipulation using MATLAB.
- CO2:** Make use of MATLAB to generate Gaussian noise and compute its basic statistical measures.
- CO3:** Design filters with the help of Simulink toolbox.
- CO4:** Apply the concepts of convolution and filters to remove noise.
- CO5:** Utilize the Fuzzy tool box to perform different operations

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2			2	2		1
CO2	2	2			2			2	2		1
CO3	2	2			2			2	2		1
CO4	2	2			2			2	2		1
CO5	2	2			2			2	2		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	1	
CO4	2	
CO5	1	

Practice:

1. Create a 10x10 random matrix with the command `A= rand (10)`. Now do the following operations.
 - a. Multiply all elements by 100 and then round off all elements of the matrix to integers with the command `A=fix(A)`.
 - b. Replace all elements of $A < 10$ with Zeros.
 - c. Replace all elements of $A > 90$ with infinity (int).
 - d. Extract all $30 \leq a_{ij} \leq 50$ in a vector b, that is find all elements between 30 and 50 and put them in a vector b.
2. Generation of Gaussian noise (Real and Complex), Computation of its mean, Variance, Mean Square Value and Probability Distribution Function.
3. Removal of noise by Autocorrelation / Cross correlation.

4. Removal of noise by Filters (Wiener/LMS).
5. Introduction to Simulink toolbox
6. Design of Filters using Simulink (LPF, HPF, BPF, BRF)
7. Introduction to Fuzzy Logic toolbox
8. Write a program in MATLAB to perform Union, Intersection and Complement operations.
9. Write a program using Fuzzy Logic to perform arithmetic and Logic Operations
10. Write a program in MATLAB to implement De-Morgan's Law.
11. Write a program in MATLAB to plot various membership functions.
12. Implement Fuzzy Inference System (FIS)

Additional Practice:

1. Identify a relevant problem in your domain and develop an appropriate solution using the Simulink toolbox, applying the knowledge you have gained so far.
2. Identify a relevant problem in your domain and develop an appropriate solution using the Fuzzy Logic toolbox, applying the knowledge you have gained so far.

Web Links:

1. [Soft Computing Tools in Engineering \(iitkgp.ac.in\)](http://iitkgp.ac.in)

Object Oriented Programming through JAVA (ECE)

Course Code: 241CS072

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Develop Java programs using basic programming constructs.
- CO2:** Apply object-oriented concepts to design Java applications.
- CO3:** Implement inheritance and polymorphism in Java programs.
- CO4:** Use packages and file handling techniques in Java applications.
- CO5:** Develop Java programs using exception handling and multithreading concepts.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	-	1	-	-	-	-	-	-
CO2	2	2	1	-	1	-	-	-	-	-	-
CO3	2	2	1	-	1	-	-	-	-	-	-
CO4	1	2	1	1	2	-	-	-	-	-	-
CO5	2	2	1	1	2	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	2	-
CO5	2	-

UNIT-1

Java Fundamentals and Problem Solving: Introduction to Java, Features of Java, Java Program Structure, Data Types, Variables, Operators, Control Statements, Arrays.

1. Write a Java program to check whether a given number is an Armstrong Number.
2. Write a Java program to generate the Fibonacci series up to N terms.
3. Write a Java program to sort the elements of an array in ascending order.
4. Write a Java program to find the second largest element in an array.
5. Write a Java program to remove duplicate elements from an array.

UNIT-2

Classes, Objects and Strings: Classes and Objects, Methods, Constructors, Constructor Overloading, Method Overloading, this, static, final, String class and its methods

1. Write a Java program to create a Student class and display student details using constructors.
2. Write a Java program to demonstrate constructor overloading.
3. Write a Java program to implement method overloading for adding values of different data types and varying numbers of arguments.
4. Write a Java program to check whether a given string is an anagram.
5. Write a Java program to check whether a given string is a pangram using String methods.

UNIT-3

Inheritance and Polymorphism: Inheritance, Types of Inheritance, super keyword, Method Overriding, Abstract Classes, Dynamic Method Dispatch, Interfaces.

1. Write a Java program to demonstrate single inheritance using Student and Result classes.
2. Write a Java program to demonstrate multilevel inheritance.
3. Write a Java program to calculate the area of different shapes using abstract classes.
4. Write a Java program to demonstrate runtime polymorphism using method overriding.
5. Write a Java program to demonstrate multiple inheritance using interfaces.

UNIT-4

Packages, File Handling : Packages, Access Specifiers, Wrapper Classes, File Handling (FileReader, FileWriter, BufferedReader, BufferedWriter)

1. Write a Java program to create and use a user-defined package.
2. Write a Java program to demonstrate the use of Wrapper Classes by converting primitive data types into wrapper objects and vice versa.
3. Write a Java program to read data from one file and write it into another file.
4. Write a Java program to count the number of characters, words, and lines in a text file.
5. Write a Java program to store even numbers in Even.txt and odd numbers in Odd.txt.

UNIT-5

Exception Handling and Multithreading: Exception Handling (try, catch, throw, throws, finally), User-defined Exceptions, Thread Life Cycle, Thread Creation, Synchronization, Inter-thread Communication.

1. Write a Java program to demonstrate multiple catch blocks in exception handling.
2. Write a Java program to create and use a user-defined exception.
3. Write a Java program to create threads by extending the Thread class.
4. Write a Java program to create threads by implementing the Runnable interface.
5. Write a Java program to solve the Producer–Consumer problem using synchronization.

Additional Practice:

1. Write a Java program to create a Calculator using methods to perform addition, subtraction, multiplication, and division.
2. Write a Java program to implement a simple Banking System using classes to perform deposit, withdrawal, and balance enquiry operations.
3. Write a Java program to maintain a Student Record System that allows adding student details and displaying the topper based on marks.
4. Write a Java program to implement a Phone Book Application that allows users to add, search, update, and delete contact details.

Reference Books:

1. The Complete Reference Java, Herbert Schildt, TMH ,8th Edition,ISBN 978-1260440232.
2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition.ISBN: 9780199459643.
3. Introduction to java programming, by Y Daniel Liang, Seventh Edition, Pearson. ISBN: 978-8131729588
4. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press.ISBN:978-9351199250

Web Links:

- 1 <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf>
- 2 <https://nptel.ac.in/courses/106/105/106105191/>
- 3 <http://java.sun.com/docs/books/tutorial/>

ECAD Tools**L T P C**

Course Code: 241EC016
0 0 2 2
Course Outcomes:
At the end of the course, student will be able to:

- CO1:** Comprehend the insight of CAD Tools in modern design.
- CO2:** Develop combinational logic circuits by using CAD tools.
- CO3:** Build sequential logic circuits using Verilog HDL operators.
- CO4:** Analyze the performance of logic schematics using CAD simulation tools.
- CO5:** Infer the performance of logic circuits using DRC, LVS and PEX.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1			2			1	1		1
CO2	3	2			2			1	1		1
CO3	2	2			2			1	1		1
CO4	3	2			2			1	1		1
CO5	3	2			2			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

Practice:

- Understanding the working platform with Xilinx Vivado and its device, family and
 - package Selection.
- Design and Implementation of Combinational Circuits Priority Encoder and Comparator using data flow & structural style.
- Design and Implementation of Sequential Circuits to detect a given sequence using with and without overlapping (mealy & Moore machines).
- Design and Implementation of a traffic light controller in a three road & four road junctions.
- Exercise on Concatenation, Replication operators, Reduction and Conditional operators in Verilog HDL.
- Plotting the (i) output characteristics (ii) Transfer characteristics of an n-channel and p-channel MOSFET with Cadence.
- Working with Schematic for Ring Oscillator with variable amounts of Pull up to pull down ratios.
- Design a full adder by instantiating the logic gates. Make a comment on design style on its performance.

9. Design a NAND gate by using NMOS, PMOS and CMOS technologies and make a comment on its performance.
10. Design a layout for given logic and test for its DRC, LVS and PEX. Make a note on change in propagation delay with respect to PEX data.

Additional Practice:

3. Design and plot the characteristics of a 4x1 digital multiplexer using pass transistor logic and TG logic.
4. Design and plot the characteristics of a positive and negative latch based on multiplexers

Text Books:

1. CMOS Digital Integrated Circuits : Analysis and Design, S. M. Kang and Y. Leblebici, McGraw-Hill Education, 3rd Edition, ISBN: 978-0071243421.
2. Silicon VLSI Technology: Fundamentals, Practice & Modeling, James D. Plummer, Micheal Deal , Peter B. Griffin, Pearson India, 1st Edition, ISBN: 978-0130850379.

Reference Books:

1. Microchip Fabrication: A Practical Guide to Semiconductor Processing, Peter Van Zant, McGraw-Hill Professional, 6th Edition, ISBN: 978-0071821018.
2. CMOS Circuit Design, Layout and Simulation, R. Jacob Baker, Wiley-IEEE Press, 4th Edition, ISBN: 978-0780334168.
3. J. M. Rabaey, A. P. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson Education India, 2nd Edition, ISBN: 978-9332573925.

Web Links:

1. https://www.cadence.com/en_US/home/company/cadence-academic-network/educators/vlsi-fundamentals.html, Cadence Design Systems.
2. <https://www.xilinx.com/video/hardware/getting-started-vivado-high-level-synthesis.html> , Xilinx Vivado High Level Synthesis.
3. https://onlinecourses.nptel.ac.in/noc23_ee137/preview. Prof. Sneha Saurabh, IIIT Delhi.

Verification Using Verilog & UVM

Course Code: 241EC017

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Develop Basic Testbench using UVM.
- CO2:** Apply assertion based and Coverage – Driven verification techniques to the testbench.
- CO3:** Implement Functional Coverage models and verify complex protocols like AXI, PLle etc.,
- CO4:** Implement TLM interfaces for communication and advanced constrained Networks.
- CO5:** Verify designs using multiple interfaces and mixed signals.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1			2			1	1		1
CO2	3	2			2			1	1		1
CO3	2	2			2			1	1		1
CO4	3	2			2			1	1		1
CO5	3	2			2			1	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

Practice:

1. Basic Testbench:
 - a. Develop a simple Verilog testbench to simulate a digital design.
 - b. Create stimuli and check responses manually.
2. Basic UVM Testbench
 - a. Develop a simple UVM testbench framework.
 - b. Implement basic UVM components: env, agent, driver, sequencer, and monitor.
3. Stimulus Generation:
 - a. Use UVM sequences to generate stimuli.
 - b. Create constrained random test cases.
4. Score boarding:

- a. Implement a scoreboard in UVM to compare expected vs. actual results.
 - b. Use functional coverage to track verification progress.
- 5. Assertion-Based Verification:
 - a. Write System Verilog assertions to check protocol compliance.
 - b. Integrate assertions into a UVM testbench.
- 6. Coverage-Driven Verification:
 - a. Develop coverage models using cover groups and cover points.
 - b. Analyse coverage results to identify untested scenarios.
- 7. VIP Integration:
 - a. Integrate UVM Verification IP (VIP) into the testbench.
 - b. Verify complex protocols like AXI, PCIe, etc.
- 8. Functional Coverage:
 - a. Define and implement functional coverage models.
 - b. Analyse coverage data to ensure all design functionalities are tested.
- 9. Reusable UVM Components:
 - a. Create reusable UVM components for different testbenches.
 - b. Parameterize components for flexibility.
- 10. Transaction-Level Modelling (TLM):
 - a. Implement TLM interfaces for communication between UVM components.
 - b. Use TLM for high-level transaction Modelling.
- 11. Advanced Stimulus Generation:
 - a. Implement advanced constrained random techniques.
 - b. Use UVM sequences to control stimulus generation dynamically.
- 12. Debugging and Logging:
 - a. Utilize UVM reporting mechanisms for debugging.
 - b. Implement custom error and status messages.

Additional Practice:

- 1. Multiple Interface Verification:
 - a) Verify designs with multiple interfaces.
 - b) Develop agents and drivers for each interface.
- 2. Mixed-Signal Verification:
 - a) Integrate Analog models with digital testbenches.
 - b) Use Real-number modelling (RNM) techniques.
- 3. Performance and Timing Verification:
 - a) Measure and verify timing constraints.
 - b) Use UVM to simulate and check timing behaviours
- 4. Interoperability Testing:
 - a) Test interoperability between different modules or IP blocks.
 - b) Use UVM to create complex test scenarios.

Text Books:

1. A Practical Guide to Adopting the Universal Verification Methodology (UVM) Second Edition, ISBN: 978-1300535935.
2. The UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology by Ray Salemi, ISBN: 978-0974164939.

Reference Books:

1. A Practical Guide for System Verilog Assertions by Srikanth Vijayaraghavan & Meyyappan Ramanathan, ISBN: 978-1489992796.
2. Getting Started with UVM: A Beginner's Guide by Vanessa R. Coppe, ISBN: 978-0615819976.

Web Links:

1. https://www.cadence.com/en_US/home/training/all-courses/86070.html
2. <https://www.chipverify.com/tutorials/uvm>
3. <https://verificationacademy.com/forums/t/systemverilog-or-uvm/39566>

Value Added Courses (VAC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241UC010	Indian Cultural Heritage & Fine Arts	FC			1	1	100	-	100	-
241PE001	Sports & Yoga	FC			1	1	100	-	100	-
241CS004	Internet of Things	FC			1	1	100	-	100	-
241CS002	Data Analysis Using Python	IC			2	2	50	50	100	-
241UC011	Employability Skills-I	FC			3	0	100	-	100	-
241UC013	Employability Skills-II	FC			3	0	100	-	100	ES-I
241UC014	Employability Skills-III	IC			3	0	100	-	100	ES-II
241UC015	Employability Skills-IV	IC			3	0	100	-	100	ES-III
241UC016	Employability Skills-V	AC			3	1	100	-	100	ES-IV
Total					20	6				

Value Added Courses (VAC)

INDIAN CULTURAL HERITAGE AND FINE ARTS

(Common to all branches Except Ag. E)

I Semester	L	T	P	C
Course Code: 241UC010	0	0	1	1

Course Outcomes: At the end of the course, students will be able to:

CO1: Apply Communication Skills by participating in various language learning activities on Indian Cultural Heritage.

CO2: Develop cultural understanding and prepare for intercultural citizenship by different activities like role play, drawing, painting etc.

CO3: Describe the different horizons in the field of art and design, skilful use of elements and principles of graphic design.

CO4: Demonstrate their talent using instruments, dance, singing, seminar etc., related to Indian culture

CO5: Recall facts and basic concepts of Indian culture through article writing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	1	1	2	-	-
CO2	-	-	-	-	-	-	1	1	2	-	-
CO3	-	-	-	-	-	-	1	1	1	-	-
CO4	-	-	-	-	-	-	1	1	1	-	1
CO5	-	-	-	-	-	-	1	1	1	-	1

Practice:

1. JAM(Just a Minute) Sessions on Indian Cultural Heritage (Speaking):

Explain the importance of JAM sessions and their format.

Activities:

Just a Minute: Each student gets 1 minute to speak on a randomly assigned topic related to Indian cultural heritage.

Topics: Ancient Indian civilization, Indus Valley, Mauryan empires, Gupta empires

2. Role-plays on Indian Itihasas and Puranas:

Overview of Indian Itihasas (Ramayana, Mahabharata) and Puranas

Activities:

Preparation: Assign roles and prepare short scripts.

Role-plays: Students perform their role-plays

Topics: Ramayana, Mahabharata, Vishnu Purana, Shiva Purana, Skanda Purana

3. Painting: Competition on ancient Indian Architectures and civilizations:

Brief on ancient Indian architectures and civilizations

Activities:

Painting Activity: Students create paintings based on the theme.

Topics: Temple Architecture (Nagara, Dravidian, Vesara), Mughal Architecture (TajMahal, Fathepur Sikhri, Humayun's Tomb)

Exhibition: Display paintings related to ancient Indian architectures and civilizations.

4. Talent shows in singing patriotic songs

Explain the format and purpose of the talent show on patriotic songs.

Activities:

Talent Performances: Students present their talent (Singing).

Topics: Patriotic songs

5. Story Narration about Ancient Historical Issues.

Importance of storytelling in preserving history

Activities:

Story Narration: Students narrate stories on assigned ancient historical issues.

Topics: Hinduism (Festivals and Temples), Buddhism Spread and Impact in Asia), Jainism (Philosophy of Non-violence, Sikhism (Teaching of the Gurus)

6. Poster Presentations on Epics, Puranas and Architecture of the Indian Temple.

Guidelines for creating effective posters on Epics, Puranas and Architecture of the Indian Temple

Activities:

Preparation: Students create posters on assigned topics.

Presentations: Students present their posters.

Topics: Temple Architecture and Sculpture (Iconography, Dravidian, Nagara, Vesara)

7. Seminars on the importance and significance of our Indian Culture. (Speaking)

Importance of seminars and public speaking tips on our Indian Culture

Activities:

Seminars: Students deliver seminars on assigned topics.

Topics: Indian Classical Dance, Indian Music traditions, Indian festivals and Fine arts, Indian Handicrafts

8. A. Craft works- Displaying different models of architectures, Overview of different Indian architectural styles

B. Musical instruments: Performance of the talent in playing different musical instruments, Introduction to various Indian musical instruments

C. Dancing: Performance on various dance forms of Indian culture, Brief on various Indian dance forms of Indian culture

Activities:

Craft Activity: Students create and display models of architectures.

Exhibition: Display and discuss the craft works.

Performances: Students performs using different instruments.

Appreciation & Discussion: Acknowledge performances and discuss instruments.

Performances: Students perform different dance forms.

Topics: Indian Handicrafts, Musical Instruments (Veena, Sitar, Tabla, Mridangam),
Indian Classical Dance (Bharathanatyam, Kuchipudi, Kathakhali, Khathak, Odissi)
(**Note:** Students can choose either Craft works, Musical instruments or dancing activities)

9. Drawing: Theme based art on Indian Religious Traditions.

Overview of drawing techniques and themes on Indian Religious Traditions

Activities:

Drawing Activity: Students create drawings based on historical themes.

Topics: Rituals, Festivals and Temples (Hinduism, Buddhism, Jainism, Sikhism etc.)

Exhibition: Display drawings and provide feedback.

10. Article Writing: On Indian Ancient Period/Heritage and Culture.(Writing)

Guidelines for writing informative articles on Indian Ancient Period / Heritage and Culture

Activities:

Topics: Indian Culture, Indian art architecture and monuments, Indian Civilization, Indian Philosophy, Indian religious Traditions

Writing Activity: Students write articles on assigned topics.

Reference Books:

1. History of India and Culture (Upto 1964)-Telugu Academy, ISBN-13: 978-8181804341/ISBN-10: 8181804341
2. R.S. Sharma., Ancient India, New Delhi, 1996, ISBN-13: 978-0-19-568785-9/ISBN-10: 0-19-568785-X
3. D.D. Kosambi, the Culture and Civilization of Ancient India in Historical Outline, Vikas Publishing, 1965, ISBN-1000653471, ISBN-9781000653472
4. V. Rama Krishna, Social Reform Movement Andhra, Vikas Publications, ISBN-0706923499, ISBN-9780706923490
5. Romila Thapar., History of India, Penguin, 1965, ISBN: 978-0-14-194976-5

Evaluation Guidelines:

- Each activity carries 10 marks for day to day assessment.
- The Continuous evaluation will be awarded based on day to day performances.

Sports & Yoga
(CE, EEE, ME, ECE, CSE, IT, AIML, CSE (DS), PT, Min. E)

Course Code: 241PE001

L	T	P	C
0	0	1	1

Course Objectives:

The main objective of introducing this course is to make the students understand the importance of sound health and fitness principles as they relate to better health.

Course Outcomes:

After completion of the course the student will be able to:

CO1: Identify their physical and mental health, including their concentration, motivation, and productivity

CO2: Demonstrate the need for health-related fitness requirements.

CO3: Develop an appreciation of physical activity as a lifetime pursuit and a means to better health.

CO4: Apply current personal fitness levels in their day-to-day lifestyle.

CO5: Recall specific facts about safety measurements, and efficiently use the techniques to minimize the risk of injury

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	-	-	-	-	1
CO2	-	-	-	-	-	-	-	-	-	-	1
CO3	-	-	-	-	-	-	-	-	-	-	1
CO4	-	-	-	-	-	-	-	-	-	-	1
CO5	-	-	-	-	-	-	-	-	-	-	1

Practice:

1. a) B.M.I (Measurement and BMI Chart Preparation)

- Height
- Weight
- Age

Activities:

- Students are informed to find out BMI for any 5 members of different age groups.

b) AAHPER Fitness Test (American Alliance for Health, Physical Education and Recreation)

Category 1	Category 2
50mts	Pull Ups
Standing Broad Jump	Sit-ups
Shuttle Run	600 Mts

Activities:

- Students are informed to find out BMI for any 5 members of different age groups.
- Students are instructed to perform all activities under Category-I (or) II

2. Surya Namaskar

- **Pranamasana (Prayer Pose)**
- **Hasta Uttanasana (Raised Arms Pose)**
- **Hasta Padasana (Hand to Foot Pose)**
- **Ashwa Sanchalanasana (Equestrian Pose)**
- **Dandasana (Stick Pose)**
- **Ashtanga Namaskara (Salute with Eight Parts or Points)**
- **Bhujangasana (Cobra Pose)**
- **Parvatasana (Mountain Pose)**
- **Ashwa Sanchalanasana (Equestrian Pose)**
- **Hasta Padasana (Hand to Foot Pose)**
- **Hasta Uttanasana (Raised Arms Pose)**
- **Pranamasana (Prayer Pose)**

Activities:

- Students are given practice on all Surya Namaskar Asanas.
- Students must participate and perform any 2 or 3 Surya Namaskar Asanas

3. Asanas

- Standing Asanas
- Sitting Asanas
- Supine Postures
- Prone Asanas

Activities:

- Students are given practice on all above Asanas.
- Students must participate and perform any 2 Asanas.

4. CPR (Cardiopulmonary resuscitation)**Activities:**

- Practical demo session on CPR by a healthcare professional.
- Quiz is conducted on the above topic.

5. Games Activities

- Kabaddi
- Volleyball
- Basketball
- Tennikoit
- Badminton
- Hand ball
- Kho Kho

Activities:

- Practice is given in all the above major games.
- Students must participate and perform in any one major game.

6. JCR Test (Jumping, Chinning, Running)

- 100mts-(Shuttle Run)
- Vertical Jump
- Chin up

Activities:

- Practice is given in all the above.
- Students must participate and perform in anyone activity.

7. Kriyas

- Dhouti,
- Bastirika
- Neti,
- Navali
- Kapalabati
- Trataka
- Nauli

Activities:

- Practice is given in all the above Kriyas.
- Students must participate and perform in any two Kriya's.

8. Sports Activities: (Athletics Throws & Jumps)

- Shotput
- Discuss
- Long jump

Activities:

- Practice is given in all the above Sports activities.
- Students must participate and perform in any one activity.

9. Pranayama

- **Nadi Shodhana (Alternate Nostril Breathing)**
- **Ujjayi Pranayama (Victorious Breath)**
- **Kapalabhati (Skull Shining Breath)**
- **Bhastrika Pranayama (Bellows Breath)**
- **Sheetali Pranayama (Cooling Breath)**
- **Sheetkari Pranayama (Hissing Breath)**
- **Bhramari Pranayama (Bee Breath)**
- **Sitali Pranayama (Cooling Breath)**

Activities:

- Practice is given in all the above Pranayama's.
- Students must practice and perform any 2 Pranayama's.

10. Sports Activities :(Athletics-Runs)

- 100Mts
- 400Mts
- 5000Mts

Activities:

- Practice is given in all the above activities.
- Students must practice and perform any 1 activity.

Reference Books:

1. Health & Wellness, Yoga Education, Sports and Fitness-S.Chand Publication-2024. ISBN: 9789358704372
2. Health and Wellness, Gordon Edlin, Eric Golanty. 14th Edn. Jones & Bartlett Learning 2022 ISBN: 978-1284235197
3. First Aid- Dr.Rajeev Sharma. ISBN: 9788171826933
4. Health and Fitness-Bharani Publications. ISBN: 978-0880115995
5. The Sports Rules Gordon Edlin, Eric Golanty. / Human Kinetics with Thomas Hanlon. -- 3rd ed. HumanKinetics, Inc.
6. A Text book Yoga-Dr.Guneet Monga Bhargava Richa Talreja

General Guidelines:

- Participation in all activities is mandatory.
- Students should carry proper sports dress to carry out Yoga Practice and regular Sports activities.

Evaluation Guidelines:

- The Continuous Internal Evaluation for this course is 100 marks.
- Each activity shall be evaluated by the concerned teacher for 10 marks as day-to-day performance. For 10 activities the students will be evaluated for 100 marks.

Internet of Things

(Common to EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 241CS004

L	T	P	C
0	0	1	1

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Choose the sensors and actuators for an IoT application.
- CO2:** Select protocols for a specific IoT application.
- CO3:** Utilize the cloud platform and APIs for IoT application.
- CO4:** Experiment with embedded boards for creating IoT prototypes.
- CO5:** Design a solution for a given IoT application.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			1						
CO2	1	2	1								
CO3	1	1	2	1							
CO4	1	2			1						1
CO5	1	2	2	1	2			1	1		1

Practice:

1. Study of active and passive sensors: Light, Temperature and Humidity, Force, Pressure, Speed, Sound etc.
2. Study of Arduino, Raspberry Pi, Beagle Bone
3. Select any one development board (Ex. Arduino or Raspberry Pi) to control LED and motor
4. Demonstrate the working of temperature and humidity sensor, level sensor, moisture sensor, distance sensor.
5. Using the same board as in (3), read data from a sensor. Experiment with both analog and digital sensors.
6. Write a program to Control any two actuators connected to the development board using Bluetooth.
7. Implement Socket communication to Read data from sensor and send it to a requesting client.
8. Create any cloud platform account, explore IoT services and register a thing on the platform.
9. Write a program to push sensor data to cloud.
10. Write a program to Control an actuator through cloud.

11. Access the data pushed from sensor to cloud and applies any data analytics or visualization services.
12. Identify a problem in your local area or college which can be solved by integrating the things you learned so far and create a prototype to solve it (Mini Project).

Additional Practice:

1. **Lighting as a service:** Smart Lightening for smart homes and smart cities helps in saving energy by adapting the lighting to ambient conditions and switching on/off or dimming the lights when needed.
Simulate the energy savings environment with LED lights or IP enabled lights or anyother variants by monitoring human movements and their environments and controlling the lights accordingly.
2. **Intelligent Traffic systems:** Smart cities have vital aspects in relation with sub domains like smart parking, surveillance, emergency response and many more.
Among all, smart traffic systems or intelligent traffic systems are one such criticalinfrastructure needed.
Design an automated environment that controls vehicle traffic on busy roads. Alsoinclude the emergency control and response mechanisms (like ambulance) at signalposts.
3. **Smart Parking:** Finding a parking space during rush hours in crowded cities can be time consuming and frustrating.
Design a prototype smart parking system based on sensor technology with anyone ofthe following features: Space allocation or remote parking monitoring or automatedguidance.
4. **Air Pollution Monitoring:** IoT based air pollution monitoring systems can monitor emission of harmful gases like CO₂, CO, NO etc by factories and automobiles.
Simulate an environment with help of any gaseous or meteorological sensors thatchecks level of gases in the air and specify whether it is dangerous or not.

Reference Books:

1. An Introduction to Internet of Things, Connecting devices, Edge Gateway and Cloud with Applications, Rahul Dubey, Cengage, 2019, ISBN: 9789353501020.
2. Adrian McEwen, Designing the Internet of Things, Wiley Publishers, ISBN: 978-1118430620.
3. IoT Fundamentals, Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetette, rob Barton, Jerome Henry, CISCO, Pearson, 2018, ISBN: 9789386873743.
4. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley, ISBN: 978-1-118-43065-1.

5. Internet of Things by Vengalapudi Appala konda, prof.Sangareddy, B.Krutakoti from Scientific International Publishing House, First Edition 2024, ISBN: 978-93-6132-958-6.

Web Links:

1. <https://iotify.io/iot-virtual-lab/>
2. https://onlinecourses.nptel.ac.in/noc18_cs46/preview
3. <https://www.electronicsforu.com/electronics-projects/internet-of-things-iot>
4. <https://www.coursera.org/specializations/iot>
5. <http://ledworldmag.com/issue/iot-lighting-ecosystem-making/>
6. <https://www.edureka.co/iot-certification-training>

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 241CS002

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Make use of control statements and data structures to solve problems
- CO2:** Apply OOPs concepts and files to develop applications.
- CO3:** Explain the data collection, management and storage for processing using Numpy
- CO4:** Make use of Pandas to create and manipulate data structures like Series and DataFrames.
- CO5:** Create plots using Matplotlib library for better visualization.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1		2			1	1		1
CO2	1	2	3		2			1	1		1
CO3	1	3	2		2			1	1		1
CO4	1	2	3		2			1	1		1
CO5	1	2	3		2			1	1		1

UNIT-I

Introduction:

History of Python, Applications of Python, Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation, Operators and Expressions, Control Flow- if, if-elif-else, for, while, break, continue, Data Structures Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions, Defining Functions, Calling Functions, Passing Arguments.

- 1.1) Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
- 1.2) Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
- 1.3) Split a string into array of characters in Python.
- 1.4) write a Python program to get the largest number from a list.
- 1.5) Write a Python program to calculate the nth Fibonacci number using a function.

UNIT -II

Object Oriented Programming:

Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using OOPS support Design with Classes: Objects and Classes, Data modeling Examples, Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, Userdefined Exceptions.

- 2.1) Write a Python program that defines a Car class with attributes like make, model, and year, and methods like start() to start the car and stop() to stop it.
- 2.2) Write a Python program that demonstrates inheritance by creating a base class Animal and derived classes like Dog, Cat, etc., each with their specific behaviors.
- 2.3) Define a base class called Animal with a method make_sound(). Implement derived classes like Dog, Cat, and Bird that override the make_sound() method to produce different sounds. Demonstrate polymorphism by calling the method on objects of different classes.
- 2.4) Write a Python program that demonstrates error handling using the try-except block to handle division by zero.

UNIT -III

Numpy:

Introduction to numpy, creating arrays, using arrays and scalars, Indexing Arrays, Array transposition, Universal array function, Array Processing, Array Input and Output, Examples.

- 3.1) Write a NumPy program using methods – info, add, array, all, greater, greater_equal, less and less_equal, equal, allclose, zeros, ones, linspace, tolist.
 - a. To get help on the add function
 - b. To test whether none of the elements of a given array is zero.
 - c. To create an element-wise comparison (greater, greater_equal, less and less_equal, equal, equal within a tolerance) of two given arrays.
- 3.2) Write a NumPy program using NumPy methods - max, min, argmax, argmin, argmax, repr, count, bincount, unique.
 - a. To extract all numbers from a given array which are less and greater than a specified number.
 - b. To find the indices of the maximum and minimum numbers along the given axis of an array.

UNIT -IV

Pandas:

Exploring Data using Series, Exploring Data using DataFrames, Index objects, Re index, Drop Entry, Selecting Entries, Data Alignment, Rank and Sort, Summary Statistics, Data Munging in Python using Pandas, Index Hierarchy, Example Problem.

4.1) Pandas DataSeries:

- i) Write a Pandas program to create and display a one-dimensional array-like object containing an array of data using Pandas module.
- ii) Write a Pandas program to convert a Panda module Series to Python list and its type.

4.2) Pandas DataFrames:

Consider Sample Python dictionary data and list labels:

```
exam_data = {'name': ['Anastasia', 'Dima', 'Katherine', 'James', 'Emily', 'Michael', 'Matthew', 'Laura', 'Kevin', 'Jonas'],
'score': [12.5, 9, 16.5, np.nan, 9, 20, 14.5, np.nan, 8, 19],
'attempts': [1, 3, 2, 3, 2, 3, 1, 1, 2, 1],
'qualify': ['yes', 'no', 'yes', 'no', 'no', 'yes', 'yes', 'no', 'no', 'yes']}
labels = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j']
```

- i) Write a Pandas program to create and display a Data Frame from a specified dictionary data which has the index labels.
- ii) Write a Pandas program to change the name 'James' to 'Suresh' in name column of the Data Frame.

- iii) Write a Pandas program to insert a new column in existing Data Frame.
iv) Write a Pandas program to get list from Data Frame column headers. v) Write a Pandas program to get list from Data Frame column headers.

UNIT -V

Introduction to Matplotlib:

Introduction to Matplotlib Library, Plotting Data: Line Plots, Scatter Plots, Customizing Plots, Common Types of Plots Bar Charts: Simple Bar Plot, Horizontal Bar Plot, Advanced Plot Customizations.

- 5.1) Create a series of plots to analyze a given dataset.
5.2) Generate a subplot layout with various plot types (scatter, line, bar).
5.3) Visualize time-series data and customize axis labels and date formats.
5.4) Create a 3D plot.

Additional Practice:

1. Write a program to find the greatest number that can be formed by using given set of numbers.
2. Write a Python program to develop a GUI based Calculator application.
3. Write a Python program to develop a GUI based todo list application for adding, deleting and updating tasks.

Reference Books:

1. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, SueBlumenberg. ISBN:978-1530051120.
2. Code with Python: Suresh Sundaradasu, S.Rama Sree ISBN: 978-9355017574
3. Python Programming, Dr.Maganti Venkatesh, Monelli Ayyavaraiah, Niveditha Ravindra Pandey, NeethumolSabu, Charulatha Publications ISBN:978-93-5577-695-6.
4. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Wes McKinney, O'Reilly Media, ISBN: 978-1491957660.

Web Links:

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>

Employability Skills- I

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E, & Agri.E)

L T P C

Course Code: 241UC011

0 0 3 0

Aptitude:

Number System, LCM & HCF, Ratio and Proportion, Averages

Reasoning:

Number Series, Letter Series, Number Analogy, Letter Analogy, Odd Man Out, Logical Sequence of Words.

Verbal:

Introduction to soft skills, how to improve communication? Parts of Speech, Mind your language towards better English, Vocabulary Expansion

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Prem kishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- II

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E.)

Course Code: 241UC013

L T P C
0 0 3 0

Aptitude:

Problems on Ages, Partnership, Percentages, Profit and Loss

Reasoning:

Coding and Decoding, Ranking Test, Alphabet Test, Direction Test

Verbal:

Written communication skill practice, Grammatical use, Concept of 4 step method for presentation, Present Tense

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Prem kishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- III

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E.)

L T P C

Course Code: 241UC014

0 0 3 0

Aptitude:

Simple Interest, Compound Interest, Time and Work, Pipes and Cisterns

Reasoning:

Blood Relations, Calendar, Clocks, Cubes and Dice, Coded Inequalities

Verbal:

Grammar in use, Group discussion, Reading Comprehension, Past Tense, Future Tense

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Prem kishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- IV

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E.)

Course Code: 241UC015

L	T	P	C
0	0	3	0

Aptitude:

Time, Speed and Distance, Problems on Trains, Boats and Streams, Mensuration - I, Mensuration - II

Reasoning:

Venn Diagrams, Syllogisms, Non - Verbal Reasoning, Seating Arrangement

Verbal:

Grammatical use, Self-introduction, Letters, E-Mail & Report writing, Error correction, Effective Communication

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Prem kishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- V

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 241UC016

L	T	P	C
0	0	3	1

Aptitude:

Permutations and Combinations, Probability, Data Interpretation, Logarithms, Statistics

Reasoning:

Puzzle Tests, Eligibility Test, Data Sufficiency, Statements – Arguments, Statements – Assumptions, Statements - Course of Action, Statements - Conclusions

Verbal:

Interview skills, Grammar in use, Interpersonal Skills, Negotiation Skills, Social Skills, Problem-Solving Skills, Time Management Skills

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal, Non-Verbal & Analytical – Jaikishan and Premkishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Mandatory Courses (MC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241AC001	Environmental Science	FC	2			0	100	-	100	-
241AC002	Constitution of India	FC	2			0	100	-	100	-
241AC003	Research Methodology	FC	2			0	100	-	100	-
241AC004	Intellectual Property Rights & Patents	FC	2			0	100	-	100	-
241AC005	Indian Knowledge Systems (IKS)	FC	2			0	100	-	100	-
	Total		10			0				

Mandatory Courses (MC)

Environmental Science

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 241AC001

L	T	P	C
2	0	0	0

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Outline the natural resources and their importance for the sustenance of the life
- CO2:** Explain about the biodiversity of India, threats and its conservation methods
- CO3:** Illustrate various attributes of the pollution, impacts and measures to control the pollution along with waste management practices
- CO4:** Describe social issues of both rural and urban environment to combat the challenges and the legislations of India in environmental protection
- CO5:** Explain the population growth and its implications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1				1		2	-	-	-	-
CO2	1				-		3	-	-	-	-
CO3	-				2		3	-	-	-	1
CO4	-				1		3	1	-	-	1
CO5	-				-		3	-	-	-	-

UNIT – I

Multidisciplinary Nature of Environmental Studies:

Definition, Scope and Importance, Need for Public Awareness.

Natural Resources: Renewable and non-renewable resources – Natural resources and associated problems.

UNIT – II

Ecosystem, Biodiversity and Its Conservation:

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers, and decomposers. Food chains, food webs and ecological pyramids.

Biodiversity And Its Conservation: Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Values of biodiversity. Hot-spots of biodiversity – Threats to biodiversity. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution and Solid Waste Management:

Environmental Pollution: Definition, Cause, effects, and control measures of:

- a. Air Pollution.
- b. Water Pollution
- c. Soil Pollution
- d. Marine Pollution
- e. Noise Pollution

Solid Waste Management:

Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution

UNIT – IV

Social Issues and The Environment:

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to Energy & Water. Resettlement and rehabilitation of people, Environmental ethics, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, and holocaust. Environment Protection Act – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act-Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V

Human Population and The Environment:

Population growth, variation among nations.

Environment and human health, Human Rights, Value Education. Role of Information Technology in Environment and human health.

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses, Erach Bharucha for University Grants Commission, Universities Press. ISBN: 9788173718625.
2. Environmental Studies, Palaniswamy – Pearson education. ISBN: 978-9332528277.

Reference Books:

1. Textbook of Environmental Science, Deeksha Dave and E.Sai Baba Reddy, Cengage Publications. ISBN: 978-8131517604.
2. Textbook of Environmental Sciences and Technology by M.Anji Reddy, B.S Publication. ISBN: 9385433385.
3. Comprehensive Environmental studies by J.P.Sharma, Laxmi publications. ISBN: 978-8170087380.

Web Links:

1. <https://archive.nptel.ac.in/courses/127/105/127105018/>
2. https://onlinecourses.swayam2.ac.in/cec24_ge05/preview

Constitution of India

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

L T P C

Course Code: 241AC002

2 0 0 0

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Explain historical background of the constitution making and its importance for building a democratic India
- CO2:** Compare the functioning of three wings of the government i.e., executive, legislative and judiciary
- CO3:** Interpret the value of the fundamental rights and duties for becoming good citizen of India
- CO4:** Compare the decentralization of power between central, state and local self-government
- CO5:** Extend the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1					3			1	2		
CO2					2			1	3		
CO3					3			2	3		
CO4					3			2	1		
CO5					2			1	3		

UNIT – I

Introduction to Indian Constitution:

Constitution' meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT – II

Union Government and its Administration Structure of the Indian Union:

Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions.

UNIT – III

State Government and its Administration Governor:

Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions

UNIT – IV

Local Administration:

District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PanchayatiRaj: Functions PRI: Zila

Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy.

UNIT – V

Election Commission:

Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women.

Text Books:

1. Introduction to the Constitution of India, Durga Das Basu, Prentice – Hall of India Pvt. Ltd. New Delhi. ISBN: 978-9388548861.
2. Indian Constitution, Subash Kashyap, National Book Trust. ISBN: 9788123707341.

Reference Books:

1. Dynamics of Indian Government & Politics, J.A. Siwach. ISBN: 9788120709768.
2. Indian Government and Politics, D.C. Gupta. ISBN: 9780706987782.
3. Constitutional Law of India , H.M.Sreevai, 4th edition in 3 volumes (Universal Law Publication). ISBN: 9788194776529.

Web Links:

1. nptel.ac.in/courses/109104045/
2. nptel.ac.in/courses/101104065/

Research Methodology

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 241AC003

L	T	P	C
2	0	0	0

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Explain the characteristics and process of research.
- CO2:** Select the research problem by applying problem identification techniques.
- CO3:** Formulate and execute research design process.
- CO4:** Report the results of research process adhering to professional ethics.
- CO5:** Analyze the results of research using statistical measures of central tendency

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1			2						2	1
CO2	1			2						2	1
CO3	1			2						2	1
CO4	1			2				3		2	1
CO5	1			2	2					2	1

UNIT – I

Meaning of Research:

Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

UNIT – II

Identification of Research Problem :

Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

UNIT – III

Research Design :

Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design.

UNIT – IV

Interpretation and Report Writing:

Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

UNIT – V

Statistical Techniques and Tools :

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete series and continuous series) – Correlation – Regression.

Text Books:

1. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint. ISBN: 9788122415223.
2. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press. ISBN: 9780367135720.

Reference Books:

1. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd. ISBN: 978-8126530755.
2. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi. ISBN: 9788120349469.
3. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi. ISBN: 978-8180545283.

Web Links:

1. <https://nptel.ac.in/courses/127106227>
2. <https://archive.nptel.ac.in/courses/121/106/121106007/>

Intellectual Property Rights & Patents

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

	L	T	P	C
Course Code: 241AC004	2	0	0	0

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Compare various types of Intellectual Property rights.
- CO2:** Discuss Intellectual Property and infer rights on such Intellectual Property owners
- CO3:** Explain the process of patenting
- CO4:** Apply for Trade marks and Copyrights.
- CO5:** Explain the methods to protect Trade secrets

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1				1			3			2
CO2	1				1			3			2
CO3	1				1			3			2
CO4	1				1			3			2
CO5	1				1			3			2

UNIT – I

Introduction to Intellectual Property Rights (IPR): Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO –Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR – Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.

UNIT – II

Copyrights and Neighboring Rights: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip Protection Act.

UNIT – III

Patents: Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Double Patenting — Patent Cooperation

Treaty – New developments in Patents – Software Protection and Computer related Innovations.

UNIT – IV

Trademarks and Trade secrets: Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities - Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing off Action - Introduction to Trade Secrets – General Principles - Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements.

UNIT – V

Cyber Law and Cyber Crime : Introduction to Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions - E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers. Relevant Cases Shall be dealt where ever necessary.

Text Books:

1. Fundamentals of IPR for Engineers- Kompal Bansal & Parishit Bansal, B. S. Publications (Press). ISBN: 9788178002774.
2. Intellectual Property -Deborah E.Bouchoux, Third Edition, Cengage Learning, New Delhi. ISBN: 0 340 67786 4.

Reference Books:

1. Intellectual property rights- Prabuddha Ganuli, Tata Mcgraw hill. ISBN: 978-0070077171.
2. Intellectual property rights M.Ashok kumar and Mohd.Iqbal Ali:, Serials Publications. ISBN: 9788183871648.
3. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi. ISBN: 979-8886848229.
4. Intellectual Property- Richard Stim, Cengage Learning, New Delhi. ISBN: 978-0766826656.

Web Links:

1. <http://www.wipo.int/portal/en/index.html>
2. <https://indiankanoon.org/>

3. <http://www.ipindia.nic.in/patents.htm>
4. <http://www.ipindia.nic.in/trade-marks.htm>
5. <http://copyright.gov.in>

Indian Knowledge Systems (IKS)

(CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min. E)

Course Code: 241AC005

L T P C
2 0 0 0

Course Outcomes:

At the end of the course, students will be able to:

- CO1:** Describe the foundations and scope of Indian Knowledge Systems.
- CO2:** Recognize major Indian contributions to knowledge, science, and culture.
- CO3:** Appreciate ethical values and sustainability rooted in Indian traditions.
- CO4:** Relate traditional knowledge to contemporary societal and technological needs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	3	1	1	-	-	-
CO2	-	-	-	-	-	3	1	1	-	-	-
CO3	-	-	-	-	-	3	1	1	-	-	-
CO4	-	-	-	-	-	3	1	1	-	-	-
CO5	-	-	-	-	-	3	1	1	-	-	-

UNIT – I

Foundations of Indian Knowledge Systems

Meaning, scope, and importance of IKS. Sources of IKS: Vedas, Upanishads, Itihasas, Puranas, Shastras. Traditional Knowledge, Indigenous Knowledge, and Western Knowledge – comparison. Gurukula system and knowledge transmission traditions

UNIT – II

Indian Civilization and Philosophical Traditions

Overview of ancient Indian civilization (Indus Valley, Maurya, Gupta). Indian philosophical schools and ethical values. Epics: Ramayana and Mahabharata – cultural and moral significance. Religious traditions: Hinduism, Buddhism, Jainism, Sikhism

UNIT – III

Arts, Architecture and Cultural Expressions

Temple architecture: Nagara, Dravidian, Vesara. Mughal architecture and monuments. Indian classical dance forms and music traditions. Handicrafts, sculpture, painting, and iconography

UNIT – IV

Traditional Knowledge in Health, Environment and Sustainability

Ayurveda and Yoga – holistic health systems. Traditional agriculture and food practices. Water conservation methods and environmental ethics. Biodiversity conservation and sustainable living

UNIT – V

Traditional Knowledge and Contemporary Relevance

Protection of Traditional Knowledge. Traditional Knowledge (TK) and Intellectual Property Rights (overview). Role of government and national initiatives. Relevance of IKS to engineering, innovation, and entrepreneurship

Text Books:

1. **Indian Knowledge Systems**, Kapil Kapoor & Avadhesh Kumar Singh, D.K. Printworld (India) Pvt. Ltd., New Delhi. ISBN: 9788124608177.
2. **Indian Philosophy – Volume I & II**, S. Radhakrishnan, Oxford University Press, New Delhi. ISBN: 9780195698418.
3. **Science and Technology in Ancient India**, O.P. Jaggi, Atma Ram & Sons, Delhi. ISBN: 9788185694085.
4. **Indian Heritage and Culture**, Madhukar K. Bhagat, McGraw Hill Education (India). ISBN: 9789332901476.
5. **Traditional Knowledge System in India**, Yogendra K. Malik, Pearson Education India. ISBN: 9788131762219.

Reference Books:

1. **Ancient Indian Science and Technology**, Debiprasad Chattopadhyaya, History of Science, Philosophy and Culture in Indian Civilization Series. ISBN: 9788187586098.
2. **Indian Culture and Heritage**, Nitin Singhanian, McGraw Hill Education. ISBN: 9789353161132.
3. **Knowledge Traditions of India**, Bhu Dev Sharma, Indian Council of Philosophical Research (ICPR). ISBN: 9788185636306.

Web Links:

1. <https://iks.aicte-india.org/>
2. <https://www.education.gov.in/iks>

Minor Degree Courses

Minor in Electronics and Communication Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC087	Fundamentals of Communications	FC	2		1	3	50	50	100	-

241EC088	Fundamentals of Signal Processing	FC	2		1	3	50	50	100	-
241EC089	Analog & Digital Circuits	IC	2			2	50	50	100	BEEE
241EC042	Wireless LAN's & PAN's	IC	3			3	50	50	100	-
241EC090	Linear & Digital IC Applications	IC	3			3	50	50	100	ADC
241EC091	(or) Sensors and Actuators									
241EC092	Embedded Microcontrollers	IC	2		1	3	50	50	100	ADC, PPSC
241EC093	(or) Digital System Design									
241EC067	Introduction to Internet of Things (or) Modern Wireless Communications	AC	2		1	3	50	50	100	EM, WLANS & PANS
241EC074			3			3	50	50	100	FC
Total			16		4	20				

Fundamentals of Communication

Course Code: 241EC087

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Summarize the functional blocks of a communication system.

- CO2:** Interpret the modulation and demodulation techniques of AM – SC Techniques.
- CO3:** Discuss the concepts of Angle modulation and demodulation.
- CO4:** Infer Pulse analog modulation and demodulation Techniques.
- CO5:** Interpret the transmitter and receiver sections.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2		1		1	2	1		1
CO2	3	2	2		1		1	2	1		1
CO3	3	2	2		1		1	2	1		1
CO4	3	2	2		1		1	2	1		1
CO5	3	2	2		1		1	2	1		1

UNIT – I

Introduction to Communication system, Elements of Communication system, Modulation, Need for Modulation, Electromagnetic Spectrum, Frequency Division Multiplexing(FDM). Introduction to Amplitude Modulation (AM), Generation and detection of AM, Spectrum of AM Signals, Power and Power Efficiency of AM.

Practice:

1. Generate amplitude modulated signal, determine the percentage modulation and demodulate the modulated signal using envelope detector.

UNIT – II

Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Spectrum of DSB-SC Signals, Coherent Demodulation of DSB-SC signals, Introduction to Single Sideband (SSB) Modulation, Generation, and detection of SSB Modulation, Introduction to VSB modulation.

Practice:

1. Generate AM-DSBSC modulated signal and demodulate the modulated signal.

UNIT – III

Frequency modulation: Frequency Modulation: Narrow Band FM, Wide BandFM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals.

Practice:

1. Generate frequency modulated signal, determine the modulation index and Bandwidth, also demodulate the frequency modulated signal.

UNIT – IV

Digital representation of analog signals: Need for Digitizing Analog information, Time Division Multiplexing, Pulse Code Modulation: Sampling, Quantization, Encoding,

Regeneration, Decoding, and Filtering, Introduction to Delta Modulation, Signal Reconstruction in Delta Modulation, Slope Overload Distortion and Granular Noise, Differential Pulse Code Modulation (DPCM).

Practice:

1. Analyse the process of pulse Code modulation.

UNIT – V

Transmitters and Receivers: Classification of Transmitters, AM Transmitters, FM Transmitters Receivers: Radio Receiver - Receiver Types - Tuned radio frequency receiver, Superheterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, Image frequency, AGC.

Practice:

1. Verify the characteristics of mixer.
2. Experimentally study the characteristics of a given AGC circuit.

Text Books:

1. Introduction to Analog and Digital Communications, Simon Haykin, Wiley, 2nd Edition, ISBN: 0471432229.
2. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, Pearson, 5th Edition, 30 August 2019, ISBN: 978-8131719534.
3. Modern digital and analog communication systems—B.P.Lathi , Zhi Ding,oxford,4th Edition, ISBN: 0195331451.

Reference Books:

1. Principles of Communication Systems - Herbert Taub, Donald L Schilling, Goutam Saha, McGraw-Hill, 4th Edition, ISBN: 1259029859.
2. Analog and Digital Communication – K. Sam Shanmugam, Willey, 2018, ISBN: 9788126536801.

Web Links:

1. <https://archive.nptel.ac.in/courses/117/105/117105143/>
2. https://onlinecourses.nptel.ac.in/noc21_ee74/preview
3. <https://archive.nptel.ac.in/courses/108/102/108102096/>
4. <https://archive.nptel.ac.in/courses/117/101/117101051/>
5. <https://web.stanford.edu/class/ee179/>
6. <https://www.udemy.com/course/analog-communication-e/>

Fundamentals of Signal Processing

Course Code: 241EC088

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand the characteristics of CT periodic signals using Fourier series.
- CO2:** Illustrate the spectral characteristics of CT aperiodic signals using Fourier Transforms.
- CO3:** Analyse sampling process and reconstruction of signals.
- CO4:** Understand Laplace and Z-transform techniques on signals.
- CO5:** Illustrate the response of continuous time LTI system.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1		2		1	1	1		1
CO2	2	1	1		2		1	1	1		1
CO3	2	2	1		2		1	1	1		1
CO4	3	2	1		2		1	1	1		1
CO5	2	2	2		1		1	1	1		1

UNIT – I

Signals: Classification of Signals, Different deterministic signals: impulse, step, ramp, gate, signum, sinc, sinusoidal, exponential, complex exponential, operations on signals. Fourier Series: Representation of Fourier series for continuous time periodic signals, Trigonometric Fourier series and Exponential Fourier series, Convergence of Fourier Series: Dirichlet's conditions, properties of Fourier series.

Practice:

1. Generation of various signals such as unit impulse, unit step, ramp, exponential and sinewave.
2. Perform Operations on signals such as Addition, Multiplication, Scaling, Shifting, and Folding.
3. Perform Fourier synthesis of square wave.

UNIT – II

Fourier Transform: Deriving Fourier Transform (FT) from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function.

Practice:

1. Calculate the Fourier Transform and Inverse Fourier Transform of a for Continuous time signal.
2. Calculate the Fourier Transform and Inverse Fourier Transform for the Standard signals.

UNIT – III

Sampling: Sampling, Sampling theorem – Graphical and analytical proof for Band Limited Signals, Nyquist rate, Nyquist duration, Impulse sampling, Natural sampling and Flat top Sampling, Reconstruction of signal from its samples, Effect of undersampling – Aliasing.

Practice:

1. Perform convolution of given continuous time signals.
2. Verify Sampling theorem.

UNIT – IV

Laplace Transform: Bilateral and unilateral Laplace Transforms, Region of convergence and its properties, Constraints on ROC for various classes of continuous time signals, Properties of Laplace Transform, Inverse Laplace Transform.

Z-Transform: Concept of Z- Transform of a Discrete Sequence, Region of convergence in Z-Transform, Properties of Z-Transform, Inverse Z-Transform.

Practice:

1. Obtain Laplace Transform and inverse Laplace Transform of a given continuous time signal.
2. Calculate the Z-Transform and Inverse Z-Transform of a given discrete time signal.

UNIT – V

Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems, Discrete Fourier transforms.

Practice:

1. Obtain Impulse and step response of given LTI system.

Text Books:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2nd Edition, ISBN: 9332550239.
2. Signals and Systems – A. Anand Kumar, PHI, 4th Edition, ISBN: 8120348400.

Reference Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition, ISBN: 0471164747 .
2. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, ISBN: 9780070702219.

3. Digital Signal Processing, P. Ramesh Babu, SciTech Publications, 6th Edition, ISBN: 9395245271.

Web Links:

1. <https://freevidelectures.com/course/3540/signals-and-systems-i> (Signals and Systems I by Prof. K.S. Venkatesh IIT Kanpur)
2. <https://nptel.ac.in/courses/108104100> (Principles of Signals and System by Prof. Aditya K. Jagannatham, IIT Kanpur)
3. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing - by Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi)

Analog & Digital Circuits

Course Code: 241EC089

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Examine the characteristics of special semiconductor diode.
- CO2:** Illustrate the performance of FET and MOSFET.
- CO3:** Realize logic minimization using suitable techniques
- CO4:** Illustrate various combinational logic circuits.
- CO5:** Construct different sequential logic circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2								1
CO2	2	1									
CO3	2	1									
CO4	3	2	1								
CO5	2	2	3								

UNIT – I

Semiconductor Devices: Tunnel Diode, Varactor Diode, LED, Photo Diode, Transistor as a switch, Transistor as an Amplifier.

UNIT – II

Transistor Characteristics-FET& MOSFET: Construction and operation of FET, Characteristic of FET, FET as a switch and an amplifier, MOSFET working and Characteristics (Depletion mode & Enhancement mode).

UNIT – III

Boolean Algebra & Minimization Techniques: Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 5 variables.

UNIT – IV

Combinational Logic Circuits: Design of Half adder, full adder, half sub-tractor, full sub-tractor, applications of full adders, 4-bit binary adder-sub-tractor circuit, BCD adder circuit, Design of decoder, de-multiplexer, encoder, multiplexer, Realization of Boolean functions using decoders & multiplexers, priority encoder, 2-bit Magnitude Comparator.

UNIT – V

Sequential Circuits: Classification of sequential circuits (synchronous and asynchronous) basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T-flip-flop, D-flipflop with reset and clear terminals). Ripple counters, Synchronous Counter Johnson counter, ring counter. Registers - shift register, bi-directional shift register, universal shift register.

Text Books:

1. Electronic Devices and Circuits, J. Millman, Christos C. Halkias, Tata Mc-Graw Hill, 4th Edition, ISBN: 9789339219543.
2. Digital Design, Morris Mano, Pearson, 3rd Edition, ISBN: 8178085550.

Reference Books:

1. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 9th Edition, ISBN: 0131189050.
2. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, ISBN: 0070669112.
3. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, John Wiley & Sons Inc., 3rd Edition, ISBN: 8126520310.

Web Links:

1. <https://nptel.ac.in/117103063/11>
2. <http://nptel.ac.in/courses/117/106/117106086/>
3. <https://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html>

Wireless LAN's & PAN's

Course Code: 241EC042

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Discuss the concept of Random Access protocols
- CO2:** Understand the Wireless LAN Protocols
- CO3:** Demonstrate the IEEE802.11 Standard for WLAN
- CO4:** Describe the Wireless PAN Protocols
- CO5:** Illustrate the IEEE802.15 Standard for WPAN

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2									1
CO2	2	2									1
CO3	1	2									1
CO4	1	2									1
CO5	2	2									1

UNIT – I

Wireless System & Random Access Protocols:

Introduction, First and Second Generation Cellular Systems, Cellular Communications from 1G to 3G, Wireless 4G systems, The Wireless Spectrum; Random Access Methods: Pure ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).

UNIT – II

Wireless LANs:

Introduction, importance of Wireless LANs, WLAN Topologies, Transmission Techniques: Wired Networks, Wireless Networks, comparison of wired and Wireless LANs; WLAN Technologies: Infrared technology, UHF narrowband technology, Spread Spectrum technology.

UNIT – III

The IEEE 802.11 Standard for Wireless LANs:

Network Architecture, Physical layer, The Medium Access Control Layer; MAC Layer issues: Hidden Terminal Problem, Reliability, Collision avoidance, Congestion avoidance, Congestion control, Security, The IEEE 802.11e MAC protocol.

UNIT – IV

Wireless PANs:

Introduction, importance of Wireless PANs, The Bluetooth technology: history and applications, technical overview, the Bluetooth specifications, piconet synchronization and Bluetooth clocks, Master-Slave Switch; Bluetooth security; Enhancements to Bluetooth:

Bluetooth interference issues, Intra and Inter Piconet scheduling, Bridge selection, Traffic Engineering, QoS and Dynamics Slot Assignment, Scatternet formation.

UNIT – V

The IEEE 802.15 working Group for WPANs:

The IEEE 802.15.3, The IEEE 802.15.4, ZigBee Technology, ZigBee components and network topologies, The IEEE 802.15.4 LR-WPAN Device architecture: Physical Layer, Data Link Layer, The Network Layer, Applications; IEEE 802.15.3a Ultra wide band.

Text Books:

1. Ad Hoc and Sensor Networks - Carlos de Morais Cordeiro and Dharma Prakash Agrawal, World Scientific, ISBN: 978-9814338882.
2. Wireless Communications and Networking - Vijay K.Garg, Morgan Kaufmann Publishers, ISBN: 9780123735805.

Reference Books:

1. Principles of Wireless Networks - Kaveh Pahlaram, Prashant Krishnamurthy, PHI, ISBN: 8120323807.
2. Guide to Wireless Communication- Marks Ciampor, Jeorge Olenewa, Cengage Learning, ISBN: 1111307318.

Web Links:

1. <https://archive.nptel.ac.in/courses/106/105/106105183/>
2. <https://archive.nptel.ac.in/courses/108/108/108108179/>

Linear & Digital IC Applications

Course Code: 241EC090

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Construct Op Amps using the differential amplifier and other improvement circuits.
CO2: Explain parameters related to measurement of Op-Amp characteristics.

- CO3:** Construct the circuits for different linear and non-linear applications using Op-Amp.
- CO4:** Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
- CO5:** Compare different digital logic families.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	3								1
CO2	3	2									1
CO3	2	2	3								2
CO4	2	2	3								2
CO5	3	2	2								2

UNIT – I

Introduction to Integrated Circuits: Integrated Circuits Types, Classification, Package Types, Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations, circuits for improving CMRR, Necessity of swamping resistors, Cascaded Differential Amplifier Stages and Level translator.

UNIT – II

Characteristics of Op-Amps: Block Diagram of an Op-Amp, Pin diagram, symbolic representation and features of 741 IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

UNIT – III

Linear and Non-Linear Applications of Op- Amps: Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti-log Amplifiers, Precision rectifiers.

UNIT – IV

D-A and A-D Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC. Different types of ADCs parallel Comparator type ADC, Counter type ADC, Successive Approximation ADC and dual slope ADC. DAC and ADC Specifications.

UNIT – V

Digital Logic Families and Interfacing: Introduction to logic families, Bipolar logic, transistor-transistor logic, TTL families, Emitter coupled logic, CMOS logic, CMOS logic families, state and dynamic electrical behavior.

Text Books:

1. Linear Integrated Circuits–D.Roy Chowdhury, New Age International (p) Ltd, 2nd Edition, ISBN: 8122403077.
2. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Edition, ISBN: 8131713660.
3. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, PHI, Pearson Education, 4th Edition, ISBN: 8131713660.

Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits-Sergio Franco McGrawHill, ISBN: 0071157220.
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James M Fiore, Cengage Learning India Ltd, ISBN: 9788131512340.
3. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, ISBN: 1259025977.

Web Links:

1. <http://nptel.ac.in/courses/117108038/Prof.GunashekaranM.K/IIScBangalore>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-3-circuits/op-amps>

Sensors & Actuators

Course Code: 241EC091

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Classify various sensors/transducers based on their applications.
- CO2:** Analyse various approaches, procedures and results related to Thermal sensors.
- CO3:** Examine the radiation sensors based on their characteristics.
- CO4:** Apply Smart Sensors in the field of Communication, Automation and Manufacturing
- CO5:** Classify various Actuators based on their applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2	2	3	2								
CO3	2	3	2								
CO4	2	3	2								
CO5	3	1									

UNIT-I

Sensors/Transducers:

Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP) - Characterization.

Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.

UNIT-II**Thermal Sensors:**

Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor - Resistance Change Type Thermometric Sensors –Thermo emf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors – Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

UNIT-III**Radiation Sensors:**

Introduction – Basic Characteristics – Types of Photo sensistors /Photo detectors– X-ray and Nuclear ,Electro analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization– Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media.

UNIT-IV**Smart Sensors:**

Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation Sensors-Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing –Sensors for environmental Monitoring.

UNIT-V**Actuators:**

Pneumatic and Hydraulic Actuation Systems - Pneumatic and hydraulic systems - Directional Control valves – Pressure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators Mechanical Actuation Systems- Mechanical aspects of motor selection Electrical Actuation Systems-Electrical systems - Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors.

Text Books:

1. Sensors and Transducers, D. Patranabis, PHI Learning Private Limited, ISBN: 9788120321984.
2. Mechatronics, W. Bolton, Pearson Education Limited, ISBN: 1292250976.

Reference Books:

1. Sensors and Actuators, D. Patranabis, PHI, 2nd Edition, ISBN: 9788120321984..
2. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, ISBN: 978-0123821966.

Web Links:

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. <https://www.hella.com/techworld/ae/Technical/Sensors-and-actuators-204/>
3. <https://www.leanix.net/en/blog/iot-devices-sensors-and-actuators-explained>

Embedded Microcontrollers

	L	T	P	C
Course Code: 241EC092	2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the microprocessor internal architecture and programming.
- CO2:** Discuss Microcontroller internal architecture and its assembly language programming.
- CO3:** Describe the Hardware interfaces with Microcontroller in Assembly Language and C programming.
- CO4:** Describe PIC Microcontroller internal architecture and its assembly language programming.
- CO5:** Illustrate the usage of ATMEGA 328P in their project designs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1:	1	3			3		1	1	1		
CO2:	1	3			3		1	1	1		
CO3:	2		3		3		1	1	1		
CO4:	2	3			3		1	1	1		
CO5:	2		3		3		1	1	1		

UNIT – I

Microprocessor: Basics of Microprocessor, 8086 Hardware architecture ,8086 registers and its functions, Min mode and Max mode system configuration ,Instruction set of 8086 and simple Programs, Interrupts, DMA.

Practice:

1. Write an Assembly language program to perform Arithmetic operations on 8 bit data.
2. Write an Assembly language program to perform Multi byte addition and subtraction.

UNIT – II

8051 Microcontroller: Comparisons between Microprocessors and microcontroller, 8051 architecture, Pin functions, Memory organization, Special Function Registers, addressing modes, Instruction set. C Programming- I/O programming, Timer programming, 8051 interrupts Programming.

Practice:

1. Introduction to KEIL Software.
2. Write an ALP to find Number of 1's and number of 0's in a given 8-bit.
3. Write an ALP to generate square wave using Timer control.

UNIT – III

External Peripheral Interface: LCD interfacing, Keyboard interfacing, Interfacing with external ROM, ADC interfacing, DAC interfacing, Stepper motor interfacing, DC motor interfacing.

Practice:

1. Interface Keypad to 8051 using proteus software.
2. Interface LCD to 8051 using proteus software.

UNIT – IV

PIC Microcontrollers: Introduction, characteristics of PIC microcontroller, memory organization, parallel and serial input and output, timers, Interrupts, PIC 16F877 architecture, instruction set of the PIC 16F877.

Practice:

1. Introduction to MPLAB XIDE software.
2. Write a C Program for LED Blinking using PIC16F877.

UNIT – V

ATMEGA 328 Microcontroller: ATMEGA 328P architecture, register file, memory, addressing mode, instruction sets, I/O ports, Case studies: interfacing with LCD, Temperature Sensor DHT11, High-Voltage Device and Relay, Bluetooth Module (HC-05), GSM Module (SIM900A), Using I2C Protocol, Using Zigbee to interface wireless sensors.

Practice:

1. Study of Arduino software.
2. Interfacing of analog sensors with Arduino.
3. Interfacing of DC Motor with Arduino.

Text Books:

1. Advanced Microprocessors and Peripherals with ARM and an introduction to Microcontrollers and Interfacing, K. M. Bhurchandi and A. K. Ray, Tata McGraw Hill, 3rd Edition, ISBN: 1259006131.

2. Micro Controller theory and Application ,Ajay .V. Deshmukh, TATA McGraw –Hill,1st Edition, ISBN: 0070585954.
3. Programming and Interfacing with Arduino, Dr. Yogesh Misra, Taylor and Francis, ISBN: 1032059850.

Reference Books:

1. The 8051 Microcontrollers and Embedded systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2nd Edition, ISBN: 8131758990.
2. Microprocessors and Interfacing, D. V. Hall,3rdEdition (SIE), ISBN: 9781259006159.
3. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 3rd Edition, ISBN: 9788131502006.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/108103157/> microprocessor and microcontrollers by IIT Gowhathi.
2. <https://nptel.ac.in/courses/108108147S> ensors and Actuators, IISc Bangalore Prof. Hardik Jeetendra Pandya.

Digital System Design

	L	T	P	C
Course Code: 241EC093	2		1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the design process of HDL based digital systems.
- CO2:** Illustrate language constructs in Verilog HDL
- CO3:** Develop Verilog Program for Combinational Logic Circuits using gate primitives.
- CO4:** Develop dataflow modeling Verilog Program for Logic Circuits.
- CO5:** Construct sequential circuits using behavioral Modeling.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1		1			1	1		
CO2	2	1	1		1			1	1		
CO3	2	1	1		2			1	1		
CO4	2	1	1		2			1	1		
CO5	2	1	1		2			1	1		

UNIT – I

INTRODUCTION TO VERILOG: Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools.

Practice:

1. Introduction to Xilinx Software

UNIT – II

LANGUAGE CONSTRUCTS AND CONVENTIONS: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators.

Practice:

1. Write a verilog code with the use of data types as scalars and vectors

UNIT – III

GATE LEVEL MODELING: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples: Adders, Subtractor and Multiplexers. Additional Examples: Design of Flip-flops with Gate Primitives, Delays, Net Types.

Practice:

1. Write a Verilog code for logic gates using gate Primitives
2. Write a Verilog code for FullAdder and subtractor using gate Primitives.
3. Write a Verilog code for Multiplexer using gate Primitives.

UNIT – IV

MODELING AT DATA FLOW LEVEL: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Design Examples- Encoder, Decoder and Comparator

Practice:

1. Write a Verilog code for encoder in dataflow model
2. Write a Verilog code for decoder in dataflow model.
3. Write a Verilog code for Comparator in dataflow model.

UNIT – V

BEHAVIORAL MODELING: Introduction, Operations and Assignments, Initial Construct, Always Construct, The case statement, *if* and *if-else* constructs, repeat construct, for loop Examples, Assignments with Delays, Design Examples-Flip-flops, Registers and Counters.

Practice:

1. Write a Verilog HDL code for the RS and JK flip-Flops using case statement.
2. Write a Verilog HDL code for the 4 bit register using *if –else* statement.
3. Write a Verilog HDL code for the 4 bit register using behavioral Modeling.

Text Books:

1. Fundamentals of Digital Logic with Verilog Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, ISBN: 1259025977.
2. Advanced digital design with the Verilog HDL, Michael D. Ciletti, Eastern economy edition, PHI, ISBN: 0136019285.

Reference Books:

1. A Verilog HDL primer by J.Bhaskar, Star galaxy publishing, 3rd Edition, 2018, ISBN: 0965039161.
2. Design through Verilog HDL by T. R. Padmanabhan, B. Bala Tripura Sundari, A JOHN WILEY & SONS, INC., Publication, ISBN: 0471441481.

Web Links:

1. <http://nptel.ac.in/courses/117105080/> by Prof.D. Roy chaudhry, IIT kharagpur
2. <http://nptel.ac.in/courses/117106086/1> by Prof.S.Srinivasan, IIT Madras
3. https://onlinecourses-archive.nptel.ac.in/noc17_cs21/ course by Prof. Indranil Sen Gupta, IIT kharagpur

Introduction to Internet of Things**Course Code: 241EC067**

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe M2M and IOT Technologies.
CO2: Identify the layers and protocols in IOT.
CO3: Describe various communication technologies used in IOT.
CO4: Demonstrate various hardware components required for IOT applications
CO5: Identify the cloud technologies Explain the applications of IoT

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1						1	1		
CO2	2	2						1	1		
CO3	2	2						1	1		
CO4	3	2						1	1		
CO5	2	2						1	1		

UNIT – I

Introduction from M2M to IoT - An Architectural Overview, building architecture, Main design principles and needed capabilities, An IoT architecture outline, M2M and IoT Technology Fundamentals - Devices and gateways.

Practice:

1. Interfacing of analog sensors with Arduino.
2. Interfacing of Digital sensors with Arduino.

UNIT – II

Functionality of Layers in IoT: Study of protocols - Wireless HART, Z-Wave, 6LoWPAN, RPL, CoAP, MQTT.

Practice:

1. Interfacing of actuators with Arduino/Node-MCU.
2. Control an actuator based on sensor input with Arduino/Node-MCU.

UNIT – III

Communication Technologies in IoT : IoT Connectivity-IEEE 802.15.4, Wi-Fi, Bluetooth, Zigbee, LPWAN, 5G Era.

Practice :

1. Develop an Application to Interface Bluetooth module with Arduino.
2. Develop an Application to Interface Wi-Fi module.

UNIT – IV

System Hardware : Sensors, Actuators, Radio Frequency Identification, Introduction to Embedded Devices for IoT - RASPBERRY PI.

Practice:

1. Interfacing of analog sensors with Raspberry pi.
2. Interfacing of digital sensors with Raspberry pi/Node-MCU.

UNIT – V

Cloud Computing: Data Collection, Storage and Computing Using a Cloud Platform for IoT Applications/ Services. Use Cases - Smart and Connected Cities, Agriculture, and Healthcare.

Practice:

1. Deploy sensor data on a cloud platform.
2. Develop IoT model using soil moisture sensor for Agriculture application.

Text Books:

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, Academic Press,. 1st Edition, ISBN: 012407684X.
2. Internet of Things (A Hands-on- Approach), Vijay Madisetti and Arshdeep Bahga, 1st Edition, VPT, ISBN: 8173719543.
3. Internet of Things - By Raj Kamal, McGraw-Hill Education. Copyright, ISBN: 9352605225.

Reference Books:

1. Internet of Things—From Research and Innovation to Market Deployment, Peter Friess, River Publishers, ISBN: 8793102941.
2. From Internet of Things to Smart Cities: Enabling Technologies - edited by Hongjian Sun, Chao Wang, Bashar I. Ahmad, CRC Press -2018, ISBN: 9781498773782.
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015, Editors Ovidiu Vermesan, ISBN: 1783553537.

Web Links:

1. NPTEL :: Computer Science and Engineering - NOC:Introduction to internet of things
BY IIT Kharagpur.
2. <https://nptel.ac.in/courses/108108147> Sensors and Actuators, IISc Bangalore
Prof. Hardik Jeetendra Pandya.

Modern Wireless Communications

	L	T	P	C
Course Code: 241EC074	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1: Summarize the functioning of basic cellular mobile radio systems
- CO2: Identify the general problems of cellular mobile networks
- CO3: Summarize various mobile propagation models
- CO4: Make use of managerial techniques for efficient use of cellular frequency bands.
- CO5: Compare basic digital cellular networks

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1								
CO2	3	1	2								
CO3	3	2	2								
CO4	3	2	2								
CO5	3	2	2								

UNIT – I

Cellular Mobile Radio Systems: Introduction to Cellular Mobile Systems, Generations-1G, 2G, 3G 4G, Performance criteria, uniqueness of mobile radio environment, operation of cellular systems, Hexagonal shaped cells, Analog and Digital Cellular systems.

Elements of Cellular Radio System Design: General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a Omni directional Antenna system, consideration of the components of Cellularsystem.

UNIT – II

Interference: Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, diversity receiver, non-co channel interference-different types.

UNIT – III

Cell Coverage for Signal and Traffic: Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long distance propagation antenna height gain, form of a point to point model.

UNIT – IV

Frequency Management and Channel Assignment: Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, Sectorization, overlaid cells, non-fixed channel assignment.

Handoff: Handoff, dropped calls and cell splitting, types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting, micro cells, vehicle locating methods, dropped call rates and their evaluation.

UNIT – V

Digital Cellular Networks: GSM architecture, GSM channels, GSM call flow, CDMA(IS-95),Forward and Reverse CDMA Channels, DECT, PACS.

Text Books:

1. Mobile Cellular Tele Communications, W.C.Y. Lee, Tata McGraw Hill, 2nd Edition, ISBN: 978-0070635999.
2. Principles of Mobile Communications, Gordon L. Stuber, Springer International, 2nd Edition, ISBN: 9780792379980.

Reference Books:

1. Wireless Communications, Theodore. S. Rapport, Pearson education, 2nd Edition, ISBN: 978-8131731864.
2. Wireless Communication and Networking, Jon W. Mark and WeihuaZhqung, PHI, 1st Edition, ISBN: 978-0130409058.
3. Wireless Communication Technology, R. Blake, Thompson Asia Pvt. Ltd., 1st Edition, ISBN: 978-8131518403.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_ee61/preview?msclid=f61e217ec14311ecb1ce5ecbd56ce03d
2. <https://www.electronics-notes.com/articles/connectivity/cellular-mobile-phone/what-is-cellular-communications.php>

Minor Degree in Civil Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241CE025	Repair & Rehabilitation of Structures	FC	3			3	50	50	100	-
241CE043	Building Planning & Computer-Aided Drawing	FC			2	2	50	50	100	-
241CE027	Green Buildings	FC	3			3	50	50	100	-
241CE040	Fundamentals of Soil Behaviour	FC	3			3	50	50	100	-
241CE054	Railway Engineering(or) Docks & Harbour Engineering	FC	3			3	50	50	100	-
241CE047										
241CE036	Environmental Impact & Risk Management(or)	IC	3			3	50	50	100	-

241CE037	Environmental Management									
241CE056	Urban Transportation Planning(or)	IC	3			3	50	50	100	-
241CE049	Intelligent Transportation Systems									
Total			18		2	20				

Repair & Rehabilitation of Structures

	L	T	P	C
Course Code: 241CE025	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the concept of repair and its need.
- CO2:** Classify various causes of deterioration of concrete structure and Distresses monitoring techniques.
- CO3:** Identify the effect of corrosion on structures.
- CO4:** Assessing the techniques for repairing.
- CO5:** Apply the NDT techniques to assess the condition of the structures& explain seismic retrofitting and maintenance of heritage structures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	3	1		2					

CO2	2		2	2		2					
CO3	2	1	2	2		2					
CO4	2		2	2		2					
CO5	2		2	2		3					

UNIT – I

Introduction:

Maintenance and Repair strategies - Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure.

UNIT – II

Deterioration of Structures:

Introduction, Basic terminology – Causes of deterioration, physically induced deterioration, chemically induced deterioration, Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking.

UNIT – III

Corrosion of structures:

Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Coatings - Cathodic protection for reinforcements-design and construction errors - Effects of cover thickness and cracking.

UNIT – IV

Rehabilitation and Retrofitting methods:

Repair: Guniting, Shotcreting, Epoxy – Cement mortar injection, Crack ceiling
Rehabilitation Methods: Grouting, Imbalance of structural stability, Strengthening & Stabilization techniques, Design consideration – Beam shear capacity strengthening – Shear transfer strengthening – Stress reduction techniques – Column strengthening, Flexural strengthening – Connection stabilization & strengthening.

UNIT – V

Damage Assessment:

Repairs to Structures - Repair of structures distressed due to earthquake – Strengthening using FRP Strengthening and stabilization techniques for repair Non – Destructive testing methods – Rebound hammer, Ultrasonic pulse velocity, Rebar locator, Corrosion meter, Penetration resistance & Pullout tests. Seismic Retrofitting and Maintenance of Heritage Structures: Earthquake damages of buildings, their retrofitting and restoration. Effects of

earthquakes. Methods of seismic retrofitting, restoration of buildings, Special care in repair and rehabilitation of heritage structures.

Text Books:

1. Maintenance Repair Rehabilitation & Minor works of Buildings- P.C. Varghese, PHI Publications, ISBN: 978-81-203-4945-2.
2. Repair and Rehabilitation of Concrete Structures – P.I. Modi, C.N. Patel, PHI Publications, ISBN : 9788120352148.

Reference Books:

1. Rehabilitation of Concrete Structures - B. Vidivelli, Standard Publishers Distributors, ISBN : 9788180141102.
2. Concrete Repair and Maintenance illustrated - Peter H.Emmons, 978-0876292860.

Web Links:

1. https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures
2. <https://nptel.ac.in/courses/105/106/105106202/>

Building Planning & Computer Aided Drawing

	L	T	P	C
Course Code: 241CE043	0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Discuss about CAD software and basic functions.
CO2: Plan different types of buildings as per NBC regulations and building laws
CO3: Sketch the various building components
CO4: Evaluate plans of Single storied building & multistoried buildings
CO5: Develop different sections at different elevations
CO6: Detailing of building components like doors, windows and roof trusses etc.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3				3	3	2	2	2	2	2
CO2	3				2	3	2	2	2	2	1
CO3	3				2	2	2	2	2	2	2
CO4	2				3	3	2	2	2	2	2
CO5	2				3	3	2	2	2	2	2
CO6	2				3	3	2	2	2	2	2

Practice:

1. Introduction to various CAD commands with simple examples
2. To understand about Principles of building planning and building bye-laws.
3. To draw the foundation details for the buildings.
4. To draw the stretcher and header bond.
5. To draw the English and Flemish bond.
6. To draw the plan section and elevation of different types of staircases
7. To draw the plan section & elevation of buildings using software a) Single storeyed b) Multi storeyed residential buildings
8. To draw the developed plan, elevation, section and site plan of public buildings (Hospital & or School buildings).
9. Detailing of building components like doors and windows.
10. To draw the elevation of roof structures like king post and queen post truss.

Additional Practice:

1. To draw the plan, elevation, section and site plan of Industrial buildings
2. To draw the plan and elevation of different types staircases.
3. To draw the plan, elevation, and section of two storied building.

Text Books:

1. Building Planning and Drawing, Dr. N. Kumara Swamy, A. Kameswara Rao, Charotar Publishing House Pvt. Ltd, 9th Edition, ISBN:978-9385039386.
2. Building Planning and Drawing S.S. Bhavi katti, Dream tech Press India Pvt. Ltd., 1st Edition, ISBN:978-9389307085.

Reference Books:

1. Building, Planning and Drawing - Tech Knowledge Publications by Nishant A. Upadhye, ISBN: 978-93-89684-17-9.
2. Model Building Bye-laws 2016, Young Global Publications, ISBN:978-8188274475.
3. Planning, Designing and scheduling, Girescharan Singh & Jagadish Singh, Published by Standard Publishers Distributors, ISBN:978-8180140051 .

Web Links:

1. <http://www.bsiet.org/notes/BPD%20Theory.pdf>
2. <https://sites.google.com/a/mitr.iitm.ac.in/iitmcivil/ce2050>
3. <http://www.cadmatesoftware.com/>

Green Buildings

Course Code: 241CE027

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO 1:** Define sustainability and a green building, along with its features and benefits.
- CO 2:** Describe the methods used to maintain indoor environmental quality.
- CO 3:** Describe the water efficiency methods
- CO 4:** Design sustainable and energy efficient civil engineering projects.
- CO 5:** Select materials for sustainable built environment & adopt waste management methods.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2				2		1			
CO2	3	3				2		1			
CO3	3	3				2		1			
CO4	2	2				2		1			
CO5	3	3				2		1			

UNIT I

Green Building Concept:

Overview of green building movement; Concept of Green building and sustainable development; Issues and strategies of Green building and sustainable development; Objectives Principals and Benefits of Green building design; Introduction to High-performance building; integrated design process of high-performance building; Green project requirements and strategies; Overview of various green rating systems worldwide.

UNIT-II

Green Building Materials and Indoor Environment Quality

Introduction; Low emitting materials; Building and material reuse; Construction waste management; Regional materials; Life cycle cost assessment of building materials and products; Factors affecting indoor environment quality; Ventilation and filtration; Building materials and finishes- Emittance level; Indoor Environment quality best practice.

UNIT-III

Water:

Reduce, Reuse and Recycle: Introduction; Wastewater strategy and water reuse/recycling; Water fixtures and water use reduction strategies.

UNIT-IV

Energy Efficiency:

Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy:

Energy efficient building envelopes, Solar Heat Gain Coefficient, U-Values for facade materials, efficient lighting technologies, energy efficient and BEE rated appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of NET ZERO buildings.

UNIT-V

Building materials:

Methods to reduce embodied energy in building materials: (a) Local building materials. (b) Natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks. (c) Materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) Reuse of waste and salvaged materials.

Waste Management:

Handling of construction & demolition waste materials, separation of household waste, handling e-waste, on-site and off-site organic waste management.

Text Books:

1. Alternative Building Materials and Technologies, K.S. Jagadeesh, B.V. Venkata Rama Reddy, and K.S. Nanjunda Rao, New Age International Publishers, ISBN: 9788122433110.
2. Green Building Fundamentals, Mike Montoya, Pearson in the USA, ISBN: 9780135066403.

Reference Books:

1. Green Buildings, Peter Gevorkian, published by McGraw-Hill. (ISBN: 9780071473590)
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison, and Rob Harrison, E & FN Spon (an imprint of Thomson Science & Professional, ISBN: 9780419236900).

Web Links:

1. <https://www.igbc.in/>
2. <http://www.sbtmanual.in/>
3. <https://www.grihaindia.org/>

Fundamentals of Soil Behaviour

	L	T	P	C
Course Code: 241CE040	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify the probable soil formation history
- CO2:** Evaluate the soil fabric by indirect and direct methods
- CO3:** Identify and solve soil water interaction problems
- CO4:** Evaluate the soil compressibility aspects and estimate probable settlements.
- CO5:** Asses the shear strength characteristics by conducting the most appropriate tests

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2	2	2	1	1	1	1	1	2
CO2	3	3	2	2	2	1	1	1	1	1	2
CO3	3	3	3	2	2	2	2	1	2	2	2
CO4	3	3	2	3	2	2	2	1	2	1	2
CO5	3	3	2	2	3	2	2	1	2	1	2

UNIT – I
Soil Formation and Composition :

Origin, nature and distribution of soil, description of individual particle, clay mineralogy, clay-water electrolytes, soil fabric and structure.

UNIT – II
Effective Stress and Soil Permeability:

Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination of coefficient of permeability.

UNIT – IV

Shear Strength of Soils:

Stress path analysis, tri-axial and direct shear tests, shear behaviour of granular soils and Fine-Grained Soils, factors affecting shear behaviour, determination of shear strength parameters, pore pressure parameters, UU, CU, CD tests, total and effective shear strength parameters, factors affecting shear strength- determination of in situ undrained strength.

UNIT – V

Critical State Model:

Introduction models and soil mechanics, use of models in engineering, elasticity, soil elasticity, plasticity and yielding, yielding of metal tubes in combined tension and torsion, elastic-plastic model for soil, elastic volumetric strains, a particular elastic-plastic model.

Text Books:

1. Soil Mechanics and Foundation Engineering, Arora K.R., Standard publisher, 2020, ISBN:978-8180141126.
2. Soil Mechanics and Foundations, Punmia, B.C., Laxmi Publications Pvt. Ltd. New Delhi, ISBN:978-8170087915.

Reference Books:

1. Fundamentals of Soil Behaviour, Mitchell, J. K., John Wiley & Sons, New York, 2Ed, ISBN:978-0471856405.
2. Muir Wood - Soil Behaviour and critical State Soil Mechanics, Cambridge University Press, ISBN:978-0521337823.

Web Links:

1. <https://nptel.ac.in/courses/105101084>
2. <https://archive.nptel.ac.in/courses/105/101/105101201/>

Railway Engineering

	L	T	P	C
Course Code: 241CE054	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain different components of railway track
- CO2:** Design track gradients as per given requirements
- CO3:** Discuss various types of tracks turnouts and crossings
- CO4:** Explain interlocking and signaling systems
- CO5:** Describe purposes and facilities at Railway Stations
- CO6:** Explain track maintenance

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1									
CO2	2	2	3								
CO3		2	3			1					
CO4		1	3			2					
CO5	1					2					
CO6	1					2					

UNIT – I

Components of Railway Engineering:

Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings – Creep of Rails- Theories related to Creep – Adzing of Sleepers- Sleeper density – Rail joints.

UNIT – II

Geometric Design of Railway Track:

Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves.

UNIT – III

Turnouts & Controllers: Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing – Inspection and maintenance of Points and Crossings.

UNIT – IV

Signalling and Interlocking:

Objectives of Signalling - Classification of Signals – Fixed Signals - Stop Signals Signalling Systems – Mechanical Signalling System - Electrical Signalling System - Systems for Controlling Train Movement – Interlocking - Modern Signalling Installations.

Text Books:

1. Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi, 2020, ISBN:9780195687798.
2. Railway Engineering, Rangwala, Charotar Publishing House, ISBN:9788177643260.

Reference Books:

1. Roads, Railways, Bridges & Tunnel Engineering, T.D.Ahuja & G.S.Birdie, ISBN:9788189401337.

Web Links:

1. <https://nptel.ac.in/courses/105/107/105107123/>
2. <http://www.nptelvideos.in/2012/11/transportation-engineering-ii.html>
3. <https://lecturenotes.in/subject/458>

Docks & Harbour Engineering

Course Code: 241CE047

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Introduce history and classifications of harbors.
- CO2:** Explain the fundamentals of Harbor planning.
- CO3:** Explain the natural forces affecting ports and general design aspects of marine structures.
- CO4:** Describe various navigational aids and dock & repair facilities.
- CO5:** Describe maintenance and protection of port facilities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	3	3	3			2				2	
CO3	1	1	3			2					
CO4	2	2						1		2	
CO5	1	1					1	2		2	

UNIT – I

Harbor Planning:

Types of water transportation, water transportation in India, requirements of ports and harbors, classification of harbors, selection of site and planning of harbors, location of harbor, traffic estimation, master plan, ship characteristics, harbor design, turning basin, harbor entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

UNIT – II

Harbor Works:

Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, the necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

UNIT – III

Docks and Repair Facilities:

Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of the lock, lock gates, types of gates.

UNIT – IV**Port facilities:**

Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.

UNIT – V**Dredging, Coastal Protection and Inland navigation:**

Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone, and beach profile. Inland waterways, Inland water transportation in India, classification of waterways, the economics of inland waterways transportation, national waterways

Text Books:

1. Dock and Tunnel Engineering, R. Srinivasan and S. C. Rangwala, Harbour, Charotar Pub House, Anand, ISBN: 9788192869261.
2. Docks and Harbour Engineering by Bindra S.P. - Dhanpat Rai & Sons, New Delhi, ISBN:9788189928858.

Reference Books:

1. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad, 2020, ISBN:9789389211160.
2. Port Design - Guidelines and recommendations by C. A. Thoresen, Tapir Publications, ISBN:9788251908399.
3. Highway, Railway, Airport and Harbor Engineering, Subramanian K. P, Scitech Publications (India) Pvt Limited, Chennai, ISBN:9788195330591.

Web Links:

1. <https://nptel.ac.in/courses/114106025>
2. <https://lecturenotes.in/s/1892-dock-harbour-and-airport-engineering/videos>

Environmental Impact & Risk Assessment

L T P C

Course Code: 241CE036

3 0 0 3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply basic principles of EIA
- CO2:** Illustrate the necessity to study the impacts
- CO3:** Interpret different risks that will be caused by projects or industries
- CO4:** Identify methods to overcome these impacts
- CO5:** Demonstrate the concepts of the legal requirements of Environmental and Risk Assessment for projects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3		1			2				1	1
CO2	2	2	2	1		2					
CO3	2	2	1	1		3					
CO4	2	2	2	1		2					
CO5	2		3			3					

UNIT – I

Introduction :

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA –.EIA process- screening – scoping - setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA.

UNIT – II

Impact Identification and Prediction:

Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological — Cumulative Impact Assessment.

UNIT – III

Social Impact Assessment and Eia Documentation:

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

UNIT – IV

Environmental Management Plan :

Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies.

UNIT – V

Environmental Risk Assessment and Management:

Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modelling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.

Text Books:

1. Environmental Impact Assessment , Canter, L.W., McGraw Hill, New York. ISBN: 0070097674.
2. Environmental Impact Assessment – Practical solutions to recurrent problems, Lawrence, D.P., Wiley-Interscience, New Jersey. ISBN: 978-0-471-72202-).

Reference Books:

1. Environmental Risk and Hazards, Cutter, S.L., Prentice-Hall of India Pvt. Ltd., New Delhi, ISBN: 0137538561.
2. Risk Assessment and Management Handbook, Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, McGraw Hill Inc., New York. (ISBN: 13978-0070359871)
3. Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control Sam Mannan, Lees, 4th Edition, Butterworth Heineman. (ISBN: 978-0-7506-7555-0).

Web Links:

1. <https://nptel.ac.in/courses/120108004>
2. <https://www.witpress.com/journals>
3. <https://www.researchgate.net/publication/235859306>

Environmental Management

Course Code: 241CE037

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand the physical and chemical treatment processes
- CO2:** Knowledge on various unit operations e.g, sedimentation tank, coagulation and filtration tank.
- CO3:** Knowledge on biological treatment significance
- CO4:** Know the aerobic treatment of wastewater
- CO5:** Understand the anaerobic treatment of wastewater

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3					2	2				1
CO2	2	2	1		2	3	2				2
CO3	3	2	3			3		2			2
CO4	3					3		3			1
CO5	2					3	3	1			2

UNIT – I

Principles of Environmental Management

Definition of Environmental Management - Principles of Environmental Management - Nature, Scope and Components of Environmental Management - Policies and Legal Aspect of Environmental Management.

UNIT – II

Sustainable Environmental solutions

Public Private Participation Model - ISO Certification - Environment Health & Safety (EHS) - Environment & Disaster Management (EDM) - Environmental organizations for planning and implementation of sustainable development.

UNIT – III

Environmental Management Plan

Preventive and reactive strategies for environmental pollution control - Life Cycle Assessment as Environmental Management Tool - Environmental Management Plan (EMP) - Components of EMP - Preparation of EMP - Case Study

UNIT – IV

Environmental Impact Assessment

Environmental Impact Assessment (EIA) - Need and Importance - Steps involved - Methods of EIA - Ad-hoc, checklist, network, matrix etc - Typical case studies of environmental impact assessment - Environmental impact statement and risk assessment

UNIT – V

Environmental Legislations

Environmental Legislation - Air, Water and Environmental acts - Preventive and reactive strategies for environmental pollution control - Environmental Audit.

Text Books:

1. Assessment and analysis of Environmental management, Shukla S. S., Shrivastva P. R., commonwealth publishers New Delhi (ISBN: 8171692192).
2. An introduction to Environmental Management, Dr, Anand Bal, Himalaya Publishing House, (ISBN-13 978-8183183758).

Reference Books:

1. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International Editions (ISBN-13 978-0070097643).
2. Environmental Management 2013, Vikas Khanna, D. R. & Chopra, A. K. & Matta, Gagan & Bhutiani, R. & Singh (ISBN-13 978-8170358220).

Web Links:

1. <https://enviromicro-journals.onlinelibrary.wiley.com/journal/14622920>.
2. <https://link.springer.com/book/10.1007/978-94-017-9118-2>

Urban Transportation Planning

	L	T	P	C
Course Code: 241CE056	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Design, conduct and administer surveys to provide the data required for transportation planning.
- CO2:** Supervise the process of data collection about travel behavior and analyze the data for use in transport planning
- CO3:** Develop and calibrate modal split, trip generation rates for specific types of land use developments
- CO4:** Apply the mode choice behaviour and mode split models
- CO5:** Adopt the steps that are necessary to complete a long-term transportation plan.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3			2	1				
CO2	2	2	1	1		2	1				
CO3	2		3			2	1				
CO4	2					2	2				
CO5	2					3	1				

UNIT – I

Introduction:

Urbanization, urban class groups, transportation problems and identification, impacts of transportation, urban transport system planning process, modeling techniques in planning. Urban mass transportation systems: urban transit problems, travel demand, types of transit systems.

UNIT – II

Data Collection:Types and Sources of Data Trip generation models - Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models.

UNIT – III

Trip Generation:

UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates; Trip Distribution by Growth Factor Methods. Problems on above.

UNIT – IV

Trip Distribution:

Gravity Models, Opportunity Models, Time Function Iteration Models. Travel demand modeling: gravity model, opportunity models, Desire line diagram. Modal split analysis. Problems on above.

UNIT – V

Traffic Assignment:

Land use transportation models – Urban forms and structures - Location models - Accessibility – Land use models - Lowry derivative models Diversion Curves; Basic Elements of Transport Networks, Coding, Route Properties, Path Building- Preparation of alternative plans - Evaluation technique.

Text Books:

1. Principles of Urban Transportation System Planning, Hutchinson B.G., McGraw Hill, ISBN :978-0070315396.
2. Introduction to Transportation Planning, Bruton M. J., Hutchinson, London, ISBN: 9780090986200.

Reference Books:

1. Transportation Engineering, Jotin Khisty, B. Kent Lall, Prentice Hall of India, ISBN:978-9332569706.
2. Transportation Engineering and Planning, C.S.Papacostas and P.D. Prevedouros, Prentice Hall of India Pvt. Ltd, ISBN: 978-0130814197.
3. Highway Engineering, S.K. Khanna& C.E.G. Justo, Nemchand & Bros., 10th Edition, ISBN: 978-8185240930.

Web Links:

1. <http://nptel.ac.in/courses/105101087/29>
2. <https://novalynx.com/store/pc/What-Is-a-Wind-Rose-d55.htm>
3. <https://ircep.gov.in/>

Intelligent Transportation Systems

	L	T	P	C
Course Code: 241CE049	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify and differentiate ITS user services and their components.
- CO2:** Study the telecommunications in ITS.
- CO3:** Interpret ITS functional areas.
- CO4:** Implement suitable ITS and services for effective transportation.
- CO5:** Applications of Automated Highway Systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			1						
CO2	3	2			1						
CO3	2	2	1	1	1						
CO4	2	2	1	1	1						
CO5	2	2	1	1	1						

UNIT – I

Introduction:

Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT – II

Telecommunications in ITS:

Importance of telecommunications in the ITS system, Information Management, Traffic Management Centers (TMC). Vehicle – Roadside communication – Vehicle Positioning System.

UNIT – III

ITS functional areas: Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

UNIT – IV

ITS User Needs and Services:

Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

UNIT – V

Automated Highway Systems:

Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

Text Books:

1. Fundamentals of Intelligent Transportation Systems Planning, M.A. Chowdhury and A. Sadek, Artech House, First Edition, ISBN: 9781580534702.
2. Intelligent Transport Systems, Sarkar, Pradip Kumar, and Amit Kumar Jain, PHI Learning, First Edition, 2018, ISBN: 9788120353001.

Reference Books:

1. Economic Impacts of Intelligent Transportation Systems: Innovations and Case Studies, Bekiaris and Y.J. Nakanishi, Elsevier/JAI, ISBN: 9780762310320.
2. Intelligent Transport Systems Standards, Bob Williams, Artech House Publishers, ISBN: 9781607839324.
3. Intelligent Transport Systems: Cases and Policies, Roger Stough, Edward Elgar, ISBN:978-1840644470.

Web Links:

1. https://www.civil.iitb.ac.in/tvm/npTEL/591 ITS_1/web/web.html
2. https://www.civil.iitb.ac.in/tvm/npTEL/592 ITS_2/web/web.html
3. <https://archive.nptel.ac.in/courses/105/101/105101008/>

Minor Degree in Electrical and Electronics Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EE055	Operation & Control of Electric machines	FC	2			2	50	50	100	BEEE
241EE056	Fundamentals of Power Electronics	FC	2			2	50	50	100	BEEE
241EE013	Electrical Measurements & Instrumentation	FC	2		2	4	50	50	100	ENA-1/BEEE
241EE006	Electric Power Generation and Distribution Systems	IC	3			3	50	50	100	ENA-1/BEEE
241EE034	Alternative Energy Sources (or)	IC	3			3	50	50	100	EPGDS / BEEE/ISM
241EE027	Utilization of Electrical Energy									
241EE037	Hybrid Electric Vehicles (or)	AC	3			3	50	50	100	FPE/OCEM

241EE035	Special Electric machines									
241EE043	Electrical Safety (or) Methods & Algorithms for Intelligent Control	AC	3			3	50	50	100	EPGD S/PSA
241EE030										
	Total		18		2	20				

Electric Power Generation & Distribution Systems

Course Code: 241EE006

L T P C
3 0 0 3

Course Outcomes:

At the end of the course, students will be able to:

- CO1:** Identify the different components of various power plants.
- CO2:** Distinguish between AC/ DC distribution systems and also estimate voltage drops of distribution systems.
- CO3:** Classify the different components of air and gas insulated substations.
- CO4:** Analyze single core and multi core cables with different insulating materials.
- CO5:** Analyze the different economic factors of power generation and tariffs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1				2					
CO2	2	3	1								
CO3	2	1	3			1					
CO4	2	3	1			1					

CO5	2	3	1								

UNIT – I

Power Stations: Principle of power generation, site selection and layout of Thermal, Nuclear, Hydro power plant, Components of Thermal and Nuclear power plant

UNIT – II

Distribution Systems: Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT – III

Air and Gas Insulated Substations: Indoor and Outdoor substations, Substations layouts of 66/11 kV showing the location of all the substation equipment, Types of Bus bar arrangements in the Sub-Stations. Types, installation, maintenance, construction, advantages of GIS, Comparison of Air and Gas insulated substations.

UNIT – IV

Underground Cables: Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation and power factor of cable. Capacitance of single and 3- Core belted Cables: Grading of Cables-Capacitance grading

UNIT – V

Economic Aspects of Power Generation and Tariff Methods: Types of load, Load curve, load duration and integrated load duration curves, Important terms and factors in Load Curve. Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Characteristics and types of Tariff.

Text Books:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar and, A. Chakrabarti, Dhanpat Rai AND Co. Pvt. Ltd ISBN:9788177000207.
2. Generation, Distribution and Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers ISBN: 9789393159175.

Reference Books:

1. Principles of Power System by V. K. Mehta and Rohit Mehta, S Chand and Company Limited, Publishers ISBN-13: 9788121930888.
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi ISBN: 9781259081743.

Web Links:

1. <https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant>
2. <https://www.euronuclear.org/1-information/energy-uses.htm>
3. <https://www.slideshare.net/9anku/electrical-distribution-system>

Operation & Control of Electric Machines

	L	T	P	C
Course Code:	2	0	0	2

Course Outcomes:

At the end of the course, students will be able to:

- CO1 Explain the concepts of electromechanical energy conversion & operation of the DC machines.
- CO2 Analyze starting methods & speed control of DC machines.
- CO3 Analyze the performance of DC machines by conducting various tests on DC machines.
- CO4 Analyze the performance of synchronous generator.
- CO5 Analyze the Parallel operation of synchronous generators.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2							1	1	
CO2	2	3	2						1	1	
CO3	3	2	2						1	1	
CO4	3	2							1	1	
CO5	2	3	2						1	1	

UNIT – I

Electromechanical Energy Conversion & introduction to DC machines:

Principles of Energy Conversion, singly excited & multi excited systems, torque production in rotating machines & general analysis of the electromechanical system.

DC Generator: Construction - the principle of operation - EMF equation – Types – Armature reaction - Characteristics – Applications.

UNIT – II

DC Motors: Principle of operation - Types- Back EMF - Torque equation – Characteristics – Losses - Efficiency – Commutation – Applications - 3 point starter - 4 point starter – Speed control methods.

UNIT – III

Single-phase Transformers: Types - constructional details – principle of operation – EMF equation – operation on no load & on load – lagging, leading & unity power factors loads – phasor diagrams of transformers – equivalent circuit.

UNIT – IV

Synchronous generator: Operation – Construction - type – Types of Armature windings – Distribution– Pitch & winding factors – E.M.F equation - armature reaction – Voltage regulation by synchronous impedance method– MMF method & Potier triangle method - Two reaction theory, Slip test.

UNIT – V

Parallel Operation of Synchronous Generators: Parallel operation with infinite bus & other alternators – Power flow equations - Synchronizing power – Load sharing– Control of real & reactive power.

Text Books:

1. Electrical Machinery by P.S. Bhimbra, R.C. Khanna & Vineet Khanna, 1st edition, 2021 ISBN: 9788174091734.
2. Electrical Machines by R. K. Rajput, Lakshmi publications, 5th edition ISBN: 9788131807460.

Reference Books:

1. Electrical Machines by D. P. Kothari, I. J. Nagarth, McGraw Hill Publications, 5th edition (ISBN: 9780070699670).
2. Electrical Machinery by Abijith Chakrabarthi & Sudhipta Debnath, McGraw Hill, 1st edition (ISBN: 9781259006456).

Web Links:

1. <http://nptel.ac.in/courses/108106071>
2. http://www.ncert.nic.in/html/learning_basket/electricity/electricity/machine/machine_content.htm
3. <https://lecturenotes.in/subject/41/electrical-machine-1>

Fundamentals of Power Electronics

	L	T	P	C
Course Code:	2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1** Explain the different types of power semiconductor devices & their Characteristics.
- CO2** Evaluate the performance of rectifiers.
- CO3** Design DC-DC & AC-AC converter with given characteristics.
- CO4** Explain the operation of Inverters.
- CO5** Explain the operation of three phase Inverters & application of PWM techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1						1	1	
CO2	2	3	2						1	1	
CO3	3	2	2						1	1	
CO4	2	3	2						1	1	
CO5	3	2	2						1	1	

UNIT – I

Introduction to Power Electronics devices:

Concept of power electronics, applications, types of power converters, operation & characteristics of Power IGBT, SCR, TRIAC, static & dynamic characteristics of SCR, protection of SCR, turn on methods of SCR & commutation of SCR, Thyristor Firing Circuits.

UNIT – II

Phase Controlled Converters: Principles of single-phase fully-controlled converter with R, RL, & RLE load, effect of freewheeling diode, Principles of single-phase half-controlled converter with RL & RLE load.

UNIT – III

DC-DC Converters: Introduction, Basic principles of step-down & step-up operation, chopper classification study of Buck, Boost & Buck-Boost regulators.

AC-AC converters: AC Voltage Controllers: Introduction, principle of operation of single-phase voltage controllers for R-L, R-L-E loads.

UNIT – IV

Inverters: Introduction, principle of operation, single phase bridge inverters with R, RL & RLC loads,

UNIT – V

3-phase bridge inverters: 180- & 120-degrees mode of operation, Voltage control of single-phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

Text Books:

1. Power Electronics – by P. S. Bhimbra, Khanna Publishers ISBN:9788174092793.
2. Power Electronics: Circuits, Devices & Applications – by M.H Rashid, Prentice Hall of India, 3rd Edition, ISBN: 9788120345317.

Reference Books:

1. Power Electronics: Essentials & Applications by L. Umanand, Wiley, Pvt. Limited, India , ISBN: 9788126519453.
2. Power Electronics, M. D. Singh & K. B. Kanchandhani, Tata McGraw – Hill Publishing Company, 2nd Edition, ISBN: 9780074633694.

Web Links:

1. <https://nptel.ac.in/courses/108/101/108101038/>
2. <https://nptel.ac.in/courses/108/102/108102145/>
3. <https://nptel.ac.in/courses/108/102/108102145/>

Electrical Measurements & Instrumentation

	L	T	P	C
Course Code: 241EE013	2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain different types of instruments for measuring AC & DC quantities.
- CO2:** Explain different types of instruments for measurement of power & power factor.
- CO3:** Identify suitable bridges for measurement of R, L, & C
- CO4:** Analyze the effectiveness of Transducers.
- CO5:** Illustrate the principle of different types of Digital Meters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1								
CO2	3	2	1								
CO3	3	2	1								
CO4	2	3	1								
CO5	3	2	1								

UNIT – I

Analog Ammeter & Voltmeters: Classification – deflecting - control & damping torques – PMMC - Moving Iron type & Electrostatic Instruments - Construction - Torque equation -

Range extension - Errors & compensations. Instrument transformers – Current & Potential transformers- Construction-Working.

UNIT – II

Analog Wattmeters & Power Factor Meters:Electrodynamometer type wattmeter (LPF & UPF) - Power factor meters: Dynamometer & M.I type (Single phase & Three phase) - Single phase induction type energy meters- Construction - theory - torque equation - advantages & disadvantages. Measurement of active & reactive power in single phase & in three phase with balanced loads.

Potentiometers: Introduction to DC & AC Potentiometers – Construction-working.

Practice:

1. Calibration & Testing of single phase energy Meter.
2. Calibration of dynamometer wattmeter using phantom loading.
3. Calibration of PMMC ammeter & voltmeter using Crompton D.C. Potentiometer.
4. Measurement of 3 phase reactive power with single phase wattmeter for balanced Loading.
5. Measurement of 3 phase power with single wattmeter & using two C.Ts.
6. Calibration of LPF wattmeter by direct loading.

UNIT – III

Measurements of Electrical parameters: DC Bridges: Wheat stone's bridge - Kelvin's double bridge for measuring low resistance - Loss of charge method for measurement of high resistance - Megger – measurement of earth resistance.

AC Bridges: Measurement of inductance & quality factor: - Maxwell's bridge - Hay's bridge - &erson's bridge. Measurement of capacitance & loss angle - Desauty's bridge - Schering Bridge.

Practice:

1. Measurement of resistance & Determination of Tolerance using Kelvin's double Bridge.
2. Capacitance Measurement using Schering Bridge.
3. Inductance Measurement using &erson Bridge.

UNIT – IV

Transducers:Definition - Classification - Resistive - Inductive & Capacitive Transducer - LVDT - Strain Gauge - Thermistors - Thermocouples - Piezo electric & Photo Diode Transducers - Hall effect sensors.

Practice:

1. Determination of the characteristics of a LVDT.

UNIT – V

Digital meters : Digital Voltmeters – Successive approximation DVM - Ramp type DVM & Integrating type DVM – Digital frequency meter - Digital multimeter - Digital tachometer - Digital Energy Meter. CRO- measurement of phase difference & Frequency using lissajous patterns.

Additional practice:

1. Measurement of resistance using Wheatstone bridge.
2. Dielectric oil testing using H.T test Kit.
3. Measurement of Choke coil parameters & single-phase power using three voltmeter & three ammeter method.

Text Books:

1. Electrical Measurements & measuring Instruments by E.W. Golding & F.C.Widdis - Wheeler Publishing ,5th Edition, ISBN: 9780273402022.
2. Modern Electronic Instrumentation & Measurement Techniques by A.D. Helfrick & W.D. Cooper - PHI ,5th Edition, ISBN: 9788120307520.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications, ISBN: 9786009578337.
2. Electrical & Electronic Measurements & instrumentation by R.K.Rajput, ISBN: 9788121929899.

Web Links:

1. Electrical Measurements by Buckingham & Price - Prentice – Hall
2. <https://archive.nptel.ac.in/courses/108/105/108105153/>
3. <https://electricalbaba.com/different-types-of-transducers/>

Alternative Energy Sources

Course Code: 241EE034

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the environmental aspects of Renewable Energy Resources.
- CO2:** Describe the use of Solar Energy & the various components used in the energy production.
- CO3:** Understand the conversion principles of Wind & Biomass Energy Resources.
- CO4:** Acquire the basic knowledge of Ocean Thermal Energy
- CO5:** Acquire the basic knowledge of energy conversion & Hydrogen Energy.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2			2					
CO2	3	3	2			2					
CO3	3	3	2			2					
CO4	3	3	2			2					
CO5	3	3	2			2					

UNIT – I

Introduction: Principles of renewable energy; energy & sustainable development, worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale

UNIT – II

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal & inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Solar Thermal systems: Flat plate collector; Solar distillation; Solar Pond electric power plant. Photovoltaic system for electric power generation.

UNIT – III

Wind Energy: Wind velocity & power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double & multiblade system. Vertical axis- Savonius & darrieus types.

Biomass Energy: Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion.

UNIT – IV

Tidal Power: Tides energy suppliers & their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages & limitations.

Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems as

UNIT – V

Green Energy: Introduction, Fuel cells: Classification of fuel cells – H₂; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy (contemporary cases).

Text Books:

1. Non-Conventional energy resources, Khan B.H, Tata Mc-Graw hill, New Delhi, 3rd Edition, ISBN: 9789352601882.
2. Non-conventional Energy Sources, G.D.Rai, Khanna Publications, New Delhi, 4th Edition, ISBN: 9788174090737.

Reference Books:

1. Renewable energy resources, Twidell, J.W. & Weir, A., BSP Books Pvt.Ltd, UK, 2nd Edition, ISBN: 9780415584388.
2. Renewable Energy Technologies, R.Ramesh, Uday kumar, Narosa Publishing House, New Delhi, 1st Edition, ISBN:9788173190674.

Utilization of Electrical Energy

Course Code: 241EE027

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify various illumination methods produced by different illuminating sources.
- CO2:** Identify a suitable motor for electric drives & industrial applications
- CO3:** Identify most appropriate heating & welding techniques for suitable applications.
- CO4:** Distinguish various traction systems & determine the tractive effort & specific energy consumption.
- CO5:** Explain the necessity & usage of different energy storage schemes for different applications & comparisons.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1								
CO2	3	2	1								
CO3	3	2	1								
CO4	3	2	1								
CO5	3	2	1								

UNIT – I

Illumination fundamentals & Methods: Illumination fundamentals Introduction - terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter Sources of light. Various Illumination Methods Discharge lamps - MV & SV lamps – Comparison between tungsten filament lamps & fluorescent tubes Basic principles of light control– Types & design of lighting & flood lighting–LED lighting - Energy conservation.

UNIT – II

Selection of Motors: Choice of Motor - Type of Electric Drives - Starting & Running Characteristics – Speed Control–Temperature Rise – Applications of Electric Drives–Types

of Industrial Loads–Continuous Intermittent & Variable Loads–Load Equalization -
Introduction To Energy Efficient Motors.

UNIT – III

Electric Heating & Welding: Advantages & methods of electric heating–Resistance heating induction heating & di electric heating. Electric Welding. Electric welding–Resistance & arc welding–Electric welding equipment–Comparison between AC & DC Welding.

UNIT – IV

Electric Traction: Traction & electrification– Special features of traction motor– Mechanics of train movement, Speed-time curves, tractive effort, Specific energy consumption, acceleration & retardation–Adhesive weight, coefficient of adhesion.

UNIT – V

Introduction to Energy Storage Systems: Need For Energy Storage - Types of Energy Storage-Thermal - Electrical - Magnetic & Chemical Storage Systems - Comparison of Energy Storage Technologies Applications.

Text Books:

1. Utilization of Electric Power – by Er.R.K Rajput – Lakshmi publications Third Edition , 2023, ISBN: 9788131808290.
2. Utilisation of Electric Power : Including Electric Drives & Electric Traction – by Suryanarayana N.V, New Age International (P) Limited - Publishers – Third edition 2024,ISBN: 9788122405460.

Reference Books:

1. Utilization Of Electric Energy: Including Electric Drives & Electric Traction -by Tarlok singh, ISBN: 9789380027845.
2. Utilization of Electric power & Electric Traction -by J.B.Gupta S.K.Kataria & Sons ISBN: 9789350142585.

Web Links:

- 1 <https://nptel.ac.in/courses/108105060>
- 2 https://onlinecourses.nptel.ac.in/noc23_ag06/preview

Hybrid Electric Vehicles

Course Code: 241EE037

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO 1: Analyze the architectures of HEVs with various components.
- CO 2: Illustrate the concept of Electric Vehicle & Hybrid Electric Vehicles.
- CO 3: Explain the Plan concept of Plug-in Electrical Vehicles.
- CO 4: Analyze the power electronics converters for HEVs.
- CO 5: Apply various energy storage technologies in Hybrid Vehicles.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	2								
CO2	2	3	3								
CO3	1	2	3	2							
CO4	2	3	3	3							
CO5	3	3	3								

UNIT-I:

Introduction: History of hybrid vehicles, architectures of HEVs, series & parallel HEVs, complex HEVs.

UNIT-II:

Hybridization of Automobile: Fundamentals of vehicle, components of conventional vehicle & propulsion load; Drive cycles & drive terrain; Concept of electric vehicle & hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV & PHEV; Fuel Cell vehicles & its constituents.

UNIT-III:

Plug-in Hybrid Electric Vehicle: PHEVs & EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs,

power management of PHEVs, PHEV battery charging.

UNIT-IV:

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV & PHEV battery chargers.

UNIT-V:

Battery & Storage Systems: Energy Storage Parameters; Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource.

Text Books:

1. Advanced Electric Drive Vehicles by Ali Emadi, CRC Press , ISBN: 9781138072855.
2. Electric & Hybrid Vehicles: Design Fundamentals by Iqbal Hussein, CRC Press, ISBN: 9780367693930.

Reference Books:

1. Introduction to Hybrid Vehicle System Modeling & Control by Wei Liu, Wiley ,ISBN: 9788126556205.
2. Electric & Hybrid Vehicles Technologies, Modelling & Control: A Mechatronic Approach by Amir Khajepour, Saber Fallah& Avesta Goodarzi, John Wiley & Sons Ltd , ISBN: 9781118341513.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/108103009/>
2. https://ndl.iitkgp.ac.in/he_document/nptel/nptel/

Special Electrical Machines

Course Code: 241EE035

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the operation & control of Stepper Motor.
- CO2:** Describe theory of operation & control of Switched Reluctance Motor.
- CO3:** Explain the operation & control of Synchronous Reluctance Motor.
- CO4:** Describe theory of operation & control of Permanent Magnet Brushless D.C. Motors.
- CO5:** Explicate the theory of PMSM & LIM & its applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1								
CO2	3	2	1								
CO3	3	2	1								
CO4	3	2	1								
CO5	3	2	1								

UNIT – I

Stepper Motors: Constructional features – Types of Stepper Motors - permanent magnet (PM) type - Hybrid type Stepper Motor - Variable Reluctance Motor (VRM) - Single stack & multiple stack VRM – Characteristics, Modes of Operation & Applications of Stepper Motor.

UNIT – II

Switched Reluctance Motors: Constructional features, Principle of operation, Torque production, Power Converters & their controllers, Methods of Rotor position sensing, Sensor less operation, Closed loop control of SRM, Characteristics.

UNIT – III

Synchronous Reluctance Motor: Construction, Working, Torque Equation, control, Advantages & Applications Synchronous Reluctance Motor

UNIT – IV

Brushless D.C. Motors: Principle of Operation, Types, EMF & torque equations, Commutation, Motor characteristics & control, Torque/speed characteristics.

UNIT – V

Permanent Magnet Synchronous Motors: Construction, Principle of Operation, EMF Equation of PMSM, Torque Equation, Comparison of Conventional & PM Synchronous Motors, Application of PMSM

Linear Induction Motors

Linear Induction Motors (LIM)- Construction– principle of operation— Development of one-sided LIM with back iron equivalent circuit of LIM-Applications

Text Books:

1. Brushless Permanent magnet & reluctance motor drives, by T.J.E.Miller, Clarendon press, Oxford , ISBN:9780198593690.
2. Special electrical Machines, by K. VenkataRatnam, University press, New Delhi, ISBN: 9781439806463.

Reference Books:

1. Special electrical machines, E.G. Janardhanan, PHI learning private limited, ISBN: 9788120348806.
2. Permanent Magnet & BLDC Motor Drives, by Krishnan R, CRC Press ISBN:9780824753849.

Web Links:

1. <https://nptel.ac.in/courses/108102156>
2. <https://www.monolithicpower.com/stepper-motors-basics-types-uses>
3. <https://epochautomation.com/synchronous-reluctance-motor-working/>

Electrical Safety

Course Code: 241EE043

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO 1:** Describe electrical hazards & safety equipment.
- CO 2:** Analyze & apply various grounding & bonding techniques
- CO 3:** Select appropriate safety method for low, medium equipment's & high voltage equipment.
- CO 4:** Participate in a safety team & Carry out proper maintenance of electrical equipment by understanding various Standards.
- CO 5:** Analyze the safety method for high voltage equipment's.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1								
CO2	3	2	1								
CO3	3	2	1								
CO4	3	2	2								
CO5	1	3	1								

UNIT-I:

Hazards of Electricity & Electrical Safety Equipment: Primary & secondary hazards-arc, blast, shocks causes & effects-safety equipment flash & thermal protection, head & eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers & signs, safety tags, locking devices- voltage measuring instruments- proximity & contact testers-safety electrical one line diagram- electrician's safety kit.

UNIT-II:

Grounding of Electrical Systems & Equipment: General requirements for grounding & bonding- definitions grounding of electrical equipment-bonding of electrically conducting materials & other equipment connection of grounding & bonding equipment- system grounding- purpose of system grounding-grounding electrode system- grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment-grounding of low voltage & high voltage systems.

UNIT-III:

Safety Procedures & Methods: The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation & approach distances-calculating the required level of arc protection-safety equipment, procedure for low, medium & high voltage systems- the one-minute safety audit

UNIT-IV:

Safety Management & Organizing Structure: Electrical safety program structure, development- company safety team- safety policy program implementation- employee electrical safety teams- safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.

UNIT-V:

Electrical Maintenance & Legal Safety Requirements & Standards: Safety related case for electrical maintenance- reliability centred maintenance (RCM) - eight step maintenance program- frequency of maintenance- maintenance requirement for specific equipment & location- regulatory bodies- national electrical safety code standard for electrical safety in work place- occupational safety & health administration standards, Indian Electricity Acts related to Electrical Safety

Text Books:

1. Electrical Safety Handbook by John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, McGraw-Hill Education, 4th Edition , ISBN: 9780071745130.
2. Electric Safety Practice & Standards, Khaled Ismail, CRC Press, Taylor & Francis, ISBN: 9781138073999.

Reference Books

1. Electrical Safety- a guide to the causes & prevention of electric hazards, Maxwell Adams.J, The Institution of Electric Engineers, IET, ISBN: 9780852968062.
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning, ISBN: 9780877655800.

Web Links:

1. <http://nptel.ac.in/courses/103106071/5>
2. <https://www.electricalsafetyfirst.org.uk>

Methods & Algorithms for Intelligent Control

L T P C

Course Code: 241EE030

3 0 0 3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Design feedback controllers for complex dynamic systems using ANN.
- CO2:** Design fuzzy logic-based controller for dynamic systems.
- CO3:** Construct TS fuzzy models for complex dynamic systems.
- CO4:** Formulate hybrid controllers by combining the concepts of Genetic Algorithm and BioInspired algorithms with ANN.
- CO5:** Formulate hybrid controllers by combining the concepts of Genetic Algorithm and BioInspired algorithms with Fuzzy logic.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3	1	2						
CO2	2	2	3	1	2						
CO3	2	2	3	1	2						
CO4	2	2	3	1	2						
CO5	2	2	3	1	2						

UNIT – I

Introduction: Introduction to intelligent control, comparison study between conventional and intelligent control, intelligent supervisory control, intelligent adaptive control.

UNIT – II

Neural network based control: Introduction to Neural Network, theory of neural network for classification and function approximation, supervised and unsupervised learning rules, RBF neural network, Support vector machines, intelligent control using Neural Network, Approximation capabilities by feed-forward and recurrent neural network, Neuro-control based on back propagation algorithm, system identification with neural network.

UNIT – III

Fuzzy logic control: Introduction to fuzzy set theory and logic, application of fuzzy logic in control system, fuzzy quantization of knowledge, fuzzy controller design, Fuzzy T-S modelling for dynamic system and stability using Lyapunov theory.

UNIT – IV

Genetic algorithm and control: Basic theory and operations of Genetic algorithm, GA based control system, optimization problem using GA related to control and other engineering problems.

UNIT – V

Bio-inspired evolutionary algorithms: Bio-inspired evolutionary algorithms – like Particle swarm optimization (PSO), simulated annealing, Fire-fly optimization, bacterial foraging etc – only the concepts and case studies related control problems.

Text Books:

1. Neural Networks, Simon Haykin. Pearson Education Asia, ISBN: 9780023527616.
2. Genetic Algorithm in Search Optimization & Machine Learning, David E. Goldberg, Pearson Education, ISBN: 9780201157673.

Reference Books:

1. Fuzzy logic (intelligence control and information), J. Yen and R. Langari, Pearson, first Edition, ISBN: 9780135258170.
2. Methods and Applications of Intelligent Control, Spyros G. Tzafestas, Kluwer academic publisher (ISBN: 9780792346241).

Web Links:

1. <https://archive.nptel.ac.in/courses/108/104/108104049/>
2. <https://archive.nptel.ac.in/courses/106/106/106106126/>

Minor Degree in Mechanical Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241ME074	Basic Mechanical Engineering	FC	2			2	50	50	100	-
241ME004	Engineering Thermodynamics	IC	2	1		3	50	50	100	SSP/MP
241ME077	Introduction to Automobile Engineering (or)	IC	3			3	50	50	100	SSP/MP
241ME078	Mechanics of Solids									
241ME012	Heat Power Engineering (or)	IC	2	1		3	50	50	100	ETD
241ME040	Refrigeration & Air Conditioning									
241ME075	Production Technology	IC	3			3	50	50	100	EW
241ME076	Metallurgy & Material Science	IC	3			3	50	50	100	SSP/MP
241ME079	Theory of Machines (or)	AC	3			3	50	50	100	SSP/MP
241ME080	Advanced Engineering Metrology									
	Total		18	2		20				

Basic Mechanical Engineering

Course Code: 241ME074

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the basic concepts of thermodynamics and fluid mechanics
- CO2:** Explain the engineering design principles and process
- CO3:** Draw the velocity and acceleration diagrams analyzing machines and mechanisms
- CO4:** Explain the different manufacturing techniques
- CO5:** Explain the fundamentals of vibrations in mechanical systems

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	2										
CO3	3	3									
CO4	2										
CO5	3	2									

Unit – I

Thermodynamics: Basic concepts and definitions (system, surroundings, state, process, cycle) Zeroth, First, and Second Laws of Thermodynamics, Properties of pure substances, Energy analysis of closed systems and Control volumes, Applications

Fluid Mechanics: Properties of fluids, Pressure variation in a static fluid, Manometry, Bernoulli's equation, Continuity equation, Venturi meter, Orifice meter, Pitot tube, Laminar and Turbulent flow, Reynolds number

Unit – II

Engineering Design:

Definition and importance of engineering design, The role of design in engineering, Historical perspectives and case studies, Steps of the engineering design process, Principles of design thinking, Introduction to computer-aided design (CAD)

Unit – III

Machines & Mechanisms:

Machines: Definition and significance of machines and mechanisms, History and evolution of mechanical systems, Applications

Mechanisms: Types of mechanisms (linkages, cams, gears), Kinematic analysis of mechanisms, Velocity and acceleration diagrams, Gears and gear trains and applications.

Unit – IV

Manufacturing Processes:

Introduction to manufacturing techniques, Casting, Forging, Forming, Machining, Welding, Joining, Powder metallurgy, Plastic and Composite manufacturing, Introduction to Computer Numerical Control (CNC) machines, Additive manufacturing. Introduction to Robotics - Joints & Links, Configurations and Applications of Robotics

Unit – V

Vibrations:

Fundamentals of Vibration: Introduction to Free vibration of single-degree-of-freedom systems, Damped vibration, Forced vibration, Vibration isolation and transmissibility.

Vibration Measurement: Vibration measuring instruments, Basic concepts of vibration control.

Text Books:

1. Basic Mechanical Engineering, P.K. Nag, Tata McGraw Hill Education, 3rd Edition, ISBN : 9780070708389.
2. Manufacturing Engineering and Technology, Serope Kalpakjian and Steven Schmid, Pearson Education; 7th Edition, ISBN-13. 978-9332587908.

Reference Books:

1. Theory of Machines, S.S. Ratan, McGraw Hill Education India Private Limited, 4th Edition, ISBN-13. 978-9353166281.
2. Engineering Design - A Project-Based Introduction, CL Dym, John Wiley & Sons Inc, 4th Edition, ISBN-13, 978-1118324585.

Web Links:

1. <https://nptel.ac.in/courses/112105123>
2. <https://archive.nptel.ac.in/courses/112/107/112107145/>

Engineering Thermodynamics

Course Code: 241ME004

L	T	P	C
2	1	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the thermodynamic concepts to analysis the system, equilibrium, processes, and irreversibility
- CO2:** Apply the zeroth and first laws of thermodynamics to the thermodynamic processes.
- CO3:** Apply the second law of thermodynamics to the thermodynamic processes.
- CO4:** Analyze thermodynamic properties of pure substances using steam tables and steam calorimetry
- CO5:** Explain the working of various refrigeration system and Psychrometric process

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Introduction:

System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility

UNIT – II

Zeroth and First Law of Thermodynamics

Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and steady flow energy equation with applications of nozzle, diffusers, turbines, compressors, and throttling. Limitations of the First Law – Enthalpy.

UNIT – III

Second Law of Thermodynamics

Heat engine and reversed heat engine, Statements of second law (Kelvin-Planck and Clausius Statement) and their equivalence/Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

UNIT – IV

Properties of Pure Substances

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry

UNIT – V

Introduction to Refrigeration: Working of Air Refrigeration System, Vapour Compression Refrigeration System, Coefficient of performance (COP), Refrigerants.

Introduction to Air Conditioning: Psychrometric properties & Psychrometric process - adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing.

Text Books:

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill Publishers, 6th Edition, ISBN: 9789352606429.
2. Thermodynamics: An Engineering Approach, Cengel, Y.A and Boles, M.A, McGraw Hill, 5th Edition, ISBN: 0073107689.

Reference Books:

1. Treatises on Heat Engineering, V.P.Vasandhani & D.S Kumar, Metropolitan Book Depot, 4th Edition, ISBN: 9788120003507.
2. Engineering Thermodynamics, Mayhew and Rogers, Longman Green & Co Ltd., 4th Edition, ISBN: 0582045665.

Web Links:

1. <https://archive.nptel.ac.in/courses/112/106/112106310/>
2. <https://archive.nptel.ac.in/courses/112/104/112104113/>
3. <https://ocw.mit.edu/courses/3-00-thermodynamics-of-materials-fall-2002/download/>

Introduction to Automobile Engineering

Course Code: 241ME077

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the Vehicle Chassis Layouts of 4-wheelers
- CO2:** Identify the different constructional features and working principles of Un-Sprung components of the given vehicle
- CO3:** Identify the different constructional features and working principles Sprung components of the given vehicle.
- CO4:** Summarize the functionalities of various Electrical systems of typical Automobile
- CO5:** Explain the different Active and Passive Vehicle Safety Systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2						1	2	1		1
CO2	3			3			1	2	1	1	1
CO3	2						1	2	1		1
CO4	3	1	1				1	2	1		1
CO5	3	1	1			3	1	2	1		1

UNIT – I

Introduction: History of Automobile and introduction to Automobile Industry, Chassis Layouts : Components of four wheeler automobile - power transmission modes, Types and Homologation of Vehicles.

UNIT – II

Transmission: Clutches, Gear Box, Rear Axles and its Types, Differential and its applications. Steering System: Steering geometry – Types of steering mechanism steering linkages of Independent and Conventional Suspension.

UNIT – III

Suspension System:

Objectives of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system, Air Suspension, Rubber Suspension.

Braking System:

Mechanical braking system, hydraulic braking system requirement of brake fluid.

UNIT – IV

Wheels and Tyres

Basic Requirements of Wheels and Tyres, Construction of Wheel Assembly, Tyre Construction, Types, Tyre Sizes and Designation, Aspect Ratio, Tyre Tread Pattern, Selection of Tyre under Different Applications.

UNIT – V**Electrical System:**

Charging circuit, generator, starting system, lighting, horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator.

Safety Systems:

Introduction, safety systems - seat belt, air bags, anti-lock brake system (ABS), Electronic Brake force Distribution (EBD), Head restraints, seats with anti-submarine effects and fuel cut off switch.

Text Books:

1. Automobile Engineering, Kirpal Singh, Vol- I, Standard Publisher, New Delhi, 2020, ISBN: 9788180142420.
2. Motor Vehicles, Newton Steeds and Garret, Butterworth, 13th Edition, ISBN: 0750637633.

Reference Books:

1. Modern Vehicle Technology, Heinz Hazler, Butterworth, London, 2nd Edition, ISBN: 0750651318.
2. Automotive Chassis, Heldt P.M., Chilton Co., New York, 2012, ISBN: 1258386380.

Web Links:

1. <https://archive.nptel.ac.in/courses/107/106/107106088/>
2. <https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/?couponCode=LEADERSALE24A>

Mechanics of Solids

Course Code: 241ME078

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Calculate stress and strain in bodies of varying cross-section and composite bars, principal stresses and strain energy.
- CO2:** Determine the shear force and bending moment diagrams for beams of various loads.
- CO3:** Analyse the variation of bending and shear stresses across a beam.
- CO4:** Compute the slope and deflection for beams of varying loads and support arrangements and torsional rigidity of a solid and hollow shaft.
- CO5:** Analyze the stresses and stability characteristics of thin, thick cylinders and columns.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2								
CO2	3	3	2	1							
CO3	3	3	2	1							
CO4	3	3	2	1							
CO5	3	3	2	1							

UNIT – I

Simple Stresses & Strains: Elasticity and plasticity – Types of stresses & strains–Hooke’s law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson’s ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr’s circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT – II

Shear Force and Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed load, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT – III

Flexural Stresses: Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT – IV

Deflection of Beams: Bending into a circular arc – slope, deflection and radius of curvature - Differential equation for the elastic line of a beam – Double integration and Macaulay's methods - Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method - application to simple cases.

Torsion: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT – V

Thin and Thick Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lamé's equation – cylinders subjected to inside & outside pressures – compound cylinders.

Columns: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

Text Books:

1. Strength of materials, GH Ryder, Palgrave Macmillan publishers India Ltd, ISBN-13978-0333109281.
2. Strength of materials, B.C. Punmia, Lakshmi publications Pvt. Ltd, 10th Edition, New Delhi, ISBN - 978-8131809259.

Reference Books:

1. Mechanics of materials, Gere & Timoshenko, CBS publications, 2nd Edition ,ISBN: 978-8123908946.
2. Strength of Materials, Andrew Pytel and Ferdinand L. Singer, Longman Publications, 4th Edition, ISBN:9780060453138.
3. Mechanics of Solids, Popov, New Pearson Education, 2nd Edition, ISBN:978-9332550216.

Weblinks:

1. <https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204>
2. <https://www.coursera.org/learn/mechanics-1>

Heat Power Engineering

Course Code: 241ME012

L	T	P	C
2	1	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply the various techniques to improve the performance of Rankine Cycle
- CO2:** Explain the working principle and performance of boiler and draught system
- CO3:** Analyse the performance of Steam nozzles
- CO4:** Analyse the performance of Impulse and Reaction Turbines
- CO5:** Analyse the performance of Steam Condensers and Gas Turbines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Steam Power Cycles:

Steam Power plant - Layout, Rankine cycle - Schematic layout, Thermodynamic analysis - Simple Cycle. Methods to improve cycle performance - Regeneration & Reheating cycle.

UNIT – II

Boiler: Classification, Working principles of low-pressure (LP) & high-pressure (HP) boilers with sketches, Boiler mountings and accessories. Performance of boiler - Equivalent evaporation - Efficiency.

Draught System: Classification – Natural and Artificial draught – Induced, Forced & Balanced draught - height of chimney for given draught and discharge - condition for maximum discharge and chimney efficiency

UNIT – III

Steam Nozzles

Function of a nozzle – applications – types, Flow through nozzles and thermodynamic analysis, assumptions, Velocity coefficient and condition for maximum discharge, Critical pressure ratio, Supersaturated flow and its effects, Degree of super saturation and Degree of undercooling, Wilson line.

UNIT – IV**Steam Turbines:**

Impulse turbine: Mechanical details - Velocity diagram - Effect of friction power developed, Axial thrust, Blade or diagram efficiency - condition for maximum efficiency.

Reaction Turbine: Mechanical details, principle of operation, Thermodynamic analysis of a stage, Degree of reaction velocity diagram, Parson's reaction turbine, Condition for maximum efficiency, Calculation of blade height. Compounding – Velocity, Pressure and Velocity Pressure compounding

UNIT – V**Steam Condensers:**

Classification - working principle, vacuum efficiency and condenser efficiency, air leakage, sources and their effects, air pump, cooling water requirement.

Gas Turbines:

Simple gas turbine plant - Ideal cycle - Essential components - Actual cycle. Regeneration, Inter cooling and Reheating cycle, Merits and demerits.

Text Books:

1. Heat Engineering, V.P Vasandani and D.S Kumar, Metropolitan Book Company, 4th Edition, ISBN: 978-8120003507.
2. Thermodynamics and Heat Engines, R. Yadav, Central publishing house, 6th Edition, ISBN:978818544403.

Reference Books:

1. Thermodynamics: An Engineering Approach, Cengel, Y. A. and Boles, M. A., Tata McGraw-Hill, 7th Edition, ISBN:978-0-07-352932-5.

2. Thermal Engineering, P.L.Ballaney, Khanna publishers, 25th Edition, ISBN:978-81-7409-031-7

Web Links:

1. <https://nptel.ac.in/courses/112/106/112106303/>
2. <https://nptel.ac.in/courses/112103262>.

Refrigeration & Air Conditioning

Course Code: 241ME040

L	T	P	C
2	1	0	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Explain the principle and applications of air refrigeration system.

CO2: Describe vapour compression refrigeration system.

CO3: Explain different types of vapour absorption refrigeration system.

CO4: Describe air-conditioning processes using the principles of Psychrometry.

CO5: Calculate loads in air-conditioning system and explain different heat pump circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2				1					1
CO2	3	2				1					
CO3	3	2				1					
CO4	2	3				1					1
CO5	3	2				1					

UNIT – I

Introduction to Refrigeration:

Necessity, application, unit and C.O.P of refrigeration, Reversed Carnot cycle, Bell Coleman cycle with its numerical problem, Air Refrigeration System (ARS), Open & Dense air system, Refrigeration system used in air crafts and its problem. Classification of Refrigerants & its Properties, Nomenclature, Ozone layer Depletion, Global Warming.

UNIT – II

Vapour Compression Refrigeration System (VCRS):

Simple Vapour Compression Refrigeration Cycle, Comparison between ARS & VCRS, Representation of cycle on T-S and P-H charts, Effect of sub cooling & super heating, Actual cycle influence of various parameters on system performance, Brief description about Actual VCRS.

UNIT – III

Vapour Absorption Refrigeration System (VARs):

Working principal of VARS, Comparison between VCRS & VARS, Description & working of principle of Ammonia-Water VARS, Lithium-Bromide water VARS, Principle & operation of three fluid absorption system. Salient features, working principle and basic components of Steam Jet Refrigeration System, Principle & operation of thermoelectric refrigeration system - Vortex tube.

UNIT – IV

Introduction to Air Conditioning:

Psychometric properties & processes, Ventilation, Infiltration, Comfort conditions, Factors Affecting Human Comfort, Factors Affecting Optimum Effective Temperature, Requirements of human comfort and concept of effective temperature, comfort chart. Air Conditioning Systems: Working principle of comfort, industrial, winter, summer, year-round, unitary and central air conditioning system.

UNIT – V

Air-conditioning load calculations:

Load concepts of Room Sensible Heat Factor, Grand Sensible Heat Factor and Effective Room Sensible Heat Factor. Classification of equipment used in an air conditioning system, Humidifier, filters, grills, registers, fans, and blowers. Air Handling Units, Heat pump – heat sources, Different types of heat pump circuits.

Text Books:

1. Refrigeration and Air-conditioning, Arora C.P., Tata Mc Graw –Hill, 4th edition, 2021, ISBN : 9789390385843.
2. Refrigeration and Air Conditioning, Khurmi R. S., S Chand, Revised edition, 2019, ISBN : 9788121927819.

Reference Books:

1. Refrigeration and Air Conditioning, Manohar Prasad, New Age International, Pvt Ltd, 3rd edition 2021, ISBN:978-8122436945.
2. A Course in Refrigeration and Air conditioning, S. C. Arora & S. Domkundwar, Dhanpatrai, ISBN: 9788120339156.

Data Book:

1. Refrigerant and Psychrometric Properties - Tables and Charts [SI Units], Mathur, M. L., and Mehta, F. S., Jain Brothers.

Weblinks:

1. <https://nptel.ac.in/courses/112105128>.
2. <https://www.udemy.com/course/water-cooler-dispenser-working-and-circuit-diagram/?couponCode=NVDPRODIN35>.
3. <https://bharatskills.gov.in/Home/StudyMaterial?var=06nHBys5P85EmOqtjA1wsA==&Default=YES>.

Production Technology

Course Code: 241ME075

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Elaborate the fundamental principles of casting process.
- CO2:** Classify the various joining process with applications
- CO3:** Discuss the basic concepts of metal forming techniques
- CO4:** Explain the basic concepts of smithy and forging techniques.
- CO5:** Explain the basic concepts of plastic processing techniques and powder metallurgy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2					1		2	1		
CO2	2	1	2			1		2	1		
CO3	2	2	1		1	1		2	1		
CO4	2	2	1		1	1		2	1		
CO5	2	2	1		1	1		2	1		

UNIT – I

Introduction:

Introduction to manufacturing process, Classification and Overview of Manufacturing Processes. Introduction to Metal Casting, Casting design considerations, Sand casting process, Casting Terminology, Types of Patterns, Pattern Materials and Pattern Allowances, Sand casting, Classifications of Moulds, moulding materials and their properties, Core, Gating system and its Design, Riser and its design, Foundry - furnaces, Melting & Pouring, Fluidity, Solidification of pure metals and alloys, Casting defects, Advanced casting processes, advantages and applications.

UNIT – II

Metal Joining:

Introduction, Classification of Welding Processes, Gas Welding & Cutting , Arc Welding-Theory of heat generation, Power Source Selection, Arc characteristics, Arc blow, ISI classification of coated electrodes, SMAW,GTAW,GMAW-CO2 12, SAW,LBW,EBW,UW, Resistance welding, Solid state welding processes, Hybrid Welding Processes, Brazing, Soldering and their applications, HAZ, characteristics of weldment, Welding Defects and Remedies.

UNIT – III

Sheet Metal Work:

Standard Specifications for Sheets, Sheet Metal Operations, Yield criteria, Plastic deformation of metals, Tools and Equipment in SMW, Deep drawing.

Forming : Hot working and Cold working, Rolling, Hubbing, Embossing, Thread rolling, Tube Piercing, Hot spinning, Press Working, Defects in metal working, Wire Drawing, Tube drawing. High Energy rate Forming (HERF) processes.

UNIT – IV

Smithing And Forging:

Forging & Forging dies, Smith Forging operations, Forging Process, Hand Forging, Power Forging, Impression Die Forging, Drop Hammers, Press Forging, Upset forging, Forging Defects and Remedies.

UNIT – V

Plastic Processing:Types of Plastics, Properties, Applications, and their processing methods, Blow molding and Injection molding.

Powder Metallurgy:Powder production methods, compaction, and sintering. Applications of powder metallurgy. Advantage and Disadvantage of Powder Metallurgy in comparison to Conventional Shaping process.

Text Books:

1. Manufacturing Engineering and Technology, Kalpakian S, Schmid S.R., Pearson Education, Delhi, 7th Edition 2018, ISBN 978-9332587908.
2. Fundamentals of Modern Manufacturing, Groover Mikell P, John Wiley and Sons Inc, 7th Edition, 2018, ISBN 978-1119722014.

Reference Books:

1. Manufacturing Science, A. Ghosh & A.K. Mallik, East West Press Pvt. Ltd Publication, 3rd Edition, ISBN 978-8176710633.
2. Manufacturing Processes, H.S. Shan, Cambridge University Publication, 2nd Edition, ISBN 978-1316638583.
3. Process and materials of manufacture, Lindberg, PHI Publications, 4th Edition, ISBN 978-8120306639.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_me16/preview
2. https://onlinecourses.nptel.ac.in/noc24_me51/preview
3. <https://archive.nptel.ac.in/courses/113/106/113106098/>

Metallurgy & Material Science

Course Code: 241ME076

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the concepts of structure of metals and equilibrium diagrams.
- CO2:** Analyse the ferrous and non-ferrous metals and alloys in industrial applications
- CO3:** Analyse the heat treatment on steels.
- CO4:** Explain the methods of making of metal powders and applications of powder metallurgy.
- CO5:** Summarize the properties and applications of ceramic and composite materials.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2	2	2									
CO3	2	2									
CO4	2	1									
CO5	2	1									

UNIT– I

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries– determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rothery’s rules, intermediate alloy phases, and electron compounds.

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe₃C.

UNIT–II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die

steels.

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT–III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe₃C system, annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT–IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.

UNIT– V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nano materials and smart materials.

Text Books:

1. Introduction to Physical Metallurgy, Sidney H Avner, TMH Publications, 2nd Edition
2. Materials Science and Metallurgy, V.D. Kodgire, Everest Publishing House, 39th Edition

Reference Books:

1. Materials Science and Engineering, An Introduction, William D. Callister, Wiley Publications, 9th Edition.
2. Mechanical Metallurgy George Ellwood Dieter, David Bacon. McGraw- Hill Book company.
3. Engineering Materials & Metallurgy, R.K. Rajput, S. Chand Publications, 2nd Edition.

Weblinks:

1. <https://archive.nptel.ac.in/courses/113/106/113106032/>
2. <https://www.coursera.org/learn/fundamentals-of-materials-science>
3. <https://www.coursera.org/learn/material-behavior>.

Theory of Machines

Course Code: 241ME079

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply the knowledge of mechanisms in real time applications
- CO2:** Construct the velocity and acceleration diagrams using relative velocity method and instantaneous centre method.
- CO3:** Calculate the velocity and acceleration of follower motions and construct the cam profile
- CO4:** Calculate the velocities of different components of a compound and epicyclic gear trains
- CO5:** Construct the turning moment diagram of engine and flywheel.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	2	2									
CO3	2	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Elements of Kinematics

Classification of Mechanisms-Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain -Limit positions- Mechanical advantage- Description of common mechanisms- Inversions of 4-bar chain: Crank and Slotted Lever mechanism, Quick Return Motion mechanism, Davis and Ackermann Steering gear mechanisms, Hooke's joint.

UNIT – II

Velocity and Acceleration Analysis

Plane motion of a rigid body: Instantaneous centre of rotation, centrode and axode - Relative motion between two bodies – Kennedy's Theorem – Graphical determination of instantaneous centre for Four bar and Single Slider Crank chain mechanisms, Determination of Angular Velocity of points and links. Motion of a Link in Machine - Determination of Displacement,

Velocity and Acceleration for a Four Bar Mechanism, Single Slider Crank chain mechanism, Double Slider Crank chain mechanism.

UNIT – III

Cams and followers

Definition and classification of Cams and Followers - Terminology - Types of follower motion: Uniform velocity, Simple harmonic motion and Uniform Acceleration and Retardation, Cycloidal motion for Knife edge, Flat face and Roller follower and offset follower.

UNIT – IV

Power Transmission:

Introduction –Modes of Power Transmission applications. Gears and Gear Trains- Classification, Terminology, Law of Gearing, Path of contact, Arc of contact. Interference, Methods of avoiding interferences. Simple gear train, Compound gear train, reverted gear train, epicyclic gear train and Differential. Table method to find velocity of components of a gear train.

UNIT – V

Turning Moment Diagrams:

Static and dynamic force analysis of planar mechanisms, Dynamic force analysis of slider crank mechanism, Inertia Torque, Angular Velocity and Acceleration of connecting rod, Crank Effort and Turning Moment Diagrams – Fluctuation of energy – Fly Wheel design.

Text Books:

1. Theory of machines, S.S.Rattan, Tata Mc Graw Hill, 5th Edition, 2019, ISBN: 9789351343479.
2. Theory of machines, Thomas Bevan, CBS Publishers, 3rd Edition, ISBN: 9788123908748.

Reference Books:

1. Theory of machines: Kinematics and Dynamics , Sadhu Singh, 3rd Edition, Pearson Publisher, 2011, ISBN: 9788131760697.
2. Theory of machines, R.K.Bansal, J.S.Brar, Laxmi Publications, 6th Edition, ISBN: 9788131808054.

Web Links:

1. https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_403_Part_3_KINEMATICS_OF_MACHINERY.pdf
2. <https://archive.nptel.ac.in/courses/112/104/112104121/>

Advanced Engineering Metrology

Course Code: 241ME080

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify the generalized concept of measurement system.
- CO2:** Summarize the concepts of DC and AC bridges used in measurement systems.
- CO3:** Apply the fundamentals in measurements and calibration of instruments.
- CO4:** Describe the working principles and operation of measuring instruments.
- CO5:** Explain the basic physics of transducers and their operating principles.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									2
CO2	3	2									1
CO3	3	2									1
CO4	3	2									1
CO5	3	2									1

UNIT-I

Generalized Configuration of Measuring System: Functional elements of a basic measuring system, different types of measurands, description of functional elements, input-output configuration of a measuring system, linear and angular measurements, comparators, interferometry, form and finish measurement, alignment and testing methods, tolerance analysis in manufacturing and assembly, concepts of coordinate-measuring machine (CMM), mathematical model for generalized configuration of a measurement system.

UNIT-II

Comparative Methods of Measurements: D.C potentiometers, D.C (Wheat stone, and Kelvin bridge) & A.C bridges (Maxwell, Anderson, and Schering bridges), transformer ratio bridges, self-balancing bridges, interference & screening, multiple earth and earth loops, electrostatic and electromagnetic interference, grounding techniques, uncertainty analysis.

UNIT- III

Characteristics of Instruments: Objective of studying the characteristics of the instruments. Static characteristics – accuracy, precision, error, sensitivity, hysteresis, threshold, drift, span, and static stiffness, dynamic characteristics – time domain and frequency domain characteristics terms, concept of mechanical loading.

UNIT-IV

Principles of Instrumentation: Sensor interrogation principles using bridge circuits, signal amplification, signal conditioning (transduction, & linearization), phase measurements, active and passive filters, isolation and shielding, elements of control theory, digital data acquisition.

UNIT- V

Principles of Transduction and Transducers: Description of various types of transduction principles. transducers based on variable resistance, variable inductance, variable capacitance, and piezo-electric effects, displacement transducers - wire wound potentiometers, LVDT, strain gauges, diaphragm type pressure transducers and other pressure measuring techniques, design of accelerometers and their applications, temperature and flow measurement techniques.

Textbooks:

1. Instrumentation for Engineering Measurements, James W. Dally, W.F. Riley and K.G. McConnell, John Wiley & Sons Inc, 2nd Edition, ISBN:978-0471551928
2. Mechanical Measurements and Instrumentation & Control, A. K. Sawhney, Dhanpat Rai & Co. (P) Limited, ISBN:978-8177000238.

Reference Books:

1. Engineering Metrology, M. Mahajan, Dhanpat Rai Publishers, 1st Edition, ISBN:978-8177000511.
2. Mechanical and Industrial Measurements, R. K. Jain, Khanna Publishers, 1st Edition ISBN:978-8174091918

Web Links:

1. <https://archive.nptel.ac.in/courses/112/106/112106139/>
2. <https://ocw.mit.edu/courses/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/>

Minor Degree in Computer Science and Engineering

Course Code	Course Title	Level	L	T	P	C	CI E	SE E	Total	Pre-requisite
241CS013	Operating Systems	IC	2		1	3	50	50	100	-
241CS007	Computer Networks	IC	2		1	3	50	50	100	-
241IT007	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC

241AI003	Data Mining	IC	2		1	3	50	50	100	-
241CS008	Object Oriented Programming through C++ (or) Java Programming	IC	2		2	4	50	50	100	PPSC
241IT006										
241CS016	Introduction to MERN Stack	IC			2	2	-	100	100	JP
241CS030	Development (or) Information Security Analysis & Audit	IC	2			2	50	50	100	-
241CS018	Advanced MERN Stack	AC			2	2	-	100	100	IMSD
241IT012	Development(or) Flutter Fundamentals	AC			2	2	50	50	100	-
Total			12		8	20				

Operating Systems

	L	T	P	C
Course Code: 241CS013	2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

CO1: Describe basic concepts of operating systems and its structure.

- CO2:** Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
- CO3:** Interpret the issues and challenges of memory management.
- CO4:** Illustrate concepts of Disk management and file system implementation.
- CO5:** Explain issues related to protection and security mechanisms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3								1		
CO2	1	3		1					2		1
CO3	1	3		1					2		1
CO4	1	3		1					1		1
CO5	2	2							1		

UNIT – I

Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot. Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

UNIT – II

Process Concept: Process scheduling, Operations on processes, Inter-process communication. Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling. Multithreaded Programming: Multithreading models, Thread libraries, Threading issues Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the following CPU scheduling algorithms:FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

UNIT – III

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

UNIT – IV

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.

Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.

File Systems: Files, Directories, File system implementation, management and optimization.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm
4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

UNIT – V

Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.

System Security: Introduction, Program threats, System and network threats.

Practice:

1. The above topics are discussed as case study in Windows/ Unix OS

Text Books:

1. Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12th Edition. ISBN: 978-0470128725.
2. Operating Systems: Internals and Design Principles, William Stallings, Prentice-Hall, 7th Edition, ISBN: 978-9332518803.

Reference Books:

1. Modern Operating Systems, Tanenbaum A S, Pearson Education, 3rd Edition. ISBN: 978-0136006633.
2. Operating Systems A Concept Based Approach, Dhamdhere D M, Tata McGraw-Hill, 3rd Edition. ISBN: 978-1259005589.
3. Operating Systems, Nutt G, Pearson Education, 3rd Edition, ISBN: 978-8131723593.

Web Links:

1. <https://archive.nptel.ac.in/courses/106/106/106106144/>
2. <https://archive.nptel.ac.in/courses/106/105/106105214/>
3. <https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems>
4. <https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923>

Computer Networks

Course Code: 241CS007

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe network topologies, reference models and media for data transmission
- CO2:** Analyze error and flow control issues in data link layer
- CO3:** Classify MAC protocols and channelization techniques
- CO4:** Apply routing algorithms and congestion control techniques for effective data transmission
- CO5:** Analyze protocols Transport and Application Layers

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2		2									
CO3		2							1	1	
CO4	1	2	2						2		1
CO5		1			1						1

UNIT – I

Network Overview: interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

Practice:

1. Study of Network devices in detail and connect the computers in Local Area Network

UNIT – II

Data Link Protocols: framing and data transparency, error detection & correction, flow control.

Practice:

1. Write a Program to implement the data link layer framing methods such as i) Character stuffing ii) bit stuffing.

UNIT – III

Media Access Control: Random Access: ALOHA, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance, Controlled Access: Reservation, Polling, Token Passing, Channelization: frequency division multiple Access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA).

Practice:

1. Write a Program to implement Sliding window protocols

UNIT – IV

Routing Algorithms: The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical

Congestion Control algorithms: General principles of congestion control, Congestion prevention policies, Approaches to Congestion Control, Traffic Aware Routing, Admission Control, Traffic Throttling: Load Shedding

Traffic Control Algorithm: Leaky bucket & Token bucket.

Practice:

1. Programs to implement routing protocols like shortest path.

UNIT – V

IP Protocols: IP Addressing, IP & ICMP.

Transmission Control Protocol: UDP & TCP.

Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP

Text Books:

1. Computer Networks — Andrew S Tanenbaum and David J Wetherall, Pearson Education, 5th Edition. ISBN: 978-0132126953
2. Data Communications and Networking – Behrouz A. Forouzan, McGraw Hill Education, 5th Edition ISBN: 978-1259064753

Reference Books:

1. Data Communications and Networks- Achut S Godbole, AtulKahate, McGraw-Hill Education (India) Pvt Limited, 2nd Edition. ISBN: 978-0-07-123110-7
2. Computer Networks, Mayank Dave, CENGAGE India, 6th Edition ISBN: 978-8131509869

Web Links:

1. <https://nptel.ac.in/courses/106105081>
2. <https://www.coursera.org/learn/fundamentals-network-communications>

Software Engineering
(Common to CSE, IT AIML & CSE (DS))

	L	T	P	C
Course Code: 241IT007	2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply software engineering practices and evaluate different software development models to design and manage the life cycle of a Student Management System (SMS).
- CO2:** Analyze the principles of Agile methodologies and compare them with traditional models by transitioning a retail software company from Waterfall to Agile.
- CO3:** Evaluate the impact of Agile processes on requirements engineering and manage unstable requirements for a social media platform project.
- CO4:** Design and implement a comprehensive testing strategy using TDD and test automation tools in an Agile project.
- CO5:** Apply Agile design principles and execute refactoring techniques to develop maintainable and scalable software systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			2						
CO2	3	2	1	1				2	2	2	1
CO3	2	1	1							2	1
CO4	3	2	2	1				2	2	2	1
CO5	1	2									

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Text Books:

1. Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
2. Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

1. Software Engineering, Lan Sommerville, Pearson, Ninth Edition.

2. Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, David J. Anderson; Eli Schragenheim.

Web Links:

1. https://www.tutorialspoint.com/software_engineering/
2. <https://www.sciencedirect.com/science/article/pii/S0950584916303329>

Data Mining

Course Code: 241AI003

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate data warehousing architectures and mining concepts for knowledge discovery.
- CO2:** Apply preprocessing techniques to prepare data for mining algorithms.
- CO3:** Build classification model using Decision tree induction.
- CO4:** Analyze association rule generation using Apriori and FP growth algorithms.
- CO5:** Apply Clustering algorithms on given data to find similarity between classes.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2		1			1	1		2
CO2	2	2	2		2			1	1		2
CO3	2	2	3		1			1	1		2
CO4	2	2	3		1			1	1		2
CO5	2	2	3		1			1	1		2

UNIT – I

Data Warehousing and Online Analytical Processing:

Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation, Data Generalization by Attribute Oriented Induction.

Data Mining: What Is Data Mining, Why Data Mining, Data Mining Functionalities, Technologies Are Used, Major Issues in Data Mining, Architecture Of Data Mining Systems Classification Of Data Mining Systems.

Practice:

1. Illustrate KDD process and explore the Data Mining tool WEKA/KNIME for Data Preprocessing, Classification and Clustering.
2. Explain ETL process important for moving data in the data warehouse.

UNIT – II

Know Your Data : Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity.

Data Preprocessing : An Overview, Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization

Practice:

1. Apply Statistical Descriptions and Measures of Similarity and Dissimilarity on given data
2. Apply PreProcessing for training data set related to Weather data

UNIT – III

Classification and Prediction: Classification: Basic Concepts, General Approach to Solving a Classification Problem, Decision Tree Induction, Model Overfitting, Evaluating the Performance of a Classifier, Issues Regarding Classification and Prediction

Practice:

1. Demonstrate classification rule process on given data set using id3 algorithm.
2. Demonstrate classification rule process on Student's Academic Performance Data using j48 algorithm.

UNIT – IV

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Association Mining to Correlation Analysis.

Practice:

1. Demonstrate Association rule generation on credit card data using apriori algorithm.
2. Demonstrate Association rule process on ontactlenses.arff using FPGrowth Algorithm

UNIT – V

Cluster Analysis: Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Evaluation of Clustering, Mining Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Practice

1. Demonstrate clustering process on given dataset using simple k-means
2. Apply Hierarchical clustering process on dataset.

Cornerstone Project:

“Student Activity & Trend Detection using Data Mining (Library, Attendance, Events, Feedback)”

Introduction

This project focuses on identifying patterns and trends in student activities using data mining techniques. The analysis integrates multiple datasets such as Library Usage, Attendance, Event Participation, and Student Feedback.

Dataset Details

You will work with four primary datasets. Each dataset can be downloaded from publicly available sources such as Kaggle. Below are the complete details:

Project 1: Library Dataset

- Fields: StudentID, BookID, BorrowDate, ReturnDate, Category
- Purpose: Measure academic involvement through book borrowing patterns.
- Download: Kaggle – Book Recommendation or Library Management datasets.

1. Book Recommendation Dataset (contains user–book interactions)

 <https://www.kaggle.com/datasets/mohamedharris/book-recommendation-dataset>

2. Library Management System Dataset

 <https://www.kaggle.com/datasets/saurabhbagchi/books-dataset>

3. Goodreads Book Borrow/User Activity Dataset

 <https://www.kaggle.com/datasets/gnanesh/goodreads-books-dataset>

Project 2: Attendance Dataset

- Fields: StudentID, AttendancePercentage, Class, Section, Subject
- Purpose: Identify correlation between attendance and performance.
- Download: Kaggle – Student Performance/Attendance datasets.

1. Student Performance & Attendance Dataset

 <https://www.kaggle.com/datasets/rodsaldanha/student-performance-data>

2. Students Exam Performance (contains attendance proxy + scores)

 <https://www.kaggle.com/datasets/spscientist/students-performance-in-exams>

3. Student Academic Performance Dataset (includes attendance)

 <https://www.kaggle.com/datasets/whenamancodes/students-performance>

Project 3: Events Participation Dataset

- Fields: StudentID, EventName, ParticipationType, CertificatesWon, EventCategory
- Purpose: Analyze co-curricular engagement.
- Download: Kaggle – Student activities & performance datasets.

1. Student Activity & Performance Dataset

 <https://www.kaggle.com/datasets/ardianumam/student-activity-and-performance>

2. Extra-curricular Activities & Participation Dataset

 <https://www.kaggle.com/datasets/lokhman/extra-curricular-activities-students>

3. Co-Curricular Activity Participation Dataset

 <https://www.kaggle.com/datasets/abhinavmoudgil95/student-activity-data>

Project 4: Student Feedback Dataset

- Fields: StudentID, CourseRating, TeacherRating, Comment, Sentiment
- Purpose: Extract student satisfaction trends (text + numeric feedback).
- Download: Kaggle – Feedback/Evaluations datasets.

1. Student Course Evaluation Dataset

 <https://www.kaggle.com/datasets/mateusdmachado/students-course-evaluations>

2. Student Satisfaction Survey (Feedback)

 <https://www.kaggle.com/datasets/ananthu017/student-feedback-survey>

3. Teaching Evaluation Dataset (Large Text Feedback)

 <https://www.kaggle.com/datasets/xplenty/academic-success-with-student-evaluations>

Student can select any one of the above and implement the cornerstone project using the following steps.

I. Data Preprocessing

1. Cleaning:

- Remove missing values.
- Normalize date formats (BorrowDate, ReturnDate).
- Remove duplicate entries.
- Convert categorical values (Department, Event Category).

2. Feature Engineering:

- LibraryScore = Total books borrowed per semester.
- AttendanceScore = Attendance percentage.
- EventScore = Count of events attended + certificates.
- FeedbackSentiment = Polarity score extracted using NLP.

3. Dataset Integration:

- Merge all datasets using StudentID as the primary key.
- Generate consolidated activity metrics for each student.

II. Model Implementation Steps

A. Clustering (Trend Detection)

- Algorithms: K-Means, DBSCAN.
- Input Features: LibraryScore, AttendanceScore, EventScore, FeedbackSentiment.
- Output: Activity clusters such as High, Medium, Low engagement.

B. Classification

- Algorithms: Decision Tree, Random Forest, Naïve Bayes.
- Target: Predict student performance or engagement levels.

C. Topic Modeling (Feedback)

- Algorithm: LDA
- Purpose: Extract themes from feedback comments such as:
 - Teaching Quality
 - Course Difficulty
 - Infrastructure
 - Stress Factors

III. Data Visualization Steps

Charts to be produced after analysis:

- Heatmap: Attendance vs CGPA
- Bar Chart: Library usage by department
- Pie Chart: Event participation percentages
- Line Chart: Monthly book borrowing trend
- Word Cloud: Feedback comments

Tools: Matplotlib, Seaborn, Plotly, Power BI.

IV. Insights & Interpretation

Based on combined analysis:

- Students with high library usage often have higher attendance and performance.
- Event participation is highest among CSE and AIML departments.
- Feedback sentiment indicates improvement needed in lab infrastructure.
- Attendance dips during mid-semester months but library usage peaks.

These insights help universities in academic planning and student support.

Text Books:

- 1 Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei Third Edition, Elsevier, ISBN: 978-9380931913
- 2 Introduction to Data Mining, PangNing Tan, Michael Steinbach and Vipin Kumar Pearson Education, ISBN: 978-1-292-02615-2

Reference Books:

- 1 Data Mining: Introductory and Advanced Topics, Margaret H. Dunham, 1st Edition Pearson Edn, ISBN: 978-8177587852
- 2 Data Mining Techniques and Applications An Introduction, Hongbo Du, 1st Edition, Cengage India, ISBN: 978-8131519554
- 3 Data Warehousing, Data Mining and OLAP, Alex Berson,.Stephen J. Smith, McGrawHill series, ISBN: 978-0070062726

Web Links:

- 1 <https://nptel.ac.in/courses/106105174/>
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Note:

- The cornerstone project team size shall be 3 or 4 students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The CIE – DDA & Internal Lab shall be evaluated for 25 marks based on project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consists of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository.

Object Oriented Programming through C++

Course Code: 241CS008

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Make use of programming constructs of C and C++
- CO2:** Summarize OOPS concepts.
- CO3:** Develop applications using constructor and destructor.
- CO4:** Apply C++ features for problem solving.
- CO5:** Apply inheritance concepts and file I/O to solve a given problem.
- CO6:** Design C++ classes using templates and STL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2					1	1		
CO2	2	1	2					1	1		
CO3	1	2	2					1	1		
CO4	1	1	1					1	1		
CO5	1	1	2					1	1		
CO6	2	1	2					1	1		

UNIT – I

Introduction to C++: Differences between C and C++, Disadvantages of Conventional Programming, Evolution of C++, Key Concepts of Object Oriented Programming, Structure of C++ program, Advantages of OOP, scope resolution Operator, Namespace.

Practice:

- Find the roots of a quadratic equation.
- Find factorial of a given number using recursion
- Implement scope resolution and namespaces.
- Illustrate the use of default arguments and access specifiers

UNIT – II

Classes and Objects: Declaring Objects- Access Specifiers and their Scope, Defining Member Function, Rules for Inline Functions, static Member Variable, static Member Function, Friend functions, overloading Member Function, Array of Objects, Object as Parameter, Object as return type, Nestedclass, Introduction to Constructors and Destructor,

Characteristics of Constructor and Destructor, Application with Constructor, Constructor with Arguments, Copy Constructor, Anonymous Objects.

Practice:

1. Program to illustrate inline functions and function overloading.
2. Program to illustrate friend function
3. Program to illustrate the use of Constructors and Destructors.
4. Program illustrating Constructor overloading.
5. Program illustrating Copy Constructor.

UNIT – III

Operator Overloading: Introduction, The Keyword Operator, Rules for Overloading Operators, Overloading Unary Operator, Overloading Binary Operator, Overloading using friend function.

Inheritance: Introduction, Reusability, Types of Inheritance, Virtual Base Classes, Object as a Class Member, Abstract Classes, Advantages and Disadvantages of Inheritance. Pointer to Class- Pointer Object, this Pointer, Pointer to Derived Classes and Base Class.

Binding Polymorphisms and Virtual Functions: Introduction, Binding in C++, Virtual Functions, Rules for Virtual Function, Abstract classes, Virtual Destructor

Practice:

1. Overload Unary, and Binary Operators using member function.
2. Overload Unary, and Binary Operators using friend function.
3. Incorporate various forms of Inheritance i. Single Inheritance ii. Multiple Inheritances iii. Multi-level inheritance iv. Hierarchical Inheritance v. Hybrid inheritance
4. Order of execution of constructors and destructors in inheritance.
5. Illustrate the use of object as a class member, pointer to a class, this pointer and Virtual Base Class.
6. Illustrate virtual functions.
7. Implement pure virtual function and calculate the area of different shapes by using abstract class.

UNIT – IV

Generic Programming with Templates: Introduction, Need for Templates, Definition of class Templates, Normal Function Templates, Overloading of Template Function, Bubble Sort Using Function Templates, Difference between Templates and Macros, Linked list with templates

Practice:

1. Illustrate the use of function template.
2. Implement template class.
3. Implement class templates with multiple parameters.

UNIT – V

Exception Handling: Introduction, Principles of Exception Handling, The Keywords try throw and catch, Multiple Catch Statements.

Files: Stream I/O ,Reading and writing to Files.

Overview of Standard Template Library: Introduction, STL Programming Model, Containers, Sequence Containers, Associative Containers, Algorithms, Iterators, Vectors, Lists, Maps

Practice:

1. Implement Exceptions handling.
2. Illustrate the use of multiple catch statements.
3. Implement List, Vector and its Operations.
4. Implement Deque and its Operations.
5. Implement Map and its Operations.

Additional Practice:

1. Develop a C++ program for flight booking system
2. Develop Qt application containing slider and spin box in which a slider responds to changes in the spin box.
3. Develop a Qt application for creating a text pad.
4. Develop a C++ program with maximum of 20 characters, that your user will be guessed and will show only asterisks (*) on the screen. The user will input or enter one character at a time. And for every correct character, the asterisk will be replaced by that character until all the characters or the mystery word/s will reveal. Your program will accept a maximum three (3) errors or mistakes in entering/inputting character otherwise the mystery word/s will be viewed. Sample Output: Output: ***** Enter your character: e
Output: ***e**e
Enter your character: a Output: sorry! the character is not existing. you still have 2 chances
Enter your character: s Output: s**e**e
Enter your character: c Output: sc*e*ce
Enter your character: i Output: scie*ce
Enter your character: n Output: science

Text Books:

1. The Complete Reference C++, Herbert Schildt, Fourth Edition, TMH ISBN-13:978-0070532465, and the ISBN-10 is 007053246X.
2. The C++ Programming Language, Bjarne Stroustrup, Fourth Edition, Pearson ISBN 978-0321563842

Reference Books:

1. A First Book Of C++, Gary Bronson, Fourth Edition, Cengage Learning ISBN-10. 8131532712 and ISBN:. 978-8131532713
2. C++ Primer Plus By Stephen Prata, Sixth Edition, Pearson ISBN: 978-0321776402
3. C++ Programming: From Problem Analysis To Program Design, Ds Malik, Eighth Edition, Cengage Learning, ISBN: 9781337102087

Web Links:

1. <http://nptel.ac.in/courses/106105151/>
2. <http://www.geeksforgeeks.org/c-plus-plus/>
3. https://infyspringboard.onwingspan.com/web/en/viewer/html/lex_auth_01350157284861542410101
4. <https://www.udemy.com/course/beginning-c-plus-plus-programming/>

Java Programming

Course Code: 241IT006

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply Java features for problem solving.
- CO2:** Build applications using principles of OOPs, interfaces and Packages.
- CO3:** Develop programs using Exception Handling to handle run-time errors.
- CO4:** Develop applications using multithreading for inter thread communication.
- CO5:** Build JDBC applications for performing CRUD operations using MySQL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1		1			1	2		1
CO2	2	1	3		1			1	2		1
CO3	2	3	2		1			1	2		1
CO4	2	2	2		1			1	2		1
CO5	2	2	3		1			1	2		1

UNIT – I

Introduction to Java: History of Java, Features of Java Language, JVM Architecture, Java source file structure. Building Blocks of Java, Control Statements, Operators, Type Conversion, Command Line Arguments, Arrays.

Practice:

1. Control Statements

- d. Select all the prime numbers within the range of 1 to 100.
- e. Find the sum of all even terms in the Fibonacci sequence up to the given range N.
- f. Check whether a given number is Armstrong or not.

2. Arrays

- d. Sort an array of integers in ascending order.
- e. Find the maximum and minimum element in an array.
- f. Remove duplicate elements from an array.

UNIT – II

Concepts of Class: Class, Object, Method, Constructor, Overloading- Method and Constructor Keywords: this, static and final, String Class and its Methods, StringTokenizer, String Buffer and StringBuilder.

Practice:

1. Class Mechanism

- d. Display the details of a person. Personal details should be given in one method and the qualification details in another method.
- e. Implement constructor and constructor overloading.
- f. Implement method overloading.

2.Strings

- e. Check if a given string is a pangram (contains every letter of the alphabet at least once).
- f. Find the most frequently occurring character in a string.
- g. Find all permutations of a given string.
- h. Check if a given string is a anagram (Ex: CAT and ACT).

UNIT – III

Inheritance: Inheritance, Types of Inheritance, super and super(), Method Overriding, Using final with inheritance, abstract with Class and Method, Dynamic Method Dispatch. Interfaces: Introduction to interface, Multiple inheritance.

Practice:

1. Inheritance & interface

- d. Implement multi level Inheritance.
- e. Implement multiple Inheritance.
- f. Find the areas of different shapes using abstract classes.

UNIT – IV

Packages: Introduction, Importing Packages and Classes, path and classpath, Access Specifiers, java.util: Collection Framework (related interfaces and classes), java.io: FileReader, FileWriter, FileInputStream, FileOutputStream, BufferedReader and BufferedWriter, Wrapper Classes.

Practice:

1. Packages & java.io

- d. Import and use user defined package.
- e. Illustrate the use of protected members in a package.
- f. Copy Even numbers into Even.txt file and Odd Numbers into Odd.txt file.

2. Collection Framework

- g. ArrayList and LinkedList
- h. Iterator and Iterable
- i. Comparator and Comparable
- j. HashMap and TreeMap
- k. HashSet and TreeSet
- l. f. HashTable

UNIT – V

Exception Handling: Introduction, Keywords: try, catch, throw, throws and finally, Multiple Catch Clauses, Checked and Unchecked Exceptions, User Defined Exceptions.

Multithreading: Introduction, Thread Life Cycle, Creation, Priorities, Synchronization, ITC.

Java Database Connectivity: Introduction, JDBC Architecture, Types of Drivers, JDBC Environment Setup, JDBC Steps, CRUD Operations.

Practice:

1. Exception Handling

- c. Illustrate exception handling mechanism using multiple catch clauses.
- d. Make use of Built-in and user-defined Exceptions in handling a run time exception.

2. Multithreading

- c. Creates threads by extending Thread class. First thread display “Good Morning” every 1 sec, the second thread displays “Hello” every 2 seconds and the third display “Welcome” every 3 seconds, (Repeat the same by implementing Runnable).
- d. Solve Producer-Consumer problem using synchronization.

3. JDBC

- a. CRUD operations.

Additional Practice:

- 1. Student Management
- 2. Inventory Management
- 3. Phone book Management

*** Note: The student must Complete & Submit a Java Programming Certificate Course offered by Oracle Academy at the end of the Practice Session.**

Text Books:

- 1. The Complete Reference Java, Herbert Schildt, TMH ,8th Edition, ISBN 978-1260440232.
- 2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition. ISBN: 9780199459643.

Reference Books:

1. Introduction to java programming, by Y Daniel Liang, Pearson, Seventh Edition. ISBN: 978-8131729588.
2. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press. ISBN: 978-9351199250.

Web Links:

1. <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf>
2. <https://nptel.ac.in/courses/106/105/106105191/>
3. <http://java.sun.com/docs/books/tutorial/>

Introduction to MERN Stack Development

Course Code: 241CS016

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Make use of HTML elements and their attributes for designing static web pages.
- CO2:** Build a web page by applying appropriate CSS styles to HTML elements.
- CO3:** Experiment with JavaScript to develop dynamic web pages and validate forms.
- CO4:** Build a basic web server using Node.js and also working with Node Package Manager (NPM)
- CO5:** Make use of Typescript to optimize JavaScript code using strict type checking

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3		2			1	2		2
CO2	2	3	2		2			1	2		2
CO3	2	2	3	1	2			1	2		2
CO4	2	3	2	2	2			1	2		2
CO5	2	2	3	1	2			1	2		2

Practice:

1. Lists, Links and Images

a. Write a HTML program, to explain the working of lists.

Note: It should have an ordered list, unordered list, nested lists and ordered list in an unordered list and definition lists.

b. Write a HTML program, to explain the working of hyperlinks using <a> tag and href, target Attributes.

Note: Use text to link □ <https://www.aec.edu.in/>

Use image to link □ <https://www.aec.edu.in/?p=Gallery>

c. Create a HTML document that has your image and your friend's image with a specific height and width. Also when clicked on the images it should navigate to their respective profiles.

d. Write a HTML program, in such a way that, rather than placing large images on a page, the preferred technique is to use thumbnails by setting the height and width parameters to

something like to 100*100 pixels. Each thumbnail image is also a link to a full sized version of the image. Create an image gallery using this technique.

2. HTML Tables, Forms and Frames

- a. Write a HTML program, to explain the working of tables. (use tags: <table>, <tr>, <th>, <td> and attributes: border, rowspan, colspan)
- b. Write a HTML program, to explain the working of tables by preparing a timetable. (Note: Use <caption> tag to set the caption to the table & also use cell spacing, cell padding, border, rowspan, colspan etc.).
- c. Write a HTML program, to explain the working of forms by designing Registration form. (Note: Include text field, password field, number field, date of birth field, checkboxes, radio buttons, list boxes using <select> & <option> tags, <text area> and two buttons ie: submit and reset. Use tables to provide a better view).
- d. Write a HTML program, to explain the working of frames, such that page is to be divided into 3 parts on either direction. (Note: first frame □ image, second frame □ paragraph, third frame □ hyperlink. And also make sure of using “no frame” attribute such that frames to be fixed).

3. HTML 5 and Cascading Style Sheets, Types of CSS

- a. Write a HTML program, that makes use of <article>, <aside>, <figure>, <figcaption>, <footer>, <header>, <main>, <nav>, <section>, <div>, tags.
- b. Write a HTML program, to embed audio and video into HTML web page.
- c. Write a program to apply different types (or levels of styles or style specification formats) - inline, internal, external styles to HTML elements. (identify selector, property and value).

4. Selector forms

- a. Write a program to apply different types of selector forms
 - i. Simple selector (element, id, class, group, universal)
 - ii. Combinator selector (descendant, child, adjacent sibling, general sibling)
 - iii. Pseudo-class selector
 - iv. Pseudo-element selector
 - v. Attribute selector

5. CSS with Color, Background, Font, Text and CSS Box Model

- a. Write a program to demonstrate the various ways you can reference a color in CSS.
- b. Write a CSS rule that places a background image halfway down the page, tilting it horizontally. The image should remain in place when the user scrolls up or down.
- c. Write a program using the following terms related to CSS font and text:

- i. font-size ii. font-weight iii. font-style
- iv. text-decoration v. text-transformation vi. text-alignment
- d. Write a program, to explain the importance of CSS Box model using
 - i. Content ii. Border iii. Margin iv. Padding

6. Applying JavaScript - internal and external, I/O, Type Conversion

- a. Write a program to embed internal and external JavaScript in a web page.
- b. Write a program to explain the different ways for displaying output.
- c. Write a program to explain the different ways for taking input.
- d. Create a webpage which uses prompt dialogue box to ask a voter for his name and age. Display the information in table format along with either the voter can vote or not.

7. Javascript Pre-defined and User-defined Objects

- a. Write a program using document object properties and methods.
- b. Write a program using window object properties and methods.
- c. Write a program using array object properties and methods.
- d. Write a program using math object properties and methods.
- e. Write a program using string object properties and methods.
- f. Write a program using regex object properties and methods.
- g. Write a program using date object properties and methods.
- h. Write a program to explain user-defined object by using properties, methods, accessors, constructors and display.

8. Javascript Conditional Statements and Loops

- a. Write a program which asks the user to enter three integers, obtains the numbers from the user and outputs HTML text that displays the larger number followed by the words “LARGER NUMBER” in an information message dialog. If the numbers are equal, output HTML text as “EQUAL NUMBERS”.
- b. Write a program to display **week** days using switch case.
- c. Write a program to print 1 to 10 numbers using for, while and do-while loops.
- d. Write a program to print data in object using for-in, for-each and for-of loops

9. Javascript Functions and Events

- a. Design a appropriate function should be called to display
 - i. Factorial of that number
 - ii. Fibonacci series up to that number
- b. Design a HTML having a text box and four buttons named Factorial, Fibonacci, When a button is pressed an appropriate function should be called to display
 - i. Factorial of that number

- ii. Fibonacci series up to that number
- c. Write a program to validate the following fields in a registration page
 - i. Name (start with alphabet and followed by alphanumeric and the length should not be less than 6 characters)
 - ii. Mobile (only numbers and length 10 digits)
 - iii. E-mail (should contain format like xxxxxxxx@xxxxxxx.xxx)

10. Node.js

- a. Write a program to show the workflow of JavaScript code executable by creating web server in Node.js.
- b. Write a program to transfer data over http protocol using http module.
- c. Create a text file src.txt and add the following content to it. (HTML, CSS, Javascript, Typescript, MongoDB, Express.js, React.js, Node.js)
- d. Write a program to parse an URL using URL module.
- e. Write a program to create an user-defined module and show the workflow of Modularization of application using Node.js

11. Typescript

- a. Write a program to understand simple and special types.
- b. Write a program to understand function parameter and return types.
- c. Write a program to show the importance with Arrow function. Use optional, default and REST parameters.
- d. Write a program to understand the working of typescript with class, constructor, properties, methods and access specifiers.

Additional Practice:

1. Write a CSS program, to apply 2D and 3D transformations in a web page
2. Design a Web page with new features of HTML file and CSS3.
3. Design a to-do list application using Javascript.

Text Books:

1. Programming the World Wide Web, Robert W Sebesta, Pearson, 7th Edition. ISBN 13 9789332518827
2. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasanth Subramanian, APress, O'Reilly, 2nd edition. ISBN 9781484226520.

Web Links:

1. <https://www.w3schools.com/html>
2. <https://www.w3schools.com/css>
3. <https://www.w3schools.com/js/>
4. <https://www.w3schools.com/nodejs>

5. <https://www.w3schools.com/typescript>

Information Security Analysis & Audit

Course Code: 241CS030

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Demonstrate fundamental concepts of information security and systems auditing
- CO2:** Analyze latest trend in management control framework
- CO3:** Identify security operations in management control framework.
- CO4:** Distinguish data evidence collection techniques.
- CO5:** Analyze data evidence evaluation in audit.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1									1
CO2	2	2					2				2
CO3	1	3		1		1		1			2
CO4	1	2					1	1		1	1
CO5	1	3		2	1		2	2			

UNIT – I

Overview of Information System Auditing: Effect of Computers on Internal Controls, Effects of Computers on Auditing, Foundations of information Systems Auditing, Conducting an Information Systems Audit.

UNIT – II

The management Control Framework-I: Introduction, Evaluating the planning Function, Leading Function, Controlling Function, Systems Development Management Controls, Approaches to Auditing Systems Development, Programming Management Controls, Data Resource Management Controls.

UNIT – III

The Management Control Framework-II: Security Management Controls, Operations management Controls Quality assurance Management Controls, Case Studies

UNIT – IV

Evidence Collection: Audit Software, Code Review, Test Data, and Code Comparison, Concurrent Auditing techniques, Interviews, Questionnaires, and Control Flowcharts. Performance Management tools- Case Studies.

UNIT – V

Evidence Evaluation: Evaluating Asset Safeguarding and Data Integrity, Evaluating System, Effectiveness, Evaluating System Efficiency, Information Systems Audit and Management: Managing the Information Systems Audit Function.

Text Books:

1. Information Systems Control and Audit, Ron Weber, Pearson Education, 1st Edition, ISBN : 978-8131704721
2. Cryptography Engineering: Design Principles and Practical Applications, Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons, ISBN: 978-0470474242

Reference Books:

1. Information System Audit and Assurance, D P Dube, TMH, New Delhi, ISBN: 978-0070585690
2. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi, ISBN: 978-8170083412

Web Links:

1. <https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks>
2. <https://computersecurity.stanford.edu/free-online-video/> [Free Online Videos]
3. CERT-In Guidelines- <http://www.cert-in.org.in/>

Advanced MERN Stack Development

	L	T	P	C
Course Code: 241CS018	0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Make use of router, template engine and authentication using sessions to develop application in ExpressJS.
- CO2:** Build a single page application using RESTful APIs in ExpressJS.
- CO3:** Make use of components, props, states and render data in ReactJS.
- CO4:** Apply router and hooks in designing ReactJS application.
- CO5:** Make use of MongoDB queries to perform CRUD operations on document database.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3		2			1	2		2
CO2	2	3	2		2			1	2		2
CO3	2	2	3		2			1	2		2
CO4	2	3	2		2			1	2		2
CO5	2	2	3		2			1	2		2

PRACTICE:

1. ExpressJS – Routing, HTTP Methods, Middleware.

- a. Write a program to define a route, Handling Routes, Route Parameters, Query Parameters and URL building.
- b. Write a program to accept data, retrieve data and delete a specified resource using http methods.
- c. Write a program to show the working of middleware.

2. ExpressJS – Templating, Form Data

- a. Write a program using templating engine.
- b. Write a program to work with form data.

3. ExpressJS – Cookies, Sessions, Authentication

- a. Write a program for session management using cookies and sessions.
- b. Write a program for user authentication.

4. ExpressJS – Database, RESTful APIs

- a. Write a program to connect MongoDB database using Mongoose and perform CRUD operations.
- b. Write a program to develop a single page application using RESTful APIs.

5. ReactJS – Render HTML, JSX, Components – function & Class

- a. Write a program to render HTML to a web page.
- b. Write a program for writing markup with JSX.
- c. Write a program for creating and nesting components (function and class).

6. ReactJS – Props and States, Styles, Respond to Events

- a. Write a program to work with props and states.
- b. Write a program to add styles (CSS & Sass Styling) and display data.
- c. Write a program for responding to events.

7. ReactJS – Conditional Rendering, Rendering Lists, React Forms

- a. Write a program for conditional rendering.
- b. Write a program for rendering lists.
- c. Write a program for working with different form fields using react forms.

8. ReactJS – React Router, Updating the Screen

- a. Write a program for routing to different pages using react router.
- b. Write a program for updating the screen.

9. ReactJS – Hooks, Sharing data between Components

- a. Write a program to understand the importance of using hooks.
- b. Write a program for sharing data between components.

10. ReactJS Applications – To-do list and Quiz

- a. Design to-do list application.

11. MongoDB – Installation, Configuration, CRUD operations

- a. Install MongoDB and configure ATLAS
- b. Write MongoDB queries to perform CRUD operations on document using insert(), find(), update(), remove()

12. MongoDB – Databases, Collections and Records

- a. Write MongoDB queries to Create and drop databases and collections.
- b. Write MongoDB queries to work with records using find(), limit(), sort(), createIndex(), aggregate().

Additional Practice:

1. Design a to-do list application using NodeJS and ExpressJS.

2. Design a Quiz app using ReactJS.
3. Complete the MongoDB certification from MongoDB University website.

Note: The student must Complete & Submit a Express Js, React Js & MongoDB Certificate Courses offered by Infosys Spring board at the end of the Practice Session.

Reference Books:

1. Programming the World Wide Web, 7th Edition, Robert W. Sebesta, Pearson, ISBN: 9789332518827
2. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, APress, O'Reilly, 2nd Edition, ISBN:9781484226520.

Web Links:

1. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384329019595161635073_shared/overview (Express Js)
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_10648877150323546000_shared/overview (ReactJs)
3. https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013177169294712832113_shared/overview (MongoDB)

Fundamentals of Flutter

	L	T	P	C
Course Code: 241IT012	0	0	2	2

Practice:

1.Introduction to Flutter

- 1. Setup Environment:** Set up the Flutter development environment on both Windows and Mac OS.
- 2. First App:** Create and run your first Flutter application in Android Studio.
- 3. Hello World:** Create a simple "Hello World" Flutter application and run it on an Android emulator.
- 4. Understanding Structure:** Modify the main Dart file to understand the structure of a Flutter app.
- 5. Hot Reload and Restart:** Practice using the hot reload and hot restart features to see how changes reflect instantly.

2. Flutter Basics

- 1. Button Widgets:** Create a Flutter app with various button widgets (Flat Button, Elevated Button, Icon Button).
- 2. Image Widget:** Create an app that displays an image using the Image widget and customize its properties.
- 3. Icon Widgets:** Use Icon widgets to display different icons in a Flutter app.
- 4. Counter App:** Build a simple counter app that increases a number each time a button is pressed using set State.
- 5. Gesture Detector:** Implement a gesture detector that changes the color of a container when tapped.

3.Flutter Basics Continued

- 1. List of Items:** Create an app with a list of items where each item can be clicked to display a toast message.
- 2. Input Validation:** Implement form input validation to ensure correct data entry.
- 3. Dialogs:** Use Alert Dialog to show a dialog box when a button is pressed.

4.Introduction to Layouts

- 1. Basic Layouts:** Create a layout using Column, Row, and Stack widgets.
- 2. Responsive Layout:** Implement a responsive layout using the Flex widget.
- 3. Single and Multiple Child Widgets:** Build a layout with a combination of single child and multiple child widgets.
- 4. Nested Layouts:** Design a complex UI using nested layouts (e.g., rows inside columns).
- 5. Gesture Detection:** Use Gesture Detector to detect various gestures (tap, double-tap).

5.Layouts Continued

1. **Navigation:** Implement navigation between two screens using the Navigator widget.
 2. **Grid View:** Create a layout using Grid View to display items in a grid.
 3. **List View:** Use List View to display a list of dynamic items.
- Scrolling:** Implement scrolling for a long list of items using List View and Scroll View

6.State Management (Basic)

1. **Stateful and Stateless Widgets:** Create a simple app to toggle between stateful and stateless widgets and observe the behavior.
2. **Form Input and Display:** Build an app with a form that takes user input and displays it on the same screen using set State.
3. **Responsive Layout with Media Query:** Create a responsive layout that adapts to different screen sizes using Media Query.
4. **To-Do List App:** Create a to-do list app where users can add and remove items dynamically.

7.Animation in Flutter

1. **Animated Container:** Create a simple animation using Animated Container.
2. **Fade Transition:** Implement a basic fade transition using Animated Opacity.
3. **Physics-based Animation:** Develop an app that uses a physics-based animation like Draggable.
4. **Hero Animation:** Implement a hero animation for navigating between screens.

8.Advanced Animations

1. **Animated Builder:** Use Animated Builder to create complex animations.
2. **Animation Controller:** Create animations with fine control using Animation Controller.
3. **Staggered Animations:** Implement staggered animations to animate multiple widgets in sequence.
4. **Curved Animations:** Use Curved Animation to create non-linear animations.

9.State Management (Advanced)

1. **Provider Package:** Use the Provider package for state management.
2. **BLoC Pattern:** Use the BLoC (Business Logic Component) pattern for managing state.
3. **River pod:** Explore and use the River pod package for state management.

10.Networking in Flutter

1. **HTTP Requests:** Use the http package to make GET and POST requests.
2. **JSON Parsing:** Parse JSON data received from an API.
3. **Fetching Data:** Fetch and display data from a remote API.
4. **Handling Errors:** Implement error handling for network requests.
5. **REST API:** Create an app that interacts with a REST API

11.Firebase Integration

1. **Firestore Setup:** Set up Firestore for a Flutter project.

2. Authentication: Implement user authentication using Firebase Auth.

3. Fire store: Use Fire store to store and retrieve data.

Firebase Storage: Upload and download files using Firebase Storage

12. Project Week

1. Project Planning: Plan a small project incorporating concepts learned.

2. Project Development: Develop the project with proper state management, layout, and networking.

3. Testing: Test the project for bugs and ensure all functionalities work as expected.

4. Optimization: Optimize the app for performance and responsiveness

Additional Practice:

1. Create a Flutter app that displays a list of items using List View. builder and allows users to add new items dynamically.

2. Develop a Flutter app that uses a Bottom Navigation Bar to navigate between different screens.

3. Create a Flutter app that implements basic form validation with input fields for name, email, and password.

Reference Books:

- 1 "Beginning Flutter: A Hands-On Guide to App Development" by Marco L. Napoli. ISBN: 978-1119550822
- 2 "Flutter in Action" by Eric Windmill, 2020. ISBN: 978-1617296147
- 3 Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart 2 by Alessandro Biessek. ISBN: 9781800565999

Web Links:

- 1 <https://flutter.dev/docs>
- 2 <https://dart.dev/guides>
- 3 <https://codelabs.developers.google.com/?cat=flutter>

Minor Degree in Artificial Intelligence and Machine Learning (offered to other branches students):

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241AI002	Artificial Intelligence	IC	2		1	3	50	50	100	-
241AI005	Machine Learning	IC	2		2	4	50	50	100	DAP
241AI015	AI Chatbots	IC	2			2	50	50	100	AI
241AI014	Soft Computing (or)	IC	2		1	3	50	50	100	AI
241CS034	Fundamentals of Data Science		2		1	3	50	50	100	-
241AI037	Natural Language Processing and Text Analytics (or)	AC	2		1	3	50	50	100	DAP
241AI036	Data Visualization Techniques									
241AI016	Prompt Engineering and GenAI (or)	AC	2		1	3	50	50	100	ML
241CS041	Social Network Analysis									
241AI017	Federated Machine Learning	AC	2			2	50	50	100	ML
TOTAL			14		6	20				

Artificial Intelligence

Course Code: 241AI002

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the historical development of AI, key milestones and contributors.
- CO2:** Apply the basic principles of AI in problem solving
- CO3:** Apply Local Search Algorithms and Optimization Techniques.
- CO4:** Choose the appropriate representation of Knowledge.
- CO5:** Summarise the expert systems and real time applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3			1				1	1		1
CO2	3	2		2				1	1		1
CO3	3	2	1	2	1			1	1		1
CO4	2		1					1	1		
CO5	2	2	1	1	1			1	1		1

UNIT-I

Introduction:

What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Practice :

1. Introduction to LISP :
 - To demonstrate simple recursive functions and list manipulation in LISP
1. Introduction to Prolog :
 - Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

UNIT-II

Problem formulation:

Problem Definition Production systems, Control strategies, Search strategies. Problem characteristics, Problem Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies

Practice :

3. Implementation of DFS for water jug problem using LISP/PROLOG

4. Implementation of BFS for tictactoe problem using LISP/PROLOG

UNIT-III

Problem solving methods

Problem graphs, Matching, Indexing and Heuristic functions Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

Practice :

3. Implementation of TSP using heuristic approach using LISP/Prolog
4. Implementation of Hillclimbing to solve 8 Puzzle Problem

UNIT-IV

Knowledge representation

Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logicStructured representation of knowledge Basic plan generation systems – Strips Advanced plan generation systems – K strips Strategic explanations Why, why not and how explanations.

Practice :

3. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.
4. Create a framebased representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

UNIT – V

Expert Learning

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Practice :

3. Using PYTHON / LISP , develop an expert system to help users plan travel itineraries, including transportation, accommodation, and activities. Utilize knowledge about travel destinations, transportation options, and user preferences to generate personalized travel plans.
4. Using PYTHON / LISP , create an expert system to assist students in selecting courses, majors, or career paths based on their interests, skills, and academic performance. Use knowledge about educational programs, career prospects, and academic requirements to make personalized recommendations.

Text Books:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig , Pearson, 3rd Edition, ISBN: 978-9332543515
2. Artificial Intelligence: Structures and Strategies for Complex Problem Solving by George F. Luger, 2nd Edition, ISBN: 978-0805347807

Reference Books:

1. Artificial Intelligence, Saroj Kaushik, Cengage Learning India, ISBN: 978-8131510995
2. Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill, ISBN: 978-0-07-052263-3
3. Artificial Intelligence: Foundations for Computational Agents, David Poole and Alan Mackworth, Cambridge University Press, ISBN: 978-1107195394

Web Links:

- 1 <https://nptel.ac.in/courses/106105077>
- 2 <https://nptel.ac.in/courses/106106126>
- 3 <https://aima.cs.berkeley.edu>

Machine Learning

Course Code: 241AI005

L	T	P	C
2	0	2	4

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Outline the Concepts of Machine Learning and Statistical Learning
- CO2:** Build Regression and Classification models for given data.
- CO3:** Apply Instance based Learning techniques and SVM techniques linear and nonlinear data.
- CO4:** Apply clustering techniques on high dimensional data to group the similar entities.
- CO5:** Make use of ensemble learning techniques to improve the performance of a model.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			2	2		1	1		
CO2	2	2	3		2	2		1	1		
CO3	3	2	3		2			1	1		2
CO4	3	2	3		2			1	1		
CO5	2	2	2		2			1	1		2

UNIT-I

INTRODUCTION

Machine Learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. Statistical Learning: Introduction, Supervised and Unsupervised Learning, The Learning Problem, Feasibility of Learning.

Practice :

1. Installation of Jupiter/Spider notebook and working on basic commands.
2. Loading and apply key preprocessing techniques on the dataset and also analyse the dataset.

UNIT-II

Supervised Learning(Regression/Classification):Basic Methods:

Concept Learning: General-to-Specific Hypotheses Ordering, Find-S and Candidate Elimination Algorithm, Version Space, and Inductive Bias.

Bayesian Learning: Probability Overview, MLE and MAP Estimates, Gaussian Naive Bayes Classifier, Bayesian Networks.

Instance-based Learning: k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN, Distance Metrics and Curse of Dimensionality.

Practice :

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Exercises to solve the real-world problems using Binary Classifier
4. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

UNIT-III

Linear Models and Regression: Linear Classification, Linear Regression, Non-linear Transformation, Logistic Regression.

Support Vector Machines: Decision Boundary and Support Vector: Optimization and Primal-Dual Problem, Soft Margin and Non-linear Decision Boundary, Kernel Functions and Radial Basis Functions introduction.

Practice :

1. Exercises to solve the real-world problems using Linear Regression
2. Exercises to solve the real-world problems using Logistic Regression
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients.

UNIT-IV

Classifier / Hypothesis Evaluation: Accuracy, Precision, Recall and F-Measures, Scores, Sampling, Bootstrapping and ROC, Hypotheses Testing and Cross-validation.

Unsupervised Learning:

Clustering : Partitional Clustering and Hierarchical Clustering, Cluster Types, Attributes and Salient Features, Hierarchical and Density-based Clustering Algorithms, Inter and Intra Clustering Similarity, Cohesion and Separation. MST and DBSCAN Clustering Algorithms.

Practice :

1. Develop a program for Bias, Variance, Remove duplicates , Cross Validation
2. Write a program to implement One-hot Encoding.
3. Write a program to implement Categorical Encoding.

UNIT – V**Ensemble Learning :**

Bagging and Boosting, Adaboost and Random Forest ,

Computational Learning Theory : Error and Noise Formalisms, Training vs. Testing, Theory of Generalization, PAC Learnability and VC Dimensions, Overfitting, Regularization and Validation.

Practice :

1. Write a program to demonstrate the working of Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
2. Use a sentiment analysis dataset from Twitter or other social media platforms, available on platforms like Kaggle and apply bagging and boosting techniques for prediction.

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Corner Stone Project:**PROJECT 1: Intelligent Loan Risk Assessment System (End-to-End ML Pipeline)****Project Implementation, Documentation and Viva Voce****• Implementation mainly focuses on**

- Collecting and integrating multiple datasets (loan + financial history)
- Advanced preprocessing (missing values, outliers, feature engineering)
- Implementing multiple models (Logistic Regression, Random Forest, XGBoost)
- Handling imbalanced data (SMOTE / resampling techniques)
- Model evaluation using ROC-AUC, F1-score, cross-validation
- Building a simple UI (Streamlit/Web app) for predictions
- Model comparison and optimization

• Documentation must contain

- Objective & real-world problem definition
- Dataset merging and preprocessing pipeline
- Feature engineering techniques
- Model comparison and evaluation metrics
- System architecture diagram
- Screenshots (UI + outputs)
- Enhancements (hyperparameter tuning, deployment)

PROJECT 2: Smart Disease Prediction System with Model Ensemble**• Implementation mainly focuses on**

- Using medical datasets (heart disease/diabetes/multi-disease)
- Data preprocessing and feature selection
- Applying multiple classifiers (SVM, kNN, Random Forest, Gradient Boosting)
- Ensemble learning (Voting / Stacking models)
- Model evaluation using confusion matrix, ROC curves
- Explainability (feature importance / SHAP basics)
- Web-based prediction interface

• Documentation must contain

- Objective
- Dataset and preprocessing steps
- Model architecture and ensemble approach
- Evaluation metrics and comparison
- Screenshots (prediction system)
- Enhancements (multi-disease prediction)

PROJECT 3: Real-Time Sentiment Analysis System with Web Scraping

• Implementation mainly focuses on

- Scraping live data (Twitter/news using APIs or scraping tools)
- Text preprocessing (stopwords, stemming, vectorization – TF-IDF)
- Training models (Naïve Bayes, Logistic Regression, LSTM optional)
- Real-time sentiment prediction
- Visualization dashboard (charts for sentiment trends)
- Handling large-scale streaming data

• Documentation must contain

- Objective
- Data collection methodology (APIs/web scraping)
- NLP preprocessing pipeline
- Model building and evaluation
- Dashboard explanation
- Screenshots
- Enhancements (real-time alerts, topic modeling)

PROJECT 4: Heart Disease Prediction using SVM

• Implementation mainly focuses on

- Loading patient dataset
- Applying Support Vector Machine (SVM)
- Data preprocessing and feature scaling
- Classification of patients (disease/no disease)
- Model evaluation using confusion matrix

• Documentation must contain

- Objective
- Dataset description
- SVM working principle
- Evaluation metrics
- Output results
- Screenshots
- Enhancements (kernel comparison)

PROJECT 5: Customer Segmentation using Clustering

• Implementation mainly focuses on

- Loading customer dataset
- Applying K-Means clustering
- Identifying groups based on features
- Visualizing clusters using plots
- Comparing clustering results

• Documentation must contain

- Objective
- Dataset details

- Clustering technique explanation
- Cluster visualization
- Results interpretation
- Screenshots
- Enhancements (DBSCAN comparison)

PROJECT 6: Fake News Detection System using Machine Learning

- Implementation mainly focuses on
 - Dataset collection (news datasets / scraping)
 - Text preprocessing (tokenization, TF-IDF, n-grams)
 - Applying classification models (Logistic Regression, SVM, Random Forest)
 - Model evaluation using precision, recall, F1-score
 - Comparing multiple models
 - Building a simple interface for prediction
- Documentation must contain
 - Objective
 - Dataset description
 - NLP pipeline
 - Model comparison
 - Evaluation metrics
 - Screenshots
 - Enhancements (deep learning models)

PROJECT 7: Sentiment Analysis using Ensemble Learning

- Implementation mainly focuses on
 - Collecting dataset (Twitter/Kaggle)
 - Text preprocessing
 - Applying Bagging and Boosting techniques
 - Training ensemble models (Random Forest / AdaBoost)
 - Predicting sentiment (positive/negative)
- Documentation must contain
 - Objective
 - Dataset source
 - Preprocessing steps
 - Ensemble methods explanation
 - Performance comparison
 - Screenshots
 - Enhancements (real-time data analysis)

PROJECT 8: Model Evaluation and Comparison System

- Implementation mainly focuses on
 - Implementing multiple models (kNN, SVM, Regression)
 - Performing cross-validation
 - Calculating accuracy, precision, recall, F1-score
 - Comparing model performance
 - Visualizing results using graphs
- Documentation must contain
 - Objective
 - Models used
 - Evaluation metrics explanation
 - Comparison results

- Graphs and charts
- Screenshots
- Enhancements (hyperparameter tuning)

Text Books:

- 1 Hands On Machine Learning with ScikitLearn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019, ISBN: 978-1492032649
- 2 Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 2019, ISBN: 978-1138492530

Reference Books:

- 1 Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, ISBN: 9780262018029
- 2 Machine Learning Tools, Dr Muddafa Maruli Krishna, Dr A Vanathi, Final Thawaksr, Dr Lokesh P. Gangani, publisher: Book Rivers, ISBN: 978-93-5515-730-0

Web Links:

- 1 <https://www.deeplearning.ai/machinelearningyearning/>
- 2 <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>
- 3 https://onlinecourses.nptel.ac.in/noc21_cs24/preview

Note:

- Students must submit the Certificate of Completion offered by any Industry.
- The capstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The SEE – Lab shall be evaluated for 50 marks based on project implementation, oral presentation, 10-minute video presentation, and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.

AI Chatbots

Course Code: 241AI015

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explore the benefits and challenges of deploying chatbots for business use cases.
- CO2:** Evaluate a fully-functional and interactive chatbot using a commercial platform.
- CO3:** Deploy the finished chatbot for public use and interaction.
- CO4:** Distinguish between the NLP and NLU Tools
- CO5:** Demonstrate Microsoft Bot Framework, RASA and Third Party API's

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3					1	1		
CO2	2	2	3		1			1	1		
CO3	1	1	2		1			1	1		
CO4	1	2			2			1	1		
CO5	2	2	2		2			1	1		1

UNIT I

Introduction: Benefits from Chatbots for a Business, A Customer-Centric Approach in Financial Services, Chatbots in the Insurance Industry, Conversational Chatbot Landscape,

Identifying the Sources of Data: Chatbot Conversations, Training Chatbots for Conversations, Personal Data in Chatbots, Introduction to the General Data Protection Regulation (GDPR)

UNIT II

Chatbot Development Essentials: Customer Service-Centric Chatbots, Chatbot Development Approaches, Rules-Based Approach, AI-Based Approach, Conversational Flow, Key Terms in Chatbots, Utterance, Intent, Entity, Channel, Human Takeover, Use Case: 24x7 Insurance Agent.

UNIT III

Building a Chatbot Solution: Business Considerations, Chatbots Vs Apps, Growth of Messenger Applications, Direct Contact Vs Chat, Business Benefits of Chatbots, Success Metrics, Customer Satisfaction Index, Completion Rate, Bounce Rate, Managing Risks in Chatbots Service, Generic Solution Architecture for Private Chatbots.

UNIT IV

Natural Language Processing, Understanding, and Generation: Chatbot Architecture, Popular Open Source NLP and NLU Tools, Natural Language Processing, Natural Language Understanding, Natural Language Generation, Applications.

UNIT V

Introduction to Microsoft Bot, RASA, and Google Dialog flow: Microsoft Bot Framework, Introduction to QnA Maker, Introduction to LUIS, Introduction to RASA, RASA Core, RASA NLU, Introduction to Dialog flow.

Chatbot Integration Mechanism: Integration with Third-Party APIs, Connecting to an Enterprise Data Store, Integration Module.

Text Books:

1. Artificial Intelligence Based Chat Bot Design, Nazneen Akhter Shaikh, Khan Samrin Syed Zebanaaz, Saniya Raheen Patel, Lambert Publication, ISBN: 978-6202786713.

Reference Books:

1. Hands-On Chatbots and Conversational UI Development: Build Chatbots and Voice User Interfaces with Chatfuel, Dialogflow, Microsoft Bot Framework, Twilio, and Alexa Skills, Packt publication, ISBN: 9781788294669.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ge29/preview
2. <https://www.geeksforgeeks.org/nlp-vs-nlu-vs-nlg/>
3. <https://dev.botframework.com/>

Federated Machine Learning

Course Code: 241AI017

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Outline the Concepts of Federated Machine Learning
- CO2:** Explore the types of Federated machine Learning.
- CO3:** Apply Optimization techniques for Federated heterogeneous networks.
- CO4:** Apply clustering techniques on high dimensional data to group the similar entities.
- CO5:** Make use of ensemble learning techniques to improve the performance of a model.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	2	2	3								
CO3	3	2	3		2						2
CO4	3	2	3								
CO5	2	2	2		2						2

UNIT – I

Introduction to Federated learning:

Introduction to Federated learning, Privacy Preserving, Distributed Machine Learning, Threats to Federated Learning, Data Valuation

UNIT – II

Types of the Federated learning

Horizontal Federated learning ,Vertical Federated Learning, Federated Transfer learning

UNIT – III

Federated Optimization for heterogeneous networks:

Deep Networks from Decentralized data, Federated Multitask Learning, Personalized Federated Learning

UNIT – IV

Federated Learning Applications:

Recommendation in health care and Finance, Mobile keyboard prediction, Learning of out of vocabulary words.

UNIT – V

Adaptive personalized Federated learning :

Privacy Preserving Deep Learning, Advances and Open Problems.

Text Books:

1. Federated Learning, Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, Han Yu, Morgan & Claypool Publishers, 2019, ISBN: 978-1681736976
2. Handbook of Big data Privacy, KimKwang Raymond Choo, Ali Dehghantanha, Springer Nature Switzerland, 2020, ISBN: 978-3030385569

Reference Books:

1. Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, ISBN: 9780262018029

Web Links:

1. <https://www.deeplearning.ai/machinelearningyearning/>
2. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
3. <https://www.udemy.com/course/machinelearning/>

Soft Computing

Course Code: 241AI014

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Compare intelligent systems and knowledge based systems

CO2: Explain fuzzy sets and fuzzy operations

CO3: Discuss neuro systems and neural network applications

CO4: Apply genetic algorithm and operators

CO5: Compare and contrast Swarm Intelligence based algorithms

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2		1			1	1		2
CO2	2	2	3		2			2	2		2
CO3	2	2	3		1			2	2		2
CO4	2	2	3		1			2	2		2
CO5	2	2	3		1			2	2		2

UNIT – I

Introduction to intelligent systems and soft computing: Intelligent systems, Knowledgebased systems, Knowledge representation and processing, Soft computing techniques.

Practice:

1. Text summarization using a simple sequencetosequence model with LSTM (Long ShortTerm Memory) layers.
2. Apply networkx library to represent and process knowledge

UNIT – II

Fundamentals of fuzzy logic systems: Introduction , Background ,Evolution of fuzzy logic, Popular applications, Stages of development of an intelligent product, Use of fuzzy logic in expert systems, Fuzzy sets , Fuzzy logic operations

Practice:

1. Learn the fundamentals of the fuzzy logic ,experiment the basic operations of fuzzy logic (Virtual Labs)
2. Learn about the Fuzzy inference system (FIS) with an example (Virtual Labs)

UNIT – III

Fundamentals of artificial neural networks Introduction Learning and acquisition of knowledge , Symbolic learning , Numerical learning, Features of artificial neural networks , Neural network topologies, Neural network activation functions, Neural network learning algorithms, Fundamentals of connectionist modeling

Practice:

1. Implement Neural Networks and Perceptron with an example (Virtual Labs)
Virtual Labs
2. Study Multilayer Perceptron apply it for image classification

UNIT – IV

Genetic algorithms and evolutionary programming: Introduction, Genetic algorithms, Procedures of genetic algorithms, working of genetic algorithms, genetic algorithm operators, Issues in GAs.

Practice:

1. Implement a genetic algorithm for finding the maximum value of a function.
2. Implement Crossover and Mutation in genetic algorithms

UNIT – V

Swarm Intelligent systems: Introduction, Swarm Intelligence based algorithms – Ant Algorithms; Bee Algorithms; Particle Swarm Optimization, Background of Ant intelligent system, ant colony systems Importance, development, applications, working of ant colony systems, Artificial Bee Colony (ABC) Optimization Behavior of real bees, ABC Algorithm, Variations of ABC: Abcgbest and Abcgbestdist

Practice:

1. Implement Particle Swarm Optimization algorithm
2. Implement ABC with GBest Algorithm: And GBestDist Algorithm

Text Books:

- 1 Soft Computing and Intelligent Systems Design Theory, Tools and Applications, Fakhreddine O. Karray and Clarence de Silva, ISBN: 978-8131723241
- 2 Artificial Intelligence and Intelligent Systems, N. P. Padhy, Oxford University press, ISBN: 9780195671544

Reference Books:

- 1 Fuzzy Logic: A Practical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, ISBN: 978-0124859654

- 2 An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, ISBN: 9780262280013

Web Links:

- 1 <https://nptel.ac.in/courses/106105174/>
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Fundamentals of Data Science

Course Code: 241CS034

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain fundamental concepts of Data Science.
- CO2:** Implement Data Collection and Preprocessing Techniques.
- CO3:** Demonstrate Proficiency in Data Loading, Storage, and File Handling
- CO4:** Conduct Exploratory Data Analysis (EDA) using Visualization and Statistical Techniques.
- CO5:** Make use of Neo4j, Cypher tools to manage and analyze graph data.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3						2	2		
CO2	2							1	2		
CO3	2	2	2					2	2		
CO4	2	2			2			2	1		
CO5	3							1	1		

UNIT – I

Introduction To Data Science: Definition and Scope of Data Science, History and Evolution of Data Science, Applications of Data Science, Data Science Lifecycle, Data Types and Structures, Tools and Technologies in Data Science.

Practice:

1. Importing and Exploring Datasets - Loading datasets using libraries and performing basic exploration.
2. Basic Data Structures - Working with data structures such as arrays, lists, data frames, and matrices.

UNIT-II

Data Collection and Preprocessing: Data Collection Methods, Data Cleaning and Handling Missing Values, Data Transformation: Normalization and Standardization, Feature Engineering and Feature Scaling, Data Integration and Aggregation.

Practice:

1. Computing summary statistics like mean, median, mode, and standard deviation for a sample dataset.
2. Handling missing values and outliers in a dataset using techniques like imputation and filtering.

UNIT – III

Data Loading, Storage, and File Formats : Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice:

1. Read data from a JSON file into a DataFrame using Pandas (pd.read_json) or R (jsonlite). Parse nested JSON structures and convert them into a flat table format.
2. Perform web scraping on an HTML page using BeautifulSoup in Python or rvest in R. Extract data from HTML tables and convert it into a DataFrame.

UNIT – IV

Exploratory Data Analysis (EDA): Descriptive Statistics, Data Visualization Techniques, Correlation and Covariance Analysis, Univariate, Bivariate, and Multivariate Analysis, Pattern Detection and Anomaly Identification.

Practice:

1. Plotting histograms and box plots to understand the distribution of a single variable.
2. Creating scatter plots and calculating correlation coefficients to study the relationship between two variables.

UNIT – V

Data Science Tools: Neo4j for dealing with graph databases, graph query language Cypher, libraries like nltk and SQLite for handling Text mining and analytics.

Practice:

1. Get hands-on experience with Neo4j to understand how to manage and query graph databases.
2. Practice writing Cypher queries to interact with graph data in Neo4j.

Text Books:

- 1 Python for Data Analysis, Wes McKinney,,O'REILLY, ISBN:978-1-449-31979-3, 1st Edition.
- 2 Doing Data Science, Rachel Schutt & O'neil, O'REILLY, ISBN:978-1-449-35865-5, 1st Edition.

Reference Books:

- 1 Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media, ISBN: 9781492041139.
- 2 Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, Matt Harrison, O'Reilly, ISBN: 9781787123137

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_cs68/preview
2. https://onlinecourses.nptel.ac.in/noc24_cs133/preview
3. <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>

Natural Language Processing and Text Analytics

Course Code: 241AI037

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain datasets for NLP tasks and context free grammar.
- CO2:** Explain Text preprocessing and stemming algorithms.
- CO3:** Explain feature engineering on text data
- CO4:** Apply similarity measures and word embedding models
- CO5:** Explain text summarization and semantic analysis.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1		1			1	1		2
CO2	2	2	2		2			1	1		2
CO3	2	2	3		1			1	1		2
CO4	2	2	3		1			1	1		1
CO5	2	2	3		1			1	1		1

UNIT – I

Overview of Natural Language Processing, Natural Language Processing and Python: Understanding Natural language Processing and applications, NLTK, Corpus and Dataset, understanding structure of sentence Defining Context free grammar, Morphological Analysis

Practice:

3. Word Analysis Learn about morphological features of a word by analysing it
4. Word Generation generate word forms from root and suffix information.

UNIT – II

Syntactic Analysis, Semantic analysis, Ambiguity resolution, Discourse integration, Preprocessing tokenization, stemming , lemmatization, Word tokenization and lemmatization

Practice:

3. Implement Porter Stemming Algorithm
4. NGrams learn to calculate bigrams from a given corpus and calculate probability of a sentence

UNIT – III

Feature engineering and NLP algorithms parsers, context free grammars, different types of parsers, POS tagging and different types of POS parsers.

Practice:

3. Morphology understanding the morphology of a word by the use of AddDelete table.
4. POS Tagging – calculate emission and transition matrix which will be helpful for tagging Parts of Speech

UNIT – IV

Basic statistical features of NLP: TFIDF, Vectorization Encoders and Decoders, Normalization, Advanced feature engineering and NLP algorithms Basics of Word2Vec

Practice:

3. Apply term frequency(TFIDF) to Measures the importance of a word to a specific document
4. Implement word embedding using word2vec

UNIT – V

Rule Based system for NLP, Machine Learning for NLP problems, Applications of NLP Text Summarization, Sentiment Analysis

Practice:

3. Chunking understand the concept of chunking and get familiar with the basic chunk tag set.
4. Building Chunker the importance of selecting proper features for training a model and size of training corpus in learning how to do cunking.

Text Books:

1. Python Natural Language Processing, Thanaki J, Packt Publishing Ltd, ISBN: 9781787121423
2. Springer Handbook of Speech Processing, Jacob Benesty, M. M. Sondhi, Yiteng Huang Springer, ISBN: 978-3-540-49127-9

Reference Books:

1. Speech & language processing, Jurafsky D, Pearson Education India, ISBN: 978-9332518414
2. Foundations of Statistical Natural Language Processing, Christopher, D. Manning and Hinrich Schütze, MIT Press, ISBN: 9780262133609

Web Links:

1. <https://www.nltk.org/data.html>

2. [https://www.analyticsvidhya.com/blog/2017/01/ultimateguidetounderstandimplemen
tnaturallanguageprocessingcodesinpython/](https://www.analyticsvidhya.com/blog/2017/01/ultimateguidetounderstandimplemen
tnaturallanguageprocessingcodesinpython/)
3. [https://datahack.analyticsvidhya.com/contest/linguipediacontestnaturallanguagepro
cessing1/?utm_source=ultimateguidetounderstandimplementnaturallanguageprocessi
ngcodesinpython&utm_medium=blog](https://datahack.analyticsvidhya.com/contest/linguipediacontestnaturallanguagepro
cessing1/?utm_source=ultimateguidetounderstandimplementnaturallanguageprocessi
ngcodesinpython&utm_medium=blog)

Data Visualization Techniques

Course Code: 241AI036

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the various types of data and principles of data visualization
- CO2:** Apply visualization techniques to a problem and its associated dataset
- CO3:** Apply structured approach to create effective visualizations
- CO4:** Outline the valuable insights from the massive dataset using visualization.
- CO5:** Build visualization dashboard to support decision making

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			1			1	1		2
CO2	2	2			2			1	1		2
CO3	2	2	3		1			1	1		2
CO4	2	2	3		1			1	1		1
CO5	2	2	3		1			1	1		1

UNIT – I

Introduction to Visualization:

Introduction to Data Visualizations and Perception: Introduction to visualization and visual perception, visual representation of data, Gestalt principles, Information overload.

Practice :

1. Introduction to various Data Visualization tools
2. Basic Visualization in Python

UNIT – II

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Practice :

1. Basic Visualization in R
2. Introduction to Tableau and Installation

UNIT – III

Classification of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multidimensional data, text and text documents.

Practice :

1. Connecting to Data and preparing data for visualization in Tableau
2. Data Aggregation and Statistical functions in Tableau

UNIT – IV

Visualization of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization. Various visualization techniques, data structures used in data visualization.**Practice :**

1. Data Visualizations in Tableau

UNIT – V

Visualization of Volumetric Data And Evaluation of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations

Practice :

1. Basic Dashboards in Tableau

Text Books:

1. Interactive Data Visualization: Foundations, Techniques, and Applications, Ward, Grinstein, Keim, Natick, A K Peters, Ltd, 2nd edition, ISBN: 978-1482257373.

Reference Books:

1. Visualization Analysis & Design, Tamara Munzner, AK Peters Visualization Series, 1st edition, ISBN: 978-1466508910.
2. Interactive Data Visualization for the Web, Scott Murray, 2nd Edition, ISBN: 978-1491921289.

Web Links:

1. <https://elearn.nptel.ac.in/shop/iitworkshops/completed/datavisualizationwithr/?v=c86ee0d9d7ed>
2. <https://www.geeksforgeeks.org/datavisualizationanditsimportance/>

Prompt Engineering and GenAI

Course Code: 241AI016

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the importance of prompt engineering, distinguish between explicit, implicit, and creative prompts.
- CO2:** Apply prompt engineering to improve NLP tasks, enhance creativity and diversity in AI-generated content.
- CO3:** Evaluate the Finetuning Language Models for Optimal Output Managing Prompt Complexity and Length.
- CO4:** Analyze the data preprocessing Techniques for language models.
- CO5:** Evaluate the ethical considerations and societal impact of generative AI technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			2			1	1		1
CO2	2	2			2			1	1		2
CO3	3	2			2			1	1		1
CO4	3	2	1		2			1	1		1
CO5	2	1	1		2			1	1		2

UNIT – I

Introduction to Prompt Engineering: What is prompt engineering and why it matters, Prompt types: explicit, implicit, and creative prompts, Best Practices for Crafting Effective Prompts

Practice:

1. Write a python program for Prompt Clarity Evaluation.
2. Write a python program for prompt Relevance Assessment
3. Write a Python Program for Prompt Diversity Experiment

UNIT – II

Practical Applications of Prompt Engineering: Improving NLP Tasks with Custom Prompts, Enhancing Creativity and Diversity in AIGenerated Content, Addressing AI Ethics and Bias through Thoughtful Prompt Engineering, Personalization and Adaptability in AIGenerated Content

Practice:

1. Write a python program for Custom Prompt for NLP Task
2. Write a python program for Enhancing Creativity in AIGenerated Content
3. Write a python program for Addressing Bias in AIGenerated Content

UNIT – III

Advanced Prompt Engineering Techniques

Customising Prompts for Specific Use Cases, Finetuning Language Models for Optimal Output Managing Prompt Complexity and Length, Enhancing Control and Diversity in Generated Text.

Practice:

1. Write a python program for Customizing Prompts for Specific Use Cases
2. Finetuning Language Models for Optimal Output using python

UNIT – IV

Foundations of Generative AI

Neural Networks and Their Relevance in AI Language Generation, Deep Learning Architectures for Text Generation and its Implications for Prompt Engineering, Data Preprocessing Techniques for Language Models

Practice:

1. Write a python program for Training a Simple Text Generation Model using LSTM
2. Data Preprocessing Techniques for Language Models using python

UNIT – V

Advanced Topics in Generative AI

Adversarial attacks and defences in generative models, Ethical considerations and societal impact of generative AI, Lang Chain Framework.

Practice:

1. Detecting and Mitigating Adversarial Attacks using python

Text Books:

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville Version: 1st Edition, ISBN: 978-0262035613.
- 2 Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit, Steven Bird, Ewan Klein and Edward Loper Version: 1st Edition, ISBN: 978-0596516499.

Reference Books:

- 1 Markov Decision Processes: Discrete Stochastic Dynamic Programming, Puterman, Martin L., Germany: Wiley, ISBN: 978-0471727828.
- 2 Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, Author: David Foster Version: 1st Editon 2019, ISBN: 978-1492041948.
- 3 Interpretable Machine Learning: A Guide for Making Black Box Models Explainable Christoph Molnar Version: 1st Edition 2019, ISBN: 978-1700895466.

Web Links:

1 https://onlinecourses.nptel.ac.in/noc20_cs74/preview

Social Network Analysis

Course Code: 241CS041	L 2	T 0	P 1	C 3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the fundamental of semantic web.
- CO2:** Illustrate knowledge representation using ontology.
- CO3:** Analyze various communities in social networks
- CO4:** Illustrate the prediction of human behaviour for social networks.
- CO5:** Design visualization of social networks.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2						1			1
CO2	2	3						1	1		
CO3	2	3	2	1				2	1		1
CO4	2	2						1			1
CO5	3	2	2					1	1		

UNIT – I

INTRODUCTION

Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Webbased networks– Applications of Social Network Analysis.

Practice:

1. Learn how to construct a social network object in R

UNIT – II

MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION

Ontology and their role in the Semantic Web: Ontologybased knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: Stateoftheart in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

Practice:

1. Perform knowledge representation of semantic web.

UNIT – III

EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS

Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – MultiRelational characterization of dynamic social network communities.

Practice:

1. Learn how to visualize a social network

UNIT – IV

PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES

Understanding and predicting human behavior for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and counter measures.

Practice:

1. Learn how to calculate node and network level summary statistics

UNIT – V

VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS

Graph theory – Centrality – Clustering – NodeEdge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrixbased representations – Matrix and NodeLink Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – CoCitation networks.

Practice:

1. Learn how to incorporate network connectivity in a spatial regression model

Text Books:

1. Social Networks and the Semantic Web ,Peter Mika, Springer ,First Edition. ISBN: 978-0-387-71000-6.
2. Handbook of Social Network Technologies and Applications ,Borko Furht, ISBN: 978-1441971418.

Reference Books:

1. Web Mining and Social Networking Techniques and applications,Guandong Xu ,Yanchun Zhang and Lin Li, First Edition, Springer. ISBN: 978-1441977342.
2. Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively ,Dion Goh and Schubert Foo, IGI Global Snippet. ISBN: 978-1599045436.
3. Max Chevalier, Christine Julien and Chantal SouléDupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet. ISBN: 9781605663074.
4. The Social Semantic Web ,John G. Breslin, Alexander Passant and Stefan Decker, ,Springer. ISBN: 978-3642424328.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- 2 <https://open.hpi.de/courses/semanticweb>
- 3 <https://crd230.github.io/lab9.html>

Minor Degree in Data Science (offered to other branches students)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241IT007	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
241CS034	Fundamentals of Data Science	IC	2		1	3	50	50	100	-
241CS012	NoSQL Databases	IC	2			2	50	50	100	-
241AI003	Data Mining	IC	2		1	3	50	50	100	-
241CS037	Health Care Data Analytics	IC	2		1	3	50	50	100	-
241CS036	(or) Business Intelligence & Analytics									PPSC
241AI004	Big Data Analytics (or)	AC	2		1	3	50	50	100	DM
241AI036	Data Visualization Techniques									DAP
241CS041		AC	2		1	3	50	50	100	-

241CS040	Social Network Analysis (or) Social Networks & Semantic Web								
	Total	14		6	20				

Software Engineering
(Common to CSE, IT AIML & CSE (DS))

Course Code: 241IT007

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply software engineering practices and evaluate different software development models to design and manage the life cycle of a Student Management System (SMS).
- CO2:** Analyze the principles of Agile methodologies and compare them with traditional models by transitioning a retail software company from Waterfall to Agile.
- CO3:** Evaluate the impact of Agile processes on requirements engineering and manage unstable requirements for a social media platform project.

- CO4:** Design and implement a comprehensive testing strategy using TDD and test automation tools in an Agile project.
- CO5:** Apply Agile design principles and execute refactoring techniques to develop maintainable and scalable software systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			2						
CO2	3	2	1	1				2	2	2	1
CO3	2	1	1							2	1
CO4	3	2	2	1				2	2	2	1
CO5	1	2									

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Text Books:

1. Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
2. Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

1. Software Engineering, Ian Sommerville, Pearson, Ninth Edition.
2. Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, David J. Anderson; Eli Schragenheim,

Web Links:

1. https://www.tutorialspoint.com/software_engineering/
2. <https://www.sciencedirect.com/science/article/pii/S0950584916303329>

Fundamentals of Data Science

	L	T	P	C
Course Code: 241CS034	2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain fundamental concepts of Data Science.
- CO2:** Implement Data Collection and Preprocessing Techniques.
- CO3:** Demonstrate Proficiency in Data Loading, Storage, and File Handling
- CO4:** Conduct Exploratory Data Analysis (EDA) using Visualization and Statistical Techniques.
- CO5:** Make use of Neo4j, Cypher tools to manage and analyze graph data.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3						2	2		
CO2	2							1	2		
CO3	2	2	2					2	2		
CO4	2	2			2			2	1		
CO5	3							1	1		

UNIT – I

Introduction To Data Science: Definition and Scope of Data Science, History and Evolution of Data Science, Applications of Data Science, Data Science Lifecycle, Data Types and Structures, Tools and Technologies in Data Science.

Practice:

3. Importing and Exploring Datasets - Loading datasets using libraries and performing basic exploration.
4. Basic Data Structures - Working with data structures such as arrays, lists, data frames, and matrices.

UNIT-II

Data Collection and Preprocessing: Data Collection Methods, Data Cleaning and Handling Missing Values, Data Transformation: Normalization and Standardization, Feature Engineering and Feature Scaling, Data Integration and Aggregation.

Practice:

3. Computing summary statistics like mean, median, mode, and standard deviation for a sample dataset.
4. Handling missing values and outliers in a dataset using techniques like imputation and filtering.

UNIT – III

Data Loading, Storage, and File Formats : Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice:

3. Read data from a JSON file into a DataFrame using Pandas (pd.read_json) or R (jsonlite). Parse nested JSON structures and convert them into a flat table format.
4. Perform web scraping on an HTML page using BeautifulSoup in Python or rvest in R. Extract data from HTML tables and convert it into a DataFrame.

UNIT – IV

Exploratory Data Analysis (EDA): Descriptive Statistics, Data Visualization Techniques, Correlation and Covariance Analysis, Univariate, Bivariate, and Multivariate Analysis, Pattern Detection and Anomaly Identification.

Practice:

3. Plotting histograms and box plots to understand the distribution of a single variable.
4. Creating scatter plots and calculating correlation coefficients to study the relationship between two variables.

UNIT – V

Data Science Tools: Neo4j for dealing with graph databases, graph query language Cypher, libraries like nltk and SQLite for handling Text mining and analytics.

Practice:

3. Get hands-on experience with Neo4j to understand how to manage and query graph databases.
4. Practice writing Cypher queries to interact with graph data in Neo4j.

Text Books:

- 1 Python for Data Analysis, Wes McKinney,,O'REILLY, ISBN:978-1-449-31979-3, 1st Edition.
- 2 Doing Data Science, Rachel Schutt & O'neil, O'REILLY, ISBN:978-1-449-35865-5, 1st Edition.

Reference Books:

- 1 Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media, ISBN: 9781492041139.
- 2 Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, Matt Harrison, O'Reilly, ISBN: 9781787123137

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_cs68/preview
2. https://onlinecourses.nptel.ac.in/noc24_cs133/preview
3. <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>

NoSQL Databases

Course Code: 241CS012

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Compare the traditional relational databases and NoSQL
- CO2:** Explain the principles and architecture of document store databases
- CO3:** Design and implement key value database solutions.
- CO4:** Illustrate the fundamental concepts and architecture of column family store databases
- CO5:** Optimize graph databases for performance and scalability

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	2	2			2						
CO3	2	2	3		1						
CO4	2	2	3		1						
CO5	2	2	3		1						

UNIT – I

Introduction to No SQL: Definition And Introduction, Traditional relational databases vs. NoSQL databases, Types of No SQL databases, Storing and Accessing Data in NoSql databases, Querying in NoSql databases, Evolution and motivation behind NoSQL databases, Characteristics, advantages, and challenges of NoSQL databases Performing Crud Operations, Creating Records, Accessing Data, Updating And Deleting Data

UNIT – II

Document Stores:

Introduction to MongoDB, Importance of NoSQL databases, Data types, Documents, nested Documents, CRUD Operations, Basic cursor methods: map, to Array, pretty, for Each, limit, count, sort, Columnar Databases, Indexing and Aggregation, MongoDB Node JS Drivers and CAP theorem.

UNIT – III

Key Value databases:

What Is a Key Value Store, Key Value Store Features, Suitable Use Cases, When Not to Use **Document Databases:** What Is a Document Database, Features, Suitable Use Cases, When Not to Use NoSQL Data Bases

UNIT – IV

Column family stores:

What Is a ColumnFamily Data Store, Features, Suitable Use Cases, When Not to Use
Graph Databases: What Is a Graph Database, Features, Suitable Use Cases, When Not to Use

UNIT – V

Graph Database:

Graph Oriented Database Platform: Neo4j Graph Databases – Model relational data – Property graph model – Neo4j Graph Platform –Components – Features – Benefits of Neo4j – Setup Development Environment – Neo4j Sandbox –Neo4j Desktop – Cypher – Match – Graph node retrieval – Graph relations retrieval – Graph properties retrieval – Nodes – Relationships – Merge data into graph – Parameter constraints –Monitor query execution – Indexes – Relational Data.

Text Books:

- 1 NoSQL Distilled, Pramod J. Sadalage, Martin Fowler, Addison Wesley. ISBN: 978-0-321-82662-6
- 2 Making Sense of NoSQL, Dan McCreary and Ann Kelly, Manning Publications. ISBN: 9781617291074

Reference Books:

- 1 Professional NoSQL, Shashank Tiwari, Wrox Press, Wiley. ISBN: 978-0470942246.
- 2 Getting Started with NoSQL, Gaurav Vaish, Packt Publishing. ISBN: 978-1849694988.

Web Links:

- 1 <https://nptel.ac.in/courses/106104135>
- 2 <https://www.geeksforgeeks.org/wheredoesmongoddbstandinthecaptheorem/>
- 3 <https://www.geeksforgeeks.org/columnarddatamodelofnosql/>

Data Mining

Course Code: 241AI003

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate data warehousing architectures and mining concepts for knowledge discovery.
- CO2:** Apply preprocessing techniques to prepare data for mining algorithms.
- CO3:** Build classification model using Decision tree induction.
- CO4:** Analyze association rule generation using Apriori and FP growth algorithms.
- CO5:** Apply Clustering algorithms on given data to find similarity between classes.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2		1			1	1		2
CO2	2	2	2		2			1	1		2
CO3	2	2	3		1			1	1		2
CO4	2	2	3		1			1	1		2
CO5	2	2	3		1			1	1		2

UNIT – I

Data Warehousing and Online Analytical Processing:

Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation, Data Generalization by AttributeOriented Induction.

Data Mining: What Is Data Mining, Why Data Mining, Data Mining Functionalities, Technologies Are Used, Major Issues in Data Mining, Architecture Of Data Mining Systems Classification Of Data Mining Systems.

Practice:

1. Illustrate KDD process and explore the Data Mining tool WEKA/KNIME for Data Preprocessing, Classification and Clustering.
2. Explain ETL process important for moving data in the data warehouse.

UNIT – II

Know Your Data : Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity.

Data Preprocessing : An Overview, Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization

Practice:

1. Apply Statistical Descriptions and Measures of Similarity and Dissimilarity on given data
2. Apply PreProcessing for training data set related to Weather data

UNIT – III

Classification and Prediction: Classification: Basic Concepts, General Approach to Solving a Classification Problem, Decision Tree Induction, Model Overfitting, Evaluating the Performance of a Classifier, Issues Regarding Classification and Prediction

Practice:

1. Demonstrate classification rule process on given data set using id3 algorithm.
2. Demonstrate classification rule process on Student's Academic Performance Data using j48 algorithm.

UNIT – IV

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Association Mining to Correlation Analysis.

Practice:

1. Demonstrate Association rule generation on credit card data using apriori algorithm.
2. Demonstrate Association rule process on ontactlenses.arff using FPGrowth Algorithm

UNIT – V

Cluster Analysis: Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Evaluation of Clustering, Mining Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Practice

1. Demonstrate clustering process on given dataset using simple k-means
2. Apply Hierarchical clustering process on dataset.

Cornerstone Project:

“Student Activity & Trend Detection using Data Mining (Library, Attendance, Events, Feedback)”

Introduction

This project focuses on identifying patterns and trends in student activities using data mining techniques. The analysis integrates multiple datasets such as Library Usage, Attendance, Event Participation, and Student Feedback.

Dataset Details

You will work with four primary datasets. Each dataset can be downloaded from publicly available sources such as Kaggle. Below are the complete details:

Project 1: Library Dataset

- Fields: StudentID, BookID, BorrowDate, ReturnDate, Category
- Purpose: Measure academic involvement through book borrowing patterns.
- Download: Kaggle – Book Recommendation or Library Management datasets.

1. Book Recommendation Dataset (contains user–book interactions)

 <https://www.kaggle.com/datasets/mohamedharris/book-recommendation-dataset>

2. Library Management System Dataset

 <https://www.kaggle.com/datasets/saurabhbagchi/books-dataset>

3. Goodreads Book Borrow/User Activity Dataset

 <https://www.kaggle.com/datasets/gnanesh/goodreads-books-dataset>

Project 2: Attendance Dataset

- Fields: StudentID, AttendancePercentage, Class, Section, Subject
- Purpose: Identify correlation between attendance and performance.
- Download: Kaggle – Student Performance/Attendance datasets.

1. Student Performance & Attendance Dataset

 <https://www.kaggle.com/datasets/rodsaldanha/student-performance-data>

2. Students Exam Performance (contains attendance proxy + scores)

 <https://www.kaggle.com/datasets/spscientist/students-performance-in-exams>

3. Student Academic Performance Dataset (includes attendance)

 <https://www.kaggle.com/datasets/whenamancodes/students-performance>

Project 3: Events Participation Dataset

- Fields: StudentID, EventName, ParticipationType, CertificatesWon, EventCategory
- Purpose: Analyze co-curricular engagement.
- Download: Kaggle – Student activities & performance datasets.

1. Student Activity & Performance Dataset

 <https://www.kaggle.com/datasets/ardianumam/student-activity-and-performance>

2. Extra-curricular Activities & Participation Dataset

 <https://www.kaggle.com/datasets/lokhman/extra-curricular-activities-students>

3. Co-Curricular Activity Participation Dataset

 <https://www.kaggle.com/datasets/abhinavmoudgil95/student-activity-data>

Project 4: Student Feedback Dataset

- Fields: StudentID, CourseRating, TeacherRating, Comment, Sentiment
- Purpose: Extract student satisfaction trends (text + numeric feedback).
- Download: Kaggle – Feedback/Evaluations datasets.

1. Student Course Evaluation Dataset

 <https://www.kaggle.com/datasets/mateusdmachado/students-course-evaluations>

2. Student Satisfaction Survey (Feedback)

 <https://www.kaggle.com/datasets/ananthu017/student-feedback-survey>

3. Teaching Evaluation Dataset (Large Text Feedback)

 <https://www.kaggle.com/datasets/xplenty/academic-success-with-student-evaluations>

Student can select any one of the above and implement the cornerstone project using the following steps.

I. Data Preprocessing

1. Cleaning:

- Remove missing values.
- Normalize date formats (BorrowDate, ReturnDate).
- Remove duplicate entries.
- Convert categorical values (Department, Event Category).

2. Feature Engineering:

- LibraryScore = Total books borrowed per semester.
- AttendanceScore = Attendance percentage.
- EventScore = Count of events attended + certificates.
- FeedbackSentiment = Polarity score extracted using NLP.

3. Dataset Integration:

- Merge all datasets using StudentID as the primary key.
- Generate consolidated activity metrics for each student.

II. Model Implementation Steps

A. Clustering (Trend Detection)

- Algorithms: K-Means, DBSCAN.
- Input Features: LibraryScore, AttendanceScore, EventScore, FeedbackSentiment.
- Output: Activity clusters such as High, Medium, Low engagement.

B. Classification

- Algorithms: Decision Tree, Random Forest, Naïve Bayes.
- Target: Predict student performance or engagement levels.

C. Topic Modeling (Feedback)

- Algorithm: LDA
- Purpose: Extract themes from feedback comments such as:
 - Teaching Quality
 - Course Difficulty
 - Infrastructure
 - Stress Factors

III. Data Visualization Steps

Charts to be produced after analysis:

- Heatmap: Attendance vs CGPA
- Bar Chart: Library usage by department
- Pie Chart: Event participation percentages
- Line Chart: Monthly book borrowing trend
- Word Cloud: Feedback comments

Tools: Matplotlib, Seaborn, Plotly, Power BI.

IV. Insights & Interpretation

Based on combined analysis:

- Students with high library usage often have higher attendance and performance.
- Event participation is highest among CSE and AIML departments.
- Feedback sentiment indicates improvement needed in lab infrastructure.
- Attendance dips during mid-semester months but library usage peaks.

These insights help universities in academic planning and student support.

Text Books:

- 1 Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei Third Edition, Elsevier, ISBN: 978-9380931913
- 2 Introduction to Data Mining, PangNing Tan, Michael Steinbach and Vipin Kumar Pearson Education, ISBN: 978-1-292-02615-2

Reference Books:

- 1 Data Mining: Introductory and Advanced Topics, Margaret H. Dunham, 1st Edition Pearson Edn, ISBN: 978-8177587852
- 2 Data Mining Techniques and Applications An Introduction, Hongbo Du, 1st Edition, Cengage India, ISBN: 978-8131519554
- 3 Data Warehousing, Data Mining and OLAP, Alex Berson,.Stephen J. Smith, McGrawHill series, ISBN: 978-0070062726

Web Links:

- 1 <https://nptel.ac.in/courses/106105174/>

- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Note:

- The cornerstone project team size shall be 3 or 4 students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The CIE – DDA & Internal Lab shall be evaluated for 25 marks based on project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consists of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository.

Health Care Data Analytics

Course Code: 241CS037

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain fundamentals of Healthcare Data Analytics.
- CO2:** Demonstrate the technologies for analyzing Biomedical Image
- CO3:** Apply predictive modeling techniques for Clinical Data
- CO4:** Apply predictive analysis techniques for genomic data
- CO5:** Illustrate NLP and Data mining for clinical text.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2								2	2	1
CO2	2	2		1	2				1	2	
CO3	1				2				2	2	1
CO4	2			2	1				1	1	1
CO5	2	2			1				2	2	

UNIT – I

An Introduction to Healthcare Data Analytics: ealthcare Data Sources and Basic Analytics Advanced Data Analytics for Healthcare Applications and Practical Systems for Healthcare Resources for Healthcare Data Analytics Electronic Health RecordsComponents of EHR Coding Systems Benefits of EHR Barriers to Adopting EHR Challenges of Using EHR Data.

Practice:

2. Clean and explore a health care dataset to understand its structure and key attributes.
Use the Diabetes dataset from the UCI Machine Learning Repository.

UNIT – II

Biomedical Image Analysis: Biomedical Imaging Modalities Object Detection Image Segmentation Image Registration Feature Extraction Mining of Sensor Data in Healthcare Mining Sensor Data in Medical Informatics Challenges in Healthcare Data Analysis Sensor Data Mining Applications.

Practice:

1. Build a model to predict if a patient will be readmitted to the hospital within 30 days.Use the Hospital Readmissions Reduction Program (HRRP) dataset.

UNIT – III

Predictive Models for Integrating Clinical and Genomic Data: Introduction Issues and Challenges Different Types of Integration Different Goals of Integrative Studies Validation Information Retrieval for Healthcare KnowledgeBased Information in Healthcare and Biomedicine Content of KnowledgeBased Information Resources Indexing Retrieval Evaluation Research Directions.

Practice:

1. Perform survival analysis on a dataset of cancer patients to estimate survival rates.
Use the SEER Cancer Incidence dataset

UNIT – IV

Natural Language Processing and Data Mining for Clinical Text: Natural Language Processing Mining Information from Clinical Text Challenges of Processing Clinical Reports Clinical Applications Social Media Analytics for Healthcare Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks Social Media Analysis for Public Health Research Analysis of Social Media Use in Healthcare.

Practice:

1. Segment patients into different groups based on their health care utilization patterns.
Use a dataset containing patient visit records, such as the National Hospital Ambulatory Medical Care Survey (NHAMCS).

UNIT – V

Advanced Data Analytics for Healthcare: Automated Decision Systems The Artificial Intelligence field Basic concepts of Expert Systems Applications of Expert Systems Structure of Expert Systems Knowledge Engineering Development of Expert Systems – Locationbased Analytics Cloud Computing Business Intelligence.

Practice:

1. Analyze health care costs and identify factors driving high costs. Use the Medical Expenditure Panel Survey (MEPS) dataset.

Text Books:

- 1 Chandan K. Reddy, Charu C. Aggarwal "Healthcare Data Analytics", CRC Press, ISBN 9781032527802

Reference Books:

- 1 Analytics in Healthcare A Practical Introduction, Christo El Morr, Hossam AliHassan, 2019, ISBN: 9783030045067

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_hs40/preview
- 2 <https://nptel.ac.in/courses/109107190>

Business Intelligence & Analytics

Course Code: 241CS036

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the Business Intelligence, Analytics and Decision Support system
- CO2:** List the technologies for Decision making, Automated decision systems
- CO3:** Explain sentiment analysis techniques
- CO4:** Illustrate Multicriteria Decision making systems, predictive modelling techniques
- CO5:** Evaluate and validate the performance of automated decision systems and expert systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	1	1				2	2	1
CO2	2	1	2	1	1				1	2	1
CO3	2	2	1	1	2				2	2	1
CO4	2	2	2	1	1				2	1	
CO5	2	1	1		1				2	1	

UNIT – I

An Overview of Business Intelligence, Analytics, and Decision Support: Information Systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems, A Framework for Business Intelligence, Business Analytics Overview, Brief Introduction to Big Data Analytics.

Practice:

1. Create interactive dashboards to visualize sales data and identify trends.

UNIT – II

Decision Making: Introduction and Definitions, Phases of the Decision, Making Process, The Intelligence Phase, Design Phase, Choice Phase, Implementation Phase, Decision Support Systems Capabilities, Decision Support Systems Classification, Decision Support Systems Components.

Practice:

1. Build a predictive model to forecast future sales.

UNIT – III

Neural Networks and Sentiment Analysis : Basic Concepts of Neural Networks, Developing Neural NetworkBased Systems, Illuminating the Black Box of ANN with Sensitivity, Support Vector Machines, A Process Based Approach to the Use of SVM, Nearest Neighbor Method for Prediction, Sentiment Analysis Overview, Sentiment Analysis Applications, Sentiment Analysis Process,, Sentiment Analysis, Speech Analytics.

Practice:

1. Use a pretrained sentiment analysis model to classify the sentiment of text data.

UNIT – IV

Model Based Decision Making: Decision Support Systems modeling, Structure of mathematical models for decision support, Certainty, Uncertainty, and Risk, Decision modeling with spreadsheets, Mathematical programming optimization, Decision Analysis with Decision Tables and Decision Trees, MultiCriteria Decision Making With Pairwise Comparisons

Practice:

1. Evaluate different investment options considering potential risks and returns.

UNIT – V

Automated Decision Systems and Expert Systems: Automated Decision Systems, The Artificial Intelligence field, Basic concepts of Expert Systems, Applications of Expert Systems, Structure of Expert Systems, Knowledge Engineering, Development of Expert Systems.

Practice:

1. Develop a system to recommend products to customers based on their purchase history and preferences.

Text Books:

- 1 Ramesh Sharda, Dursun Delen, Efraim Turban, J.E. Aronson, Ting Peng Liang, David King, “Business Intelligence and Analytics: System for Decision Support”, 10th Edition, Pearson Global Edition., ISBN: ISBN:9789352866489.

Reference Books:

- 1 Data Analytics: The Ultimate Beginner's Guide to Data Analytics Paperback – 12 November 2017 by Edward Mize, ISBN: 9781925997576.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc24_cs65/preview
- 2 <https://www.geeksforgeeks.org/what-is-business-intelligence/>

Big Data Analytics

Course Code: 241AI004

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate big data challenges in different domains
- CO2:** Use various techniques for mining data stream.
- CO3:** Demonstrate building blocks of Hadoop
- CO4:** Make use of Pig and Hive to structure big Data
- CO5:** Apply Spark tool to analyze big data.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		1	2				1	2	1
CO2	2	3		1	2				1	2	1
CO3	2	1		3	2				1	2	2
CO4	2	3		2	2				1	2	2
CO5	2	2		1	3				1	2	2

UNIT – I

Introduction to big data: Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting.

Practice:

- Hadoop File System Operations: Implement the following file management tasks in Hadoop: a.) Adding files and directories b.) Retrieving files c.) Deleting files

UNIT – II

Stream Processing:

Mining data streams: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics Platform (RTAP) Applications.

Practice:

- Loading DataSet in to HDFS for Spark Analysis.

UNIT – III

Introduction to Hadoop: History of Hadoop, the Hadoop Distributed File System, Components of Hadoop Analyzing the Data with Hadoop, Scaling Out, Hadoop Streaming, Design of HDFS, Java interfaces to HDFS Basics, Developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Failures, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features Hadoop environment.

Practice:

1. Map Reduce Word Count Hadoop Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.

UNIT – IV

Pig: Hadoop Programming Made Easier: Admiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Checking out the Pig Script Interfaces, Scripting with Pig Latin. Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works with examples, Querying and Analyzing Data.

Practice:

1. Hive Queries a) Install Hive Framework b) Implement Hive to create, alter, and drop databases, tables
2. Hive Queries Implement hive queries and joins to perform display and retrieve the data

UNIT – V

Spark: Installing Spark, Spark applications, Jobs, stages and Tasks, Resilient Distributed data sets, Shared Variables, Anatomy of a Spark job run.

Practice:

1. Demonstrate Spark SQL on Hive
 - a) Create a SQLContext object and load the Parquet file into DataFrame
 - b) Load the Dataframe into Hive table.
 - c) Verify the created Hive table in Hive environment
 - d) Execute Spark SQL query

Text Books:

- 1 Hadoop: The Definitive Guide, Tom White, O'reilly, 4th Edition, ISBN: 978-1491901632
- 2 Hadoop for Dummies, Dirk deRoos, Paul C.Zikopoulos, Roman B.Melnyk, Bruce Brown, Rafael Coss, John Wiley & Sons, ISBN: 978-1118727128

Reference Books:

- 1 Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Bill Franks, John Wiley & sons, ISBN: 978-1118224912
- 2 Harness the Power of Big Data: The IBM Big Data Platform, Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, Tata McGraw Hill Publications, ISBN: 9780071808187
- 3 Big Data Science & Analytics: A Hands On Approach , Arshdeep Bahga and Vijay Madisetti, VPT, ISBN: 978-0996025577
- 4 Learning Spark: Lightning Fast Big Data Analysis Paperback, Holden Karau, ISBN: 978-1449358624

Web Links:

- 1 Hadoop: <http://hadoop.apache.org/>
- 2 Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
- 3 <https://nptel.ac.in/courses/106106142>

- 4 <https://www.cloudera.com/servicesandsupport/tutorials.html>
- 5 <https://www.databricks.com/spark/gettingstartedwithapachespark>

Data Visualization Techniques

Course Code: 241AI036

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the various types of data and principles of data visualization
- CO2:** Apply visualization techniques to a problem and its associated dataset
- CO3:** Apply structured approach to create effective visualizations
- CO4:** Outline the valuable insights from the massive dataset using visualization.
- CO5:** Build visualization dashboard to support decision making

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			1				1		2
CO2	2	2			2				1		2
CO3	2	2	3		1				1		2
CO4	2	2	3		1				1	1	1
CO5	2	2	3		1				1	1	1

UNIT – I

Introduction to Visualization:

Introduction to Data Visualizations and Perception: Introduction to visualization and visual perception, visual representation of data, Gestalt principles, Information overload.

Practice:

1. Introduction to various Data Visualization tools
2. Basic Visualization in Python

UNIT – II

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Practice:

1. Basic Visualization in R
2. Introduction to Tableau and Installation

UNIT – III

Classification of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.

Practice:

1. Connecting to Data and preparing data for visualization in Tableau
2. Data Aggregation and Statistical functions in Tableau

UNIT – IV

Visualization of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization. Various visualization techniques, data structures used in data visualization.

Practice:

1. Data Visualizations in Tableau

UNIT – V

Visualization of Volumetric Data And Evaluation of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations

Practice:

1. Basic Dashboards in Tableau

Text Books:

- 1 Interactive Data Visualization: Foundations, Techniques, and Applications, Ward, Grinstein, Keim, Natick, A K Peters, Ltd, 2nd edition. ISBN: 978-1-4822-5737-3.

Reference Books:

- 1 Visualization Analysis & Design, Tamara Munzner, AK Peters Visualization Series, 1st edition. ISBN: 978-1466508910.
- 2 Interactive Data Visualization for the Web, Scott Murray, 2nd Edition. ISBN: 978-1491921289.

Web Links:

- 1 <https://elearn.nptel.ac.in/shop/iit-workshops/completed/data-visualization-with-r/?v=c86ee0d9d7ed>
- 2 <https://www.geeksforgeeks.org/data-visualization-and-its-importance/>

Social Network Analysis

Course Code: 241CS041

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the fundamental of semantic web.
- CO2:** Illustrate knowledge representation using ontology.
- CO3:** Analyze various communities in social networks
- CO4:** Illustrate the prediction of human behaviour for social networks.
- CO5:** Design visualization of social networks.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2							1		
CO2	2	3							1		
CO3	2	3	2	1						1	
CO4	2	2							1		
CO5	3	2	2						1	1	

UNIT – I

Introduction

Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Webbased networks– Applications of Social Network Analysis.

Practice:

- Construct a social network object in R

UNIT – II

Modelling, Aggregating And Knowledge Representation

Ontology and their role in the Semantic Web: Ontologybased knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: Stateoftheart in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

Practice:

- Perform knowledge representation of semantic web.

UNIT – III

Extraction And Mining Communities In Web Social Networks

Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – MultiRelational characterization of dynamic social network communities.

Practice:

1. How to visualize a social network

UNIT – IV

Predicting Human Behavior And Privacy Issues

Understanding and predicting human behavior for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and counter measures.

Practice:

1. Calculate node and networklevel summary statistics

UNIT – V

Visualization And Applications Of Social Networks

Graph theory – Centrality – Clustering – NodeEdge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrixbased representations – Matrix and NodeLink Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – CoCitation networks.

Practice:

1. How to incorporate network connectivity in a spatial regression model

Text Books:

- 1 Social Networks and the Semantic Web ,Peter Mika, Springer ,First Edition. ISBN: 978-0-387-71000-6.
- 2 Handbook of Social Network Technologies and Applications ,Borko Furht, ISBN: 978-1441971418.

Reference Books:

- 1 Web Mining and Social Networking Techniques and applications,Guandong Xu ,Yanchun Zhang and Lin Li, First Edition, Springer. ISBN: 978-1441977342.
- 2 Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively ,Dion Goh and Schubert Foo, IGI Global Snippet. ISBN: 978-1599045436.
- 3 Max Chevalier, Christine Julien and Chantal SouléDupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet. ISBN: 9781605663074.
- 4 The Social Semantic Web ,John G. Breslin, Alexander Passant and Stefan Decker, ,Springer. ISBN: 978-3642424328.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- 2 <https://open.hpi.de/courses/semanticweb>
- 3 <https://crd230.github.io/lab9.html>

Social Networks and Semantic Web

Course Code: 241CS040

L	T	P	C
2	0	1	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize the concepts of semantic web and social network analysis.
- CO2:** Describe the knowledge representation on the Semantic web.
- CO3:** Make use of ontology engineering in social networks.
- CO4:** Identify the architectures and challenges in building social networks
- CO5:** Compare various survey methods of social networks.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		1					1		
CO2	2	3							1	1	
CO3	2	3	2								
CO4	2	2	3						1		
CO5	3	2	1						1	1	

UNIT – I

Web Intelligence: Thinking and Intelligent Web Applications, The Information Age, The World Wide Web, Limitations of Today's Web, The Next Generation Web, Machine Intelligence, Artificial Intelligence, Ontology, Inference engines, Software Agents, BernersLee www, Semantic Road Map, Logic on the semantic Web.

Practice:

1. Plot the trend of Moore's law from 1970 to today. Then project processor performance for the year 2020 based on Moore's law.

UNIT – II

Knowledge Representation for the Semantic Web: Ontologies and their role in the semantic web, Ontologies Languages for the Semantic Web –Resource Description Framework (RDF) / RDF Schema, Ontology Web Language (OWL), UML, XML/XML Schema.

Practice:

1. Why is it necessary to consider less powerful expressive languages for the Semantic Web?

UNIT – III

Ontology Engineering: Ontology Engineering, Constructing Ontology, Ontology Development Tools, Ontology Methods, Ontology Sharing and Merging, Ontology Libraries and Ontology Mapping, Logic, Rule and Inference Engines. Practice: Describe an ontology with the domain of your university faculty, with teachers, courses, and departments.

Practice:

1. Use an inference engine to validate your ontology and check for inconsistencies.

UNIT – IV

Semantic Web Applications, Services and Technology: Semantic Web applications and services, Semantic Search, elearning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWLS Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Methods

Practice:

1. Why would Semantic Web Services promote open Web standards and a distributed Web?

UNIT – V

Social Network Analysis and semantic web: What is social Networks analysis, development of the social networks analysis, Electronic Sources for Network Analysis – Electronic Discussion networks, Blogs and Online Communities, Web Based Networks, Building Semantic Web Applications with social network features.

Practice:

1. List three potential applications that would benefit from the Semantic Web environment.

Text Books:

- 1 Thinking on the Web – Berners Lee, Godel and Turing, Wiley inter science. ISBN: 978-0471768661.
- 2 Social Networks and the Semantic Web, Peter Mika, Springer. ISBN: 978-0-387-71000-6.

Reference Books:

- 1 Semantic Web Technologies, Trends and Research in Ontology Based Systems, J. Davies, R. Studer, P. Warren, John Wiley & Sons. ISBN: 9780470030332..
- 2 Information sharing on the semantic Web – Heiner Stuckenschmidt; Frank Van Harmelen, Springer Publications. ISBN: 978-3-540-20594-4
- 3 Programming the Semantic Web, T. Segaran, C. Evans, J. Taylor, O'Reilly, SPD. ISBN: 978-0596153816.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_cs78/preview
- 2 <https://tinyurl.com/hhywdjx8>

3 <https://open.hpi.de/courses/semanticweb>

Minor Degree in Petroleum Technology (offered to other branches students)

Course Code	Course Name	Level	L	T	P	C	CIE	SE E	Total	Pre-requisite
241PT027	Introduction to Petroleum Engineering	FC	2			2	50	50	100	-

241PT035	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
241PT047	Fundamentals of Geology & Reservoir Engineering	IC	3			3	50	50	100	-
241PT048	Fundamentals of Drilling & Production Engineering (or) Unconventional Hydrocarbon Resources	IC	3			3	50	50	100	-
241PT016										
241PT049	Natural Gas Hydrates (or) Fundamentals of Liquefied Natural Gas	AC	3			3	50	50	100	-
241PT005										
241PT050	Artificial Lift Techniques (or) Enhanced Oil Recovery	AC	3			3	50	50	100	-
241PT003										
241PT012	Petroleum Refinery Engineering	AC	3			3	50	50	100	-
Total			20			20				

Introduction to Petroleum Engineering

Course Code: 241PT027

L T P C
2 0 0 2

Course Outcomes:

At the end of the Course, Student will be able to:

- CO 1:** Identify the various streams in the petroleum industry.
- CO 2:** Outline the onshore and offshore reservoirs.

- CO 3:** List out the various artificial lift techniques.
- CO 4:** Illustrate various attributes in mid-stream processing and storage.
- CO 5:** Describe the crude oil products and their specifications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT-I

What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector- Midstream Processing-Downstream Processing-Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II

Exploration & Production-Indian and World Scenario of Petroleum and Natural Gas Resources- The Reservoir-Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs - Reservoir Drives. Exploration and Drilling Rigs- Rig Components- Drill and drill bits- Drilling fluids.

UNIT III

Well Completions Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.
Artificial Lift: Principles and operation of Rod Pumps Down Hole Pumps - Gas Lift - Plunger Lift- Electrical submersible pumps.

UNIT IV

Separation of Reservoir Fluids- Manifolds and Gathering - Production Separators - Gas Treatment and Compression - Oil & Gas Storage.
Midstream processing: Transportation of Crude Oil & its Products and Natural Gas- - World and Indian pipeline scenario- Design of Oil and Gas pipelines Safety aspects of pipelines- Environmental issues.

UNIT V

Crude Oil Refining: Classification and Composition - Constituents - Products and their specifications- Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Text Books:

1. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, ABB ATPA Oil and Gas. eISBN: 978-1329783454

2. John R. Fanchi and Christiansen, R.L. Introduction to Petroleum Engineering, John Wiley & Sons. eISBN:9781119193463

Reference Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; Elsevier publications, 2nd Edition. eISBN: 0-444-99564-1
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier eISBN: 978-1-85617-689-7

Web Links:

1. <https://www.studentenergy.org>
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Pipeline_transport
4. https://petrowiki.org/Production_system

Unit Operations in Petroleum Industry

Course Code: 241PT035

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Understand the Heat and Mass Transfer Principles
- CO2:** Prioritize Proficiency in Conduction Mechanisms
- CO3:** Explain Mastery of Convective Heat Transfer
- CO4:** Apply Knowledge of Heat Exchange Equipment and Evaporation
- CO5:** Distinguish Mass Transfer and Distillation Techniques

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3									2	1
CO2	3									2	1
CO3	3									2	1
CO4	3									2	1
CO5	3									2	1

UNIT – I

Introduction: Objective, scope and outcome of the course.

Conduction: Introduction to unit operation and its application in petroleum engineering. Heat Transfer and its application, Modes of heat transfer one dimensional and two-dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

UNIT – II

Convection: Convective heat transfer, natural and forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, Fouling factor, Heat transfer with and without phase change conditions.

UNIT – III

Heat Exchange equipment: Introduction to double pipe, shell and tube exchangers, condensers, extended surface equipment.

Evaporation- Type of evaporators and their applications single and multiple effect evaporators, operation of forward– backward and mixed feed operations.

UNIT – IV

Mass transfer and its application: Analogies in transfer process, basic concept of diffusion and interphase mass transfer. Mass transfer theory film theory Penetration and surface renewal theory.

UNIT – V

Distillation: Rectification, reflux ratio, calculation of numbers of plates by McCabe Thiele method, optimum reflux ratio

Basic introduction to absorption, liquid extraction, leaching

Drying: Equilibrium mechanism theory of drying, drying rate curve

Text Books:

1. Heat and Mass Transfer: Fundamentals and Applications by Yunus A. Çengel and Afshin J. Ghajar. eISBN: 978-9339223199
2. Introduction to Chemical Engineering Thermodynamics" by J.M. Smith, H.C. Van Ness, and M.M. Abbott. eISBN: 978-0070145870

Reference Books:

1. Transport Processes and Separation Process Principles" by Christie John Geankoplis.
eISBN: 9789332549432
2. Process Heat Transfer" by Donald Q. Kern. eISBN: 978-0074632178

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc22_me139/preview
2. https://www.engineeringtoolbox.com/convective-heat-transfer-d_430.html
3. <https://www.thomasnet.com/articles/process-equipment/double-pipe-heat-exchangers/>
4. <https://pages.mtu.edu/~fmorriso/cm3120/lectures/2020%20CM3120%20First%20Diffusion%20Lecture%209.pdf>
5. <http://www.dempt.co.za/mso2015/handout4.pdf>

Fundamentals of Geology & Reservoir Engineering

Course Code: 241PT047

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO 1:** Explain the general facts of the earth.
- CO 2:** Compare and classify various kinds of rocks.
- CO 3:** Explain how basins are formed.
- CO 4:** Understand the basic concepts in petroleum reservoir engineering.
- CO5:** Acquire the knowledge on drive mechanisms and how to apply the material balance to oil reservoirs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3									2	1
CO2	3									2	1
CO3	3									2	1
CO4	3									2	1
CO5	3									2	1

UNIT-I

Origin and Evolution of Earth:

Dimensions, origin, internal structure of the earth -- crust, mantle, core. Internal dynamic process- Plate tectonics, Continental drift, Earthquake and Volcanoes. External dynamic process – weathering-erosion-deposition. Principles of stratigraphy.

UNIT-II

Petrology:

Origin of igneous, sedimentary and metamorphic rocks. Sedimentology -Sedimentary structures- petrographic characters of conglomerate, sandstone, shale, and limestone.

UNIT-III

Sedimentary Basins:

Introduction to sedimentary basins and deltaic systems; Topographic maps, Thematic maps, and their profiles

UNIT-IV

Some basic concepts in reservoir engineering: Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor-Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor- Hydrocarbon phase behaviour, Basic concepts in PVT analysis.

UNIT-V

Material balance applied to oil reservoirs: General form -The material balance expressed as a linear equation- Reservoir drive mechanism- Solution gas drive- Gas cap drive- Natural water drive- compaction drive under related pore compressibility phenomena.

Darcy's law and applications: Darcy's law and field potential- Sign convention

Textbooks:

1. Engineering Geology, Bell, F.G., 2nd Edition, Butter worth Heimann. eISBN: 978-0750680776
2. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science eISBN: 978-0444418302

Reference Books:

1. Text book of Geology, Mukherjee, P.K., The World Press Pvt. Ltd., eISBN: 9786039657736.
2. Principles of Engineering Geology, Bangar, K.M., 2nd Edition, Standard Publishers eISBN: 9788180141157.
3. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing eISBN: 9780080480688.

Web Links:

1. web.crc.losrios.edu/~jacksch/classes/earthscience/Chapter1.pdf
2. <https://ocw.mit.edu/courses/earth-atmospheric-and-aerospace-engineering/12-001-sedimentary-geology/ch11.pdf>
3. www.ucmp.berkeley.edu/fosrec/ONeill.html
4. <https://wiki.seg.org/wiki/Volumetrics>
5. https://petrowiki.spe.org/Material_balance_in_oil_reservoirs

Fundamentals of Drilling & Production Engineering

Course Code: 241PT048

L T P C
3 0 0 3

Course Outcomes:

At the end of the Course, Student will be able to:

CO 1: Explain the Overview of GTO

CO 2: Design of the drill string, drilling hydraulics.

CO 3: Determine the well head pressure, down-hole pressure and operating oil/ gas flow rates of the reservoir.

CO 4: Illustrate the concepts of artificial lift methods

CO 5: Determination of stimulation methods in production operations

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3									2	1
CO2	3									2	1

CO3	3									2	1
CO4	3									2	1
CO5	3									2	1

UNIT-I

Overview of drilling: Drilling plan - GTO -Types of drilling, Hydrostatic pressure, Pore pressure, Causes of abnormal pore pressure, abnormal pore pressure evaluation - Measurement while drilling & logging while drilling data -Direct measurements of pore pressure – Drilling fluid properties - Drilling fluid hydraulics calculations - Bit Hydraulics Formation integrity tests – Fracture gradient determination – Theory of wellbore – FIT procedural Guidelines – Predicting fracture gradient.

UNIT-II

Wellbore stability – e in-situ stress - Determination of rock properties, Failure criteria – Stress distribution around a wellbore - safe mud weights to prevent hole collapse, Kick tolerance Use of kick tolerance to calculate wellbore pressures. Casing: Functions of casing – Types of casing – Casing properties and specifications – Casing connections – Factors influencing casing design – Combination strings – Tension criterion - Compression loads – Biaxial effects – Triaxial analysis. Cementation: Introduction to cement slurries - Cementing nomenclature - Cement additives.

UNIT-III

Petroleum production system over all view, Production from various types of reservoirs based on drive mechanisms, field development method, Safety control system. Properties of oil and natural gas: Solution Gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-IV

Basic concepts on artificial lift methods: Sucker rod pumping system, electrical submersible pumps, hydraulic piston pumping, progressive cavity pumping, plunger lift, hydraulic jet pumping, and Gas lift system.

UNIT-V

Production Stimulation: Well problem identification, Matrix acidizing, Fundamentals of Hydraulic fracturing.

Textbooks:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc. eISBN: 978-0136621553
2. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books. eISBN: 9780080479958.

Reference Books:

1. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman eISBN: 978-0860107149
2. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.

Web Links:

1. <https://www.slb.com/resource-library/oilfield-review/defining-series/defining-drilling>
2. <https://onepetro.org/JPT/article/36/06/889/73274/Wellbore-Stability>
3. https://petrowiki.spe.org/Production_system
4. https://wiki.aapg.org/Artificial_lift
5. <https://www.petrosync.com/blog/what-is-well-stimulation/>

Unconventional Hydrocarbon Resources

	L	T	P	C
Course Code: 241PT016	3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the present global energy scenario
CO2: Determine the Characteristics of a Tight Reservoir and Oil
CO3: Illustrate the origin and characterize shale gas
CO4: Demonstrate the Characteristics of Coal Bed Methane and Gas Hydrates
CO5: Explain the heavy oil reservoirs and their challenges

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2										
CO2	2										
CO3	2										
CO4	2										
CO5	2										

UNIT – I

Introduction

Introduction to Unconventional Hydrocarbon resources, Coal Bed Methane: Geological controls in CBM plays, Resource estimation, Drilling, completion and production performance of a CBM well, Indian Scenario

UNIT – II

Tight Gas and Oil

Characteristics of a Tight Reservoir; What makes them Tight; The Permeability Jail; Where to find Tight Reservoirs; Drilling practices for Tight reservoirs; Formation Evaluation; Hydraulic Fracturing, Post Fracture Reservoir evaluation; New Technologies

UNIT – III

Shale Gas/ Oil

Introduction, geology, important occurrences, petrophysical properties, hydro fracturing, horizontal wells, production profiles.

UNIT – IV

Coal Bed Methane and Gas Hydrates

Characteristics of Coal Bed Methane Gas; Drilling practices for Coal Beds; Workflow for Coal Bed Formation Evaluation, Cleat, Gas Content; Hydraulic Fracturing, Depressuring and Dewatering issues Success and Lessons learnt so far; Gas Hydrates: Minerology, Chemistry and physical properties, stability, challenges and pitfalls

UNIT – V

Non-Conventional Oil

Introduction to Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales; origin and occurrence worldwide, resources, reservoir characteristics, new production technologies

Textbooks:

- 1 Unconventional Gas Reservoirs: Evaluation, Appraisal, and Development, Islam M.R., Gulf Professional Publishing, 2014 eISBN: 978-0128017682.
- 2 Coal Bed Methane: From Prospects to Pipeline, Thakur P., Aminian K., Schatzel S., Elsevier Science Publishing, 2015. eISBN: 978-0128002138

Reference Books:

- 1 Geophysical Characterization of Gas Hydrates: 14 (Geophysical Developments), Michael Riedel, Satinder Chopra, Society of Exploration Geophysicists; 1st edition, 2010 eISBN: 978-1560802454
- 2 Shale Gas: Exploration and Environmental and Economic, Anurodh Mohan Dayal, Devleena Mani, Elsevier Science Publishing, 2017. eISBN: 978-0128041519.

Web Links:

- 1 <https://link.springer.com/article/10.1007/s13202-021-01404-x>
- 2 https://spgindia.org/10_biennial_form/P260.pdf
- 3 <https://www.iogp.org/wp-content/uploads/2016/10/An-introduction-to-shale-oil-and-gas-Jul2015-1.pdf>https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
- 4 https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
- 5 <https://www.open.edu/openlearn/science-maths-technology/living-without-oil/content-section-1>.

Natural Gas Hydrates

Course Code: 241PT049

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to:

- CO 1:** Explain the necessity of natural gas hydrates, different hydrate types and formers.
- CO 2:** Apply different hand calculation methods and computer methods for rapid estimation of hydrate formation conditions.
- CO 3:** Outline the design information for battling hydrates using chemicals and the reasons responsible for dehydration of gas.
- CO 4:** Identify the regions of pressure and temperature for combating hydrate formation and the importance of physical properties of design processes.
- CO 5:** Examine the relationship between fluid phase equilibria and hydrate formation and water content of natural gas.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2									2
CO2	2	2									2
CO3	3	2									2
CO4	3	2									2
CO5	2	2									2

UNIT-I

Introduction: Overview of Natural Gas Hydrates; Natural Gas; The Water Molecule; Hydrates; Water and Natural Gas; Heavy Water.

Hydrate Types and Formers: Type I Hydrates; Type II Hydrates; Type H Hydrates; Size of the Guest Molecule; N-Butane; Other Hydrocarbons; Cyclopropane; 2-Butane; Hydrogen and Helium; Chemical Properties of potential Guests; Liquid Hydrate Formers; Hydrate Forming Conditions; $L_A + L_N + H$ Correlations; Quadruple Points; Other Hydrate Formers; Hydrate Formation at ^0C ; Mixtures.

UNIT-II

Hand Calculation Methods: Gas Gravity Method; K-Factor Method; Baillie-Wichert Method; Other Correlations; Comments on all of these methods; Local Models.

Computer Methods: Phase Equilibrium; Van der Waals and Platteeuw; Parrish and Prausnitz; NG and Robinson Methods; Calculations; Dehydration.

UNIT-III

Inhibiting Hydrate Formation with Chemicals: Freezing Point Depression; Hammer-Schmidt Equation; Nielsen-Bucklin Equation; New method; Brine Solutions; Comment on the Simple Methods; Advanced Calculation Methods; Inhibitor Vaporization; Comment on the Injection Rates; Safety Considerations; Low Dosage Hydrate Inhibitors.

Dehydration of Natural Gas: Water Content Specification; Glycol Dehydration; Mole Sieves; Refrigeration.

UNIT-IV

Combating Hydrates using Heat and Pressure: Plugs; Use of heat; Depressurization; Melting a Plug with Heat; Hydrate Plug Location.

Physical Properties of Hydrates: Molar Mass; Density; Enthalpy of Fusion; Heat Capacity; Thermal conductivity; Mechanical Properties; Volume of Gas in Hydrate.

UNIT-V

Phase Diagrams: Phase Rule; Comments about Phases; Single Component Systems; Binary Systems; Phase behavior below $0^{\circ}C$; Multi component Systems.

Water Content of Natural Gas: Dew Point; Equilibrium with Liquid Water; Equilibrium with Solids.

Text Books:

1. Natural Gas Hydrates: A Guide for Engineers, John Carroll, Elsevier Publications, 3rd Edition, 2014. eISBN: 9780128000748
2. Clathrate Hydrates of Natural Gas, E Dendy Sloan, Jr., C Koh, CRC Publications, 3rd Edition, 2007. eISBN: 978-0849390784

Reference Books:

1. Natural Gas Hydrates in Flow Assurance, E Dendy Sloan, Jr., C Koh, Amadeu K Sum, Elsevier Publications, 2011. eISBN: 9781856179454
2. Exploration of Gas Hydrates; Geophysical Techniques, Naresh Kumar Thakur, Sanjeev Rajput, Springer Publications, 2011. eISBN: 978-3662519578

Web Links:

1. https://www.researchgate.net/publication/300953314_Hydrate_Types_and_Formers
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Glycol_dehydration
4. <https://www.hindawi.com/journals/jther/2010/271291/>
5. <https://www.ogj.com/articles/print/volume-91/issue-13/in-this-issue/gas-processing/chart-estimates-water-content-of-sour-natural-gas.html>

Fundamentals of Liquefied Natural Gas

	L	T	P	C
Course Code: 241PT005	3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the LNG value chain
CO2: Classify the different liquefaction technologies of LNG
CO3: Explain the components of LNG receiving terminals
CO4: Summarize LNG storage and transportation facilities
CO5: Identify major equipment and safety aspects of LNG industry

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	2									2
CO3	3	2									2
CO4	3	2									2
CO5	3	2									2

UNIT – I

Introduction: Overview of LNG industry -History of LNG industry – Base load LNG – Development of an LNG Project – World and Indian Scenario– Properties of LNG.

UNIT – II

Propane precooled mixed refrigerant process – Description of Air products C3MR LNG process–. Description of Conoco Phillips optimized cascade (COPOC) process – Liquefaction– LNG flash and storage.

Other Liquefaction Processes: Description of Linde MFC LNG process- Precooling and Liquefied Petroleum Gas (LPG) recovery – Liquefaction and sub cooling- Trends in LNG train capacity –strategy for grassroots plant- offshore LNG production.

UNIT – III

Gas pre-treatment: Slug catcher– NGL stabilization column – Acid gas removal unit – Molecular sieve dehydrating unit Receiving terminals in India – Main components and description of marine facilities – LNG tanks– Process descriptions. –Mercury and sulphur removal unit–NGL recovery–Nitrogen rejection–Helium recovery.

UNIT – IV

LNG Shipping Industry: LNG fleet – Types of LNG ships – Moss – Membrane – prismatic; Cargo measurement and calculations, Cryogenic heat exchangers: Spiral– Wound heat exchangers – Plate & fin heat exchangers – Cold boxes; Centrifugal compressors –Axial compressors – Reciprocating compressors; LNG pumps and liquid expanders –Loading Arms and gas turbines, Description of Regasification.

UNIT – V

Submerged combustion vaporizers- Open rack vaporizers–Shell and tube vaporizers: direct heating with seawater, and indirect heating with seawater. Safety design of LNG facilities – Security issues for the LNG industry – Environmental issues– Risk-based analysis of an LNG plant.

Ambient air vaporizers: Direct heating with ambient air – Indirect heating with ambient air.

Textbooks:

- 1 LNG: Basics of Liquefied Natural Gas, Stanley Huang, Hwa Chiu and Doug Elliot, Ist Edition, PETEX. eISBN: 978-0886982171
- 2 Marine Transportation of LNG (Liquefied) and related products, Richard G. Wooler, Gornell Marine Press. eISBN: 9780608024646

Reference Books:

- 1 Natural Gas by Sea: The Development of a new technology, Roger Rooks, Wither by Publishers eISBN: 9780856140549
- 2 Marine Transportation of Liquefied Natural Gas, Robert P Curt, Timothy D. Delaney, National Maritime Research Centre. eISBN:

Web Links:

- 1 <http://folk.ntnu.no/skoge/prost/proceedings/aiche2008/data/papers/P139095.pdf>
- 2 https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook_demos/lng/html/index.Htm
- 3 [http://petrowiki.org/Liquified_natural_gas_\(LNG\)](http://petrowiki.org/Liquified_natural_gas_(LNG))
- 4 <http://www.chebeague.org/fairwinds/risks.htm>
- 5 http://www.beg.utexas.edu/energyecon/LNG_Safety_and_Security_Update_2012.pdf

Artificial Lift Techniques

Course Code: 241PT050

L T P C
3 0 0 3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the fundamental concepts of artificial lift techniques such as reservoir pressure, well productivity and reservoir fluids
- CO2:** Apply sucker rod lift system, polished rod motion, FRP sucker rods, criteria for rod string design with advantages and limitations.
- CO3:** Apply gas lift, gas compression requirements sonic flow, subsonic flow, volumetric efficiency advantages and limitations.
- CO4:** Explain electrical submersible pumps, principle hydraulic piston pumping advantages and limitations.
- CO5:** Explain hydraulic jet pumping advantages and disadvantages.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1									
CO2	3	2									
CO3	3	2									
CO4	2	1									
CO5	2	1									

UNIT-I

Introduction of artificial lift:

Definition and Purpose of artificial lift selection-Reservoir pressure and well productivity-reservoir fluids-Types of artificial lift.

UNIT-II

Sucker Rod lift:

Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods-Non-API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift

installation.

UNIT –III

Gas lift:

Gas lift system-gas compression requirements sonic flow-subsonic flow- volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve-continuous and intermittent gas lift advantages and limitations

UNIT-IV

Electrical submersible pumps, Progressive cavity pumping:

Electrical submersible Pumps (ESP)-principle-hydraulic piston pumping-ESP design-ESP advantages and limitations.

Progressive cavity pumping: Plunger lift-working principle-design-plunger liftmodels-progressive cavity pumping (PCP) advantages and limitations

UNIT-V

Hydraulic Jet pumping:

Hydraulic Jet pumping-selection of jet pump-advantages and dis- advantages. **Selection of artificial lift method:** Artificial lift method selection-gas lift vs pumpassisted lift-installation and replacement of artificial lift-maintenance of artificial lift.

Text Books:

1. Petroleum Production engineering: A computer-assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books.eISBN: 978-0123838469
2. Petroleum Engineering Handbook-Production Operations Engineering, volume 4by Joe Dunn Clegg and Larry W. Lake, SPE. eISBN: 978-1555631147

Reference Books:

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E.Economides, Prentice-Hall, N.J-07488. eISBN: 978-0136586832
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn WellBooks, Tulsa, Oklahoma.ceISBN: 978-0878141545

Web Links:

1. http://petrowiki.org/Sucker-rod_lift
2. http://petrowiki.org/Gas_lift
3. http://petrowiki.org/Electrical_submersible_pumps
4. http://petrowiki.org/Hydraulic_pumping
5. https://en.wikipedia.org/wiki/Progressive_cavity_pump.

Enhanced Oil Recovery

Course Code: 241PT003

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the basic features and technical foundations of the most common EOR methods
- CO2:** Explain the basic geological factors for flooding of reservoirs
- CO3:** Apply screening criteria to a given reservoir to select a displacement method both technically and economically
- CO4:** Make Use of rock, fluid, and reservoir data for the Displacement of fluids in the reservoir
- CO5:** Apply screening criteria to a given reservoir to select a chemical method for flooding

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3										2
CO2	2										2
CO3	3										2
CO4	3										2
CO5	2										2

UNIT – I

Principles of enhanced oil and gas recovery methods. IOR, EOR& EGR. Screening criteria for EOR methods.

UNIT – II

Geological Factors in Enhanced Oil Recovery

Reservoir heterogeneities, Examples of geological factors in enhanced recovery projects

Natural fractures,

Determination of Residual Oil Saturation based on

Geophysical Well logging techniques, Determination of residual saturation, Well-log-derived oil saturation determination in open hole, Residual oil saturation determination in cased wellbore

UNIT – III

Immiscible displacement: Injection well location, production well completion, surface installation. Miscible drive: Miscible slug flooding, thermodynamic miscibility, ternary

diagrams, methods of miscible drive. Benham's correlations, physical and mathematical modelling.

UNIT – IV

Displacement of fluids in reservoir: capillary force; viscous force; phase trapping; mobilization of trapped phases, and alteration of viscous/capillary force ratio.

UNIT – V

Design aspects of chemical flooding. Case studies of surfactant, alkali, polymer, ASP flooding. WAG process, SWAG process, and Chemical augmented WAG process. Foam flooding.

Textbooks:

- 1 Enhanced Oil Recovery: Mechanisms, Technology, and Feasibility" by Ajay Mandal and Keka Oja. eISBN: 978-0128200810.
- 2 Applied Enhanced Oil Recovery, Aural Carcoane, Prentice Hall eISBN: 9780130442727

Reference Books:

- 1 Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, eISBN: 9781851666171
- 2 Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier eISBN: 978-3-319-31421-1
- 3 Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, eISBN: 9780132816014

Web Links:

- 1 <https://www.ogj.com/oil-drilling-and-production/production-operations/ior-eor.html>
- 2 http://www.ccop.or.th/ppm/document/INWS4/INWS4DOC03c_Norway_GUNNA_R.pdf
- 3 https://petrowiki.org/Polymer_waterflooding
- 4 https://www.glossary.oilfield.slb.com/en/Terms/a/alkaline_flooding.aspx
- 5 https://petrowiki.org/Conformance_improvement

Petroleum Refinery Engineering

Course Code: 241PT012

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Identify the types of petroleum feed stocks and products by their properties
- CO2:** Make use of process knowledge to solve operational problems and increase the efficiency
- CO3:** Apply the knowledge of crucial processes to meet the end product demands
- CO4:** Prioritize the demand of various petrochemicals to optimize the processes
- CO5:** Classify various petrochemical products and their uses

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2										
CO2	2										
CO3	2										
CO4	2										
CO5	2										

UNIT – I

Basic of Petroleum:

Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as True Boiling (TBP), American Society for Testing Materials (ASTM).

UNIT – II

Properties of Crude and Petroleum Products:

Various types of Average Boiling Points of Crude Oil & Petroleum Fractions.

Types of Gases & their Composition, Types of Gasoline & it's Important Properties and tests such as ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content etc,

Various Types of Naphtha and their Important Properties & Applications.

Important Tests & Properties of Kerosene such as Flash& Fire Point, Smoke Point, Aniline Point etc., Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc.

Heavy Fractions like Lube Oil, Bitumen, Asphalt etc & their Important Properties such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.

UNIT – III

Processing of Petroleum:

Pretreatment of Crude (Dehydration & Desalting), Pumping of Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux, ADU & VDU.

UNIT – IV

Thermal & Catalytic Cracking:

Thermal cracking – Processes, operating parameters, feed stock selection and product yields, Advantages –Types and functions of secondary processing – Visbreaking – Processes, operating parameters and advantages–Coking –Operating parameters and advantages. Fluid catalytic cracking –processes, operating parameters, feed stock selection and product yields –Advantages.

UNIT – V

Treatment Techniques:

Physical Impurities found in Crude& their Removal, Sweetening Techniques, Production and Treatment of LPG & their Methods, Dehydration and Sweetening of Gases, Gasoline Treatment such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Treatment of kerosene.

Textbooks:

- 1 Petroleum Refining: Technology and Economics ,J.H.Gary and G.E.Handwerk, 5th Edition, Marcel Dekkar, Inc. eISBN: 9780203907924
- 2 Elements of Petroleum Processing, D S Jones, Wiley–Blackwell. eISBN: 9780471964896

Reference Books:

- 1 Petroleum Refining Engineering, WL Nelson, 4th Edition, McGraw Hill Company eISBN: 9780070462687
- 2 Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers eISBN: 9780846404385
- 3 Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company eISBN: 9782710810650

Web Links:

- 1 <https://www.scribd.com/doc/.../Surface-Production-Operations-Volume-1-Oil-System>
- 2 www.academia.edu/.../Ken_Arnold-Surface_Production_Operations_Volume_1_3rdE
- 3 <https://byjus.com/chemistry/petroleum/>
- 4 <https://www.slideshare.net/.../surface-production-operations-volume-iv-pumps-compr...>
- 5 https://www.researchgate.net/publication/359449933_Petroleum_sludge_treatment_and_disposal_techniques_a_review

Minor Degree in Mining Engineering

Course Code	Course Name	Level	L	T	P	C	CI E	SEE	Total	Pre-requisite
241MN003	Development of Mineral Deposits	FC	3			3	50	50	100	-
241MN041	Green Mining	FC	3			3	50	50	100	-
241MN006	Surface Mining	IC	3			3	50	50	100	DMD
241MN024	Drilling & Blasting	IC	3			3	50	50	100	DMD

241MN007	Underground Coal Mining Technology (or) Underground Metal Mining Technology	IC	3			3	50	50	100	DMD
241MN008										
241MN014	Mine Legislation & General Safety (or) Environmental Pollution & Control	AC	3			3	50	50	100	UCMT / UMMT
241MN028										
241MN045	Industrial Safety Practices (or)	AC	2			2	50	50	100	-
241MN046	Ground Control									
Total			20			20				

Development of Mineral Deposits

Course Code: 241MN003

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Summarize different stages in the life of a mine
- CO2:** Choose a suitable location for opening to a deposit.
- CO3:** Explain Exploratory and Production Drilling
- CO4:** Categorize the use of explosives and blasting.
- CO5:** Summarize material handling and transportation in mining

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Introduction to mining: Mining terminologies, Stages in the life of the mines- Prospecting, Exploration, Development, Exploitation, Reclamation, Brief overview of Surface & Underground Mining Methods.

UNIT – II

Access to mineral Deposits: Adits, shafts, incline - location, shape and size; Drilling, blasting and removal of debris. Methods of shaft sinking –conventional, mechanized and special methods; opening up of surface deposits.

UNIT – III

Exploratory and Production Drilling: Principles of drilling, Types of drill, Drill rods and drill bits – types and applications, Exploratory drilling - Drilling fluid; Production drilling – Rotary, Percussive, Rotary- percussive, pneumatic; Drill patterns.

UNIT – IV

Explosives and Blasting: Types of explosives, Properties of explosives, Detonators. Detonating cords, and detonating fuse and nonel detonator. Storage and transport of explosives, Mechanics of blasting, Primary and secondary blasting, Blast geometry and design, electrical and non electrical methods, delay blasting techniques, handling misfires.

UNIT – V

Material Handling and Transportation in Mines: LHD, SDL, shuttle car, AFC and belt conveyors; Raises, winzes, ore passes, ore chutes; shovels, dumpers, silo, bin, CHP, tippler.

Text Books:

1. Elements of Mining Technology, D.J.Deshmukh, Denett& Co., Nagpur Vol. I, ISBN: 978-8189904333.
2. Surface Mining, Dr T.N.Singh, Lovely Prakashan, Dhanbad , 2nd Edition, ISBN: 978-8179561294.

Reference Books:

1. Indian Bureau of Mines, Minerals Year Book & other publications, Latest Edition.
2. Explosives and blasting techniques, G.K Pradhan, Latest edition. ISBN: 978-0470512275.

3. Rock Blasting and Overbreak Control, Dr. Calvin Konya; Precision Blasting Services, Montville, Ohio 2nd Edition, ISBN: 9780318198965.

Web Links:

1. <http://www.miningglobal.com/operations/gifs-5-stages-mining-life-cycle>
2. <https://www.minecationsstandards.org/fileadmin/MAS/documents/nmas-national>
3. [stabdards/afghanistan/AMAS_07.04_Storage_Transportation_Handling_of_Explosives.Pdf](#)

Green Mining

	L	T	P	C
Course Code: 241MN041	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the importance of green mining.
- CO2:** Plan and scheduling of activities related to mine waste management.
- CO3:** Analyze the impact of water pollution due to mining.
- CO4:** Distinguish progressive and final mine closure planning
- CO5:** Explain the usage of renewable energy in mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11

CO1		3	1								
CO2			1								
CO3		3									
CO4	2										
CO5		3	1								

UNIT – I

Footprint Reduction: Importance of green mining, Sustainable project management, Corporate social responsibility for industrial sustainability, Environment Friendly Mining Equipment's, Clean development mechanism (CDM), CCUS technology, Application of Bio Fuels.

UNIT – II

Mine Waste Management: Types of mine waste Overburden, Tailings and other wastes. Characterization, disposal, management of different types of mining waste.

UNIT – III

Mine Water: Sources of pollution, Effect of mining on water bodies, Treatment of mine water, Water conservation initiatives in mines, zero waste water discharge.

UNIT – IV

Mine Closure Planning: Progressive and final mine closure planning, structure of mine closure report, Legislative provisions on mine closure planning.

UNIT – V

Renewable Energy: Usage of renewable energy in mines solar power, wind power; associated problems.

Text Books:

1. Green Mining: The Way Forward, Anil Jha, Das Gupta Co Pvt Ltd Publication, 2019, ISBN: 978-8194161424.
2. Sustainable Mining Practices, A.K. Gorai and D. Nimaje, Narosa Publishing House, ISBN: 9788184876048.

Reference Books:

1. Mining and Environmental Sustainability, G. S. Roonwal, ASTRAL Publication, ISBN: 9789351247591.
2. Advances in Productive, Safe, and Responsible Coal Mining, Joseph Hirschi, Elsevier Ltd, 2019, ISBN: 9780128156263.

Web Links:

1. <https://www.mdpi.com/books/pdfview/book/3216>

2. <https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/greenmining.html>
3. <https://www.sciencedirect.com/science/article/pii/S187661021200077X>
4. [Oxford scientists show how green mining could pave the way to net zero and provide the metals we need for a sustainable future | University of Oxford](#)
5. Green Mining (mdpi.com)

Surface Mining

Course Code: 241MN006

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Analyze different surface mining methods
- CO2:** Design the layout of a large opencast mine
- CO3:** Design drilling and blasting for Surface mining
- CO4:** Choose the better excavation and loading equipments
- CO5:** Organize the transportation system

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1		2							
CO2	3	1	1								
CO3	3	1	1								
CO4	3	1									
CO5	3	2									

UNIT – I

Introduction: Status and scope of surface mining- Applicability, Limitations and, advantages and disadvantages. Methods of opening box cut, selection of site for box cut. Surface Mining Methods: Open pit Mining, Open cast Mining, Quarrying, High-wall Mining Modern Methods. Placer Mining.

UNIT – II

Open Pit Layout and Design: Planning the layout and open pit mine with special reference to large mechanized mines. Optimum dimensions of open pit mines. Removal of over burden and disposal, Bench Design/Geometry, Design and stability slopes.

UNIT – III

Blast Design in Surface Mines: Drillability, mechanics of drilling, major types of drilling machines. Blasting: Basics of mechanics of blasting, principles of fragmentation. Blast design, Adverse impacts of blasting in surface mines. Controlled blasting techniques. Novel methods of blasting.

UNIT – IV

Excavation and Loading: Shovels, Dragline, Front-end loader. Non-Cyclic Surface Mining: Bucket Wheel Excavators and Continuous surface miners. Auxiliary Equipment: Stackers, Graders, Dozers, Ripper.

UNIT – V

Transport Equipment: Selection of mode of transport. Dumpers, Aerial ropeways-monocable and bicable types and their constructional details. Conveyor systems, ICC system, Slurry Transportation.

Text Books:

1. Surface Mining Technology, S. K. Das, Lovely Prakashan, Dhanbad.
2. Surface Mining, G. B. Mishra, Dhanbad Publishers.

Reference Books:

1. Opencast Mining unit operations, V.V.Rzhevsky, Mir Publisher's, Moscow, ISBN: 978-0873351087.
Open Pit Mine Planing and Design Crawford, T.john, American Institute of
2. Mining, Metallurgical and Petroleum Engineers, ISBN: 978-0873351027.

Web Links:

1. <http://www.cienciaviva.pt/img/upload/Introduction%20to%20mining.pdf>
2. http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/safework/documents/normativeinstrument/wcms_107828.pdf
3. <https://www.iitbhu.ac.in/faculty/min/rajesh-rai/NMEICTSlope/Pdf/03%20Types%20of%20slope%20failure.pdf>

Drilling & Blasting

Course Code: 241MN024

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Differentiate between types of drilling machines.
- CO2:** Identify and classify explosives
- CO3:** Analyze problems associated with open cast blasting and mitigation.
- CO4:** Analyze problems associated with underground blasting and mitigation.
- CO5:** Assess blasting in metal mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	2								
CO2	3										
CO3	1	3									
CO4	1	3									
CO5	1	3									

UNIT – I

Drilling: Drillability, mechanics of drilling, major types of drilling machines, Principles of drilling, Types of drill, Drill rods and drill bits -Types and applications, Exploratory and Production Drilling.

UNIT – II

Explosives and Blasting Accessories: Mechanism of blasting, Explosives- types and properties. Selection of explosives, Handling, and storage of explosives. Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders. Blast Design in Surface and Underground Mines.

UNIT – III

Drilling and Blasting in Surface Mines: Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure.

UNIT – IV

Drilling and Blasting in Underground Coal Mines: Blast hole patterns and their applicability, blasting-off-solid, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

UNIT – V

Drilling and Blasting in Underground Metal mines: Blast hole patterns and their applicability, blast design for horizontal drivage, long hole blasting, vertical crater retreat blasting.

Text Books:

1. Principle of rock drilling, B. Misra, U.M. Rao Karanam, Taylor & Francis, CRC Press, ISBN: 9781138033646.
2. Drilling & Blasting Minetech, Pradhan G.K., Ghose A.K., Bhubaneswar, India: Mintech, ISBN: 9789383183039.

Reference Books:

1. Elements of Mining Technology, DJ Deshmukh, Denet, First Edition, Vol. 1, ISBN: 978-81-89940-02-7.
2. Surface mining, GB Mishra, Dhanbad, Vol.1, ISBN: 978-0873351027.

Web Links:

1. <https://archive.nptel.ac.in/courses/123/105/123105003/>
2. <https://www.rpmdrilling.co.za/blast-hole-drilling-process/>
3. www.railsystem.net/drill-and-blast-method/

Underground Coal Mining Technology

	L	T	P	C
Course Code: 241MN007	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the fundamentals of underground coal mining.
- CO2:** Explain the various mine development methods.
- CO3:** Explain the long wall mining method.
- CO4:** Analyze the various thick and deep seam mining methods.
- CO5:** Categorize the various modern mining methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3										
CO2	2		3								
CO3	3										
CO4	3	2	1								
CO5	2			3							

UNIT – I

Introduction: Formation of coal deposits, structures associated with coal deposits, rank and grade of coal. Different coal mining methods: factors influencing choice of coal mining methods. Status of coal mining industry in India and global scenario.

UNIT – II

Bord and Pillar Mining: Applicability, limitations, advantages and disadvantages of Bord and pillar mining method. Development-Design of pillars and panel, supports. Depillaring-methods and sequence of operations, splitting and slicing of pillars, supports. Partial extraction techniques. Extraction of multi seams. Stowing Techniques. Mechanization- SDL, LHD, Continuous miners, belt conveyors, UDM etc., Case studies.

UNIT – III

Longwall Mining: Applicability, limitations, merits and demerits, Longwall mining Methods- Advancing and Retreating, Thin and Thick seam. Longwall Development- Gate roads, longwall face. Face Mechanization, Shearer, Plough, AFC, Powered Supports. Sequence of operations- Cutting and conveying of coal from face. Case studies.

UNIT – IV

Thick Seam Mining: Applicability, limitations, and problems associated with thick seam mining, selection of mining method, caving and stowing methods. Different slicing methods- inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing, Caving methods- Sublevel Caving Working Steep and Moderately Thick Seams- Blasting Gallery method, Room and Pillar method, Descending Shield method of Mining. Design of Supports, Case studies.

UNIT – V

Modern Coal Mining Methods: Horizon Mining, Hydraulic Mining, Underground Coal Gasification. Case studies.

Text Books:

1. Principles and Practices of Modern Coal Mining, R. D. Singh, New Age International, ISBN: 978-8122429705.
2. Modern Coal Mining Technology, S. K. Das, Lovely Prakashan Publishers, 2nd Edition, ISBN: 978-81-7850-043-6.

Reference Books:

1. Underground Coal Mining Methods, J. G. Singh, BrajKalpa Publishers, Varnasi, ISBN: 81-7525-204-9.
2. Coal Mining, I.C.F. Statham, The Caxton Publishing Company Ltd. Inc, Vol. I, II, III and Vol. III, ISBN: 978-81-7850-043-9.
3. Winning and working coal, R. T. Deshmukh, D.J Deshmukh Vol 1 & 2, ISBN: 97-88-189904333.

Web Links:

1. <https://osme.co.in/wp-content/uploads/2023/01/UCMR-BAL-1.pdf>
2. https://www.digitalxplore.org/up_proc/pdf/340-151522605452-56.pdf

Underground Metal Mining Technology

Course Code: 241MN008

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the fundamentals of metal mining
- CO2:** Analyze the various mine development methods.
- CO3:** Analyze the basics of stoping
- CO4:** Compare the various stoping methods.
- CO5:** Categorize the various special stoping methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3					3					
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Introduction to Metal Mining: Terminologies in metal mining. Special Characteristics of Metalliferous deposit. Scope and limitations of underground metal mining. Access to deposits, Status of metal mining in India and World.

UNIT – II

Mine Developments: Factors affecting choice of level interval, Cross cuts, drive, shape and size of drive, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development. Division of mining area into working units and level pattern, dimensions of panels and blocks. Unit Operations in Metal Mining.

UNIT – III

Basics of Stopping: Stopping methods- applicability, limitations, merits and demerits. Selection of stopping methods. Stope design and production planning in various methods of stopping. Support design.

UNIT – IV

Stoping Methods: Supported and un-supported Stoping Methods, Caving methods. Description, application and design of stoping methods. Mechanisation of stopes.

UNIT – V

Novel Techniques: In-situ leaching, bio-mineral engineering, hydraulic mining, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.

Text Books:

1. Introductory Mining Engineering, H L Hartman, John Wiley and sons. ISBN: 978-0471811778.
2. Elements of Mining Technology, D.J.Deshmukh. Vol III. ISBN: 978-8184890700.

Reference Books:

1. Deep Mining, Jack Spalding, mining publications, ISBN: 978-0-903078-36-8
2. Mineral engineers hand book, Peele, Vol. I & II, ISBN: 978-0873352205 & 978-0873352212.
3. U/G Mining Method, Hustrulid, society for mining, metallurgy & Exploration, ISBN: 978-0873352643.

Web Links:

1. <https://www.911metallurgist.com/methods-mining-metals/>
2. <https://www.greatmining.com/metals.html>

Mine Legislation & General Safety

L T P C

Course Code: 241MN014

3 0 0 3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the general principle of mining laws and regulations
- CO2:** Compare the rules and regulation framed under CMR& MMR.
- CO3:** Explain the various mining rules and Indian electricity rules
- CO4:** Explain the Mineral concession rules and mine act
- CO5:** Explain the training rules and DGMS circular

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3				2					
CO2	1	3									
CO3			2								
CO4											
CO5			3								

UNIT – I

General principles of mining laws, The Mines Act 1952, The mines & Minerals (Regulation & Development) Act 2015, Industrial dispute Act 1947.

UNIT – II

The Coal Mines Regulations 2017 and The Metalliferous Mines Regulations 2019.

UNIT – III

The Mines Rules 1955, Mine rescue rule 1985, Indian Electricity rule 1956.

UNIT – IV

The Mineral Concession Rules 2017, The Mineral Concession and Development Rules 2017.

UNIT – V

Introduction to Environmental Legislation in mines, Land Acquisition & Revenue: Concepts: Related laws and regulations. Forest Conservation Act 1980.

Text Books:

1. Mines act, Mine Rules, CMR, MMR, MVTC, Mine Rescue Rules, DGMS
2. Legislation in Indian Mines: A critical appraisal, Rakesh and S. D. Prasad, Mrs Asha Lata Varnasi, 5th Edition.

Reference Books:

1. Proceeding of the National Seminar on Policies, A. K. Ghosh, S. K. Ray and A. K. Patra, Statutes & Legislation in Mines, CIMFR, Dhanbad.
2. Mineral Concession Rules 1960, V. K. Malhotra, Malhotra Bros., Patna, Supplementary Edition.

Web Links:

1. <https://mines.gov.in/writereaddata/UploadFile/MMDR%20Act,1957.pdf>
2. <https://dgms.gov.in>.

Environmental Pollution & Control

	L	T	P	C
Course Code: 241MN028	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Illustrate the fundamentals of environmental issues in mining
CO2: Examine the various causes of water pollution.

- CO3:** Analyze the various causes of air pollution.
CO4: Analyze the methods for mine reclamation
CO5: Assess environmental impact due to mining.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Air Pollution: Atmospheric science; Sources of air pollution in mines; Effect of air pollution and preventive measures; Ozone layer and greenhouse effect; Dispersion model.

UNIT – II

Water Pollution: Sources of water pollution; Effect and preventive measures of water pollution; Ground water and its contamination; Water pollution modeling - biological oxygen demand and chemical oxygen demand; Acid mine drainage; Waste water treatment.

UNIT – III

Noise Pollution: Terminologies associated with noise; Sources and effects of noise; Measurement of noise; Noise standard and guidelines; Noise control strategies.

UNIT – IV

Land Reclamation and Rehabilitation: Causes of land degradation; Land reclamation method- Rehabilitation, Reclamation, Restoration; Factor affecting the land restoration; Land reclamation planning.

UNIT – V

Socio-Economic Impact Assessment: Socio-economic impact of mining, Quality of life index.

Text Books:

1. Environmental Pollution and Control, Peirce J. Jeffrey, Elsevier Science & Technology, Fourth Edition, 2018, ISBN: 978-0128125428.
2. Principle and practices of modern coal mining, R.D. Singh, New Age International, ISBN: 978-8122416464.

Reference Books:

1. Ground Control, Peng, S.S. Wiley Publications, New York, ISBN: 978-0471775410.
2. Open pit mine planning and Design, W. Hustrulid and M. Kuchta, A. A. Balkema Rotterdam, 1st edition, Vol – I, ISBN: 978-9056990736.
3. Surface Mining, G. B. Mishra, Lovely Prakashan Dhanbad, 1st Edition, ISBN: 978-81-85500-42-6.

Web Links:

1. <https://miningandblasting.wordpress.com/2011/08/30/mine-planning-and-scheduling-smart-practice>
2. https://onlinecourses.nptel.ac.in/noc22_ce22/preview

Industrial Safety Practices

Course Code: 241MN045

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe Occupational Health Hazards
CO2: Analyze the concept of Ergonomics and its importance in Industrial safety
CO3: Describe Importance of Industrial safety.
CO4: Analyze and apply effects of radiation on human body
CO5: Analyze different accident prevention techniques

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3									
CO2	2	3									
CO3	2	3									
CO4	2	3									
CO5	2	3									

UNIT – I
Introduction to industrial safety

Safety scenario in national and international arena, identification of safety issues in different industries and their remedial measures, general safety practices.

UNIT – II
Ergonomics

Ergonomics – Importance, Ergonomics Hazards – Musculoskeletal Disorders and Cumulative Trauma Disorders, ergonomics studies.

UNIT – III
Industrial Health and Hygiene

Occupational health hazard & classification of health hazards, Occupational health and hygiene surveillance, legislative measures and prevention of health hazards.

UNIT – IV
Personal Protective Equipment

Types of personal protective equipment and their usages.

UNIT – V
Accident Prevention Techniques

Types of accidents, causes of accidents- unsafe acts and conditions, accident investigation and prevention.

Text Books:

1. The Factories Act with amendments, Govt. of India Publications DGFASLI, Mumbai, ISBN: 978-9352471010.

2. Frank P Lees – Loss of prevention in Process Industries, Butterworth- Heinemann Ltd., London, Vol. 1 and 2, ISBN: 978-0750633016 & 978-0750633023.

Reference Books:

1. Accident Prevention Manual, NSC, Chicago, ISBN: 978-1118240295.
2. Occupational safety Manual, BHEL, Trichy, ISBN: 978-81-73190163.
3. Safety Management, John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, ISBN: 978-8173190162.

Web Links:

1. <https://www.osha.gov/>
2. <https://www.healthandsafetyatwork.com/>
3. <http://ohsonline.com/>

Ground Control

Course Code: 241MN046

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe about concept of ground control in mines.
CO2: Analyze strata pressure and management.
CO3: Illustrate types of Roof support.
CO4: Analyze the design of structure in rock.
CO5: Explain about the Subsidence in mining.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3									

C02	2	3									
C03	2	3									
C04	2	3									
C05	2	3									

UNIT – I

Introduction: Definition and concept of ground control in mines, Ground control practice in mines, constraints on ground control design.

UNIT – II

Strata pressure and management: The modern concept of strata pressure redistribution. Manifestation of strata pressure, convergence, load on the prop, creep, heave, roof fall, and fracture systems due to mining. In-situ stress measurement, instrumentation.

UNIT – III

Roof support: Timber and steel supports, friction and hydraulic prop, arches, shotcrete, roof truss, roof bolts and cable bolts powered supports stowing caving strip packing pump packing rock reinforcement.

UNIT – IV

Design of structures in rock: Design of underground openings. Design of pillars, design of open pit slopes, waste dumps, and embankments, design of stopes.

UNIT – V

Subsidence: Theories of subsidence, factors affecting subsidence, prediction, and measurement of subsidence. Damage and prevention of damage due to subsidence, Bumps and rock bursts-causes, occurrence, and control.

Text Books:

1. Rock Mechanics and Design of structures in rock, Obert & Duvall, ISBN: 978-0471192994.
2. Coal Mining Ground Control, Peng S.S., ISBN: 978-0470512277.

Reference Books:

1. Fundamental of Rock Mechanics, Jaeger and cook, ISBN: 978-0470015393.
2. Rock Mechanics and Ground Control, V. Singh & B.P. Khare, ISBN: 978-8187739557.

Web Links:

1. <https://www.sciencedirect.com/science/article/pii/S1877705812045055>
2. <https://core.ac.uk/download/pdf/237427482.pdf>
3. <https://raiseandlevel.com/how-to-prevent-ground-subsidence-in-residential-areas/>

Minor Degree in Agricultural Engineering (offered to other branches students):

Agricultural Engineering							Marks			Pre-requisite
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE082	Fundamentals of Renewable Energy Sources	FC	3			3	50	50	100	-
241AE083	Post-harvest Engineering of Cereal Crops	FC	3			3	50	50	100	-
241AE084	Ground Water Hydrology	FC	3			3	50	50	100	-
241AE085	Micro Irrigation Systems	IC	2			2	50	50	100	-
241AE086	Surface Water Hydrology (OR)	IC	3			3	50	50	100	GWH
241AE087	Land & Water Management Engineering									

241AE088	Agricultural Process Engineering & Food Quality (OR)	AC	3			3	50	50	100	PHECC
241AE089	Post-harvest Engineering for Horticultural Pro									
241AE090	Agricultural & Machinery Equipment (or)	AC	3	0	0	3	50	50	100	FRES
241AE091	Design of Bio-energy systems									
Total			20			20				

Fundamentals of Renewable Energy Sources

Course Code: 241AE082

L T P C
3 0 0 3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the fundamental concepts of renewable energy.
- CO2:** Analyze the principles of solar energy and explore its various applications.
- CO3:** Describe wind energy conversion systems, including wind generators, and evaluate their power generation capabilities.
- CO4:** Analyze the processes involved in biogas production from biomass.
- CO5:** Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3	2							
CO2	3	2	2	2							
CO3	3		3		2						1
CO4	3		3	2		1					
CO5	3		3	2		1					

UNIT – I

Renewable energy sources

Different sources of renewable energy- concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources. Criteria for assessing the potential of RES. Comparison of renewable energy sources with non-renewable sources.

UNIT – II

Solar energy

Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system. Solar photo voltaics- basics and applications, p-n junctions. Solar cells, PV systems, stand alone, grid connected solar power station. Calculation of energy through photovoltaic power generation and cost economics.

UNIT – III

Wind Energy

Wind energy- energy availability, general formula, lift and drag. Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators. Working principle of wind power plant. Wind farms, aero-generators, wind power generation system.

UNIT – IV

Energy from Biomass

Biogas- basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry. Generation of power from biogas. Design & use of different commercial biogas plants.

UNIT – V

Other source of energy

Power generation from urban, municipal and industrial waste. Ocean thermal and electric power generation, wave and tidal power. Power generation from biomass (gasification & Dendro- thermal). Mini and micro hydel plants. Fuel cells and its associated parameters

Text Books:

1. Rai G D. Non-Conventional Energy Sources. Khanna Publishers, New Delhi. (ISBN:978-81-7409-073-8)
2. Basu P. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press. (ISBN: 10-0123749883)

Reference Books:

1. Patel M R. Wind and Solar Power Systems. CRC Press, Boca Raton. (ISBN: 978-0849315701)
2. Deublein D and Steinhauser A. Biogas from Waste and Renewable Resources. WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim. (ISBN: 9783527621705)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf

Post-Harvest Engineering of Cereal Crops

	L	T	P	C
Course Code: 241AE083	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Explain the importance of different unit operations and working of size reduction equipments.
- CO2:** Identify various methods for determining moisture content, EMC and drying.
- CO3:** Compare separator equipments based on physical characteristics of grains and explain material handling devices.
- CO4:** Explain the importance, design and working of milling equipments for cereals.
- CO5:** Explain the importance, design and working of milling equipments for rice.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2		1	1					
CO2	3	2	2	2							
CO3	3	2	2	2	2						
CO4	3	2	2	2							
CO5	3	2	2	1							

UNIT – I

Unit operations in grain processing

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals. Cleaning and grading: Principles of cleaning, scalping, sorting and grading; Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill.

UNIT – II

Drying

Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of cereal grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

UNIT – III

Separation and Material Handling

Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes & hoists, pneumatic conveying, power requirement for conveying and elevating.

UNIT – IV

Milling of wheat, corn, pulses and oil seeds

Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods.

UNIT – V

Milling of Rice

Merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN-13. 978-8125911425)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta. (ISBN-10. 9788120409699)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-Hall Inc., New Jersey. (ISBN-13. 9788120409699)

- Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P
McGraw-Hill Book Co., Boston.(ISBN-13. 978-8184959635)

Web Links:

- <http://www.cigr.org/documents/CIGRHandbookVol4.pdf>
- <http://ecoursesonline.iasri.res.in/course/view.php?id=22>

Ground Water Hydrology

Course Code: 241AE084

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Explain properties of various water bearing formations and movement of ground water.
- CO2:** Determine the aquifer properties under unsteady state and steady state subsurface flow conditions.
- CO3:** Explain design, development and construction of wells.
- CO4:** Analyze various water quality parameters and explain the occurrence of saline water intrusion.
- CO5:** Select appropriate method for exploration and replenishment of ground water.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO 10	PO11
CO 1	1										
CO 2		2			3		1				
CO 3			3	2							
CO 4	1		2								
CO 5	1	1									

UNIT-I

Occurrence and Movement of Ground water: Introduction- Global water scenario; Water resources status in India; Origin and age of ground water; groundwater column, zones of aeration and saturation, Aquifer and its types; Aquifer characteristics.

Ground water movement: Darcy's law; Determination of Hydraulic conductivity; Ground water flow rates and directions; Ground water tracers, General flow equations through porous media.

UNIT-II

Well Hydraulics: Determination of aquifer parameters under steady/ unsteady,

uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer by different methods- Dupit Theim, Theis, Jacob and Chow's; Characteristic well losses; Specific capacity.

UNIT-III

Water Wells: Classification of wells; Methods of drilling of wells; Design and assembly of gravel packing; Installation of well screens; Common well drilling difficulties; Completion and development of well; Well Rehabilitation.

UNIT-IV

Ground water quality: Sources of salinity; Measures of water quality; Chemical, Physical and Biological analysis of ground water; Ground water samples; Water quality criteria; Occurrence of saline water intrusion- Ghyben-Herzberg relation between fresh and saline waters.

UNIT-V

Ground Water Investigations: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction-based methods for surface investigation of ground water, sub-surface ground water investigation through geophysical / resistivity; Methods of artificial recharge of ground water.

Text Books:

1. Groundwater, H.M. Raghunath, New Age International, 3rd Edition. (ISBN: 978-8122419047)
2. Groundwater Hydrology, D.K. Todd, John Wiley and Son, New York, 2nd Edition. (ISBN: 9788126508365)

Reference Books:

1. Land and Water Management Engineering, V.V.N Murty and M.K Jha, Kalyani Publishers, 6th Edition. (ISBN: 978-9327214659)
2. Groundwater and tube wells, Garg S.P, Oxford and IBH publishing company limited, New Delhi.(ISBN: 8120408268)

Web Links:

1. <http://nptel.ac.in/courses/105105042/>
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=124667/>

Micro Irrigation Systems

	L	T	P	C
Course Code: 241AE085	2	0	0	2

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Assess the adaptability, problems, and prospects of different types of sprinkler irrigation systems.
- CO2:** Plan and design the layout of sprinkler irrigation systems, including the hydraulic design of lateral, sub-main, and main pipelines, and select appropriate pumps and power units.
- CO3:** Evaluate the performance of sprinkler irrigation systems by analyzing water distribution patterns, overlapping of sprinklers and laterals, uniformity coefficient, and pattern efficiency.
- CO4:** Explain the types, components, and advantages and disadvantages of micro irrigation systems (drip, spray, and bubbler), and design effective drip irrigation systems considering wetting patterns and irrigation requirements.
- CO5:** Perform proper operation and maintenance of micro irrigation systems, addressing issues like clogging, filter cleaning, flushing, and chemical treatment, and apply fertigation techniques, understanding their benefits, limitations, and best practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1:					1						
CO2:	2		1		2						
CO3:					1						
CO4:	2		1		2						
CO5:		2			1	1					1

UNIT – I

Introduction to Sprinkler Irrigation Systems

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems.

UNIT – II

Design and Components of Sprinkler Irrigation Systems

Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system.

UNIT – III

Performance Evaluation and Micro Irrigation Systems

Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency; Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components.

UNIT – IV

Design and Operation of Drip Irrigation Systems

Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

UNIT – V

Fertigation in Micro Irrigation Systems

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Text Books:

1. Principles of Sprinkler Irrigation system, Mane M S and Ayare B L.Jain Brothers, New Delhi.(ISBN : 9788183601504)
2. Irrigation: Theory and Practice, Michael A M. ,Vikas Publishing, New Delhi. (ISBN:978-8125918677)

Reference Books:

1. Micro Irrigation - Theory and Practices, Suresh R, Standard Publishers Distributors, Delhi. (ISBN:9788180141508)
2. Sprinkler Irrigation, Sivanappan R K.,Oxford & IBH Publishing House, New Delhi. (ISBN:978-8120402324)

Web Links:

1. http://agritech.tnau.ac.in/agricultural_engineering/agriengg_swc_microirri_ferti.html
2. Course: Micro Irrigation Systems Design 3(2+1) (iasri.res.in)

Surface Water Hydrology

Course Code: 241AE086

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Calculate the mean areal precipitation using various methods.
CO2: Explain rainfall characteristics and measuring devices in India.
CO3: Explain runoff and stream flow measurement methods.
CO4: Estimate the discharge volume of runoff using hydrographs and unit hydrographs.
CO5: Plan a reservoir using flood routing techniques for management of natural resources.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2										
CO2	2	1			2						
CO3	2	1			2						
CO4	2			2	3						
CO5	1	2			3						

UNIT-I

Precipitation: Hydrology-definition, hydrological cycle and its components. Forms of Precipitation, Characteristics of rainfall in India (types of monsoon). Measurement of Rainfall – Recording and Non-Recording Rain gauges- Rain gauge network density for different topographic conditions – Point rainfall analysis - Presentation of Rainfall data – Mass Curve and hyetograph, Mean Precipitation over an area –

Arithmetic Mean, Thiessen Polygon, Isohyetal methods, DAD Relationships and curves. Probability Analysis of Rainfall – Return Period, Plotting position by Weibull's method – Rainfall events at different probability levels (20%, 40%, 60%, and 80 %).

UNIT-II

Runoff: definition-components of runoff-direct runoff and base flow, overload flow and interflows, pictorial representation of different routes of runoff. Runoff characteristics of streams – perennial, intermittent and ephemeral streams. Definition and Estimation of peak runoff using rational method.

Stream flow measurement: Measurement of stream flows. Measurement of stage and velocities, staff gauge, wire gauge, automatic stage recorders, current meters (horizontal and vertical axis meters), calibration ($V = a N_s + b$). Rainfall-Runoff relations ($R = a P + b$), curve fitting and determination of 'a' and 'b' and (correlation coefficient). Intensity-Duration-Frequency-Relationship ($i = ((KT_x) / (D+A) n)$). Determination of net effective rainfall-infiltration indices- Phi index.

UNIT-III

Hydrographs: definition and components, factors affecting flood hydrographs, hydrograph separation for simple and complex storms – Method I, II and III. Unit Hydrograph-concept and the three implications of the definitions and the two basic assumptions. Effects of the characteristics of storms (duration of rain, time-intensity

pattern, areal distribution of runoff and amount of runoff) on the shape of the resulting hydrographs. Derivation of Unit hydrographs for simple and complex storms. Derivation of an average unit hydrographs from several storms of the same duration (proper procedure of computing average peak flow and time to peak).

UNIT-IV

Unit Hydrographs: The methods for conversion of unit hydrograph of different durations, (1) method of superposition and (2) S-curve. Concept of S-curve method, explanation application and determination of lower duration graph from the given higher duration graph and vice-versa. Concepts of Synthetic unit hydrograph, Snyder's synthetic unit hydrograph and formulas relating to hydrograph features (basin lag, Peak flow and time base of the unit hydrograph). Concept and application of Instantaneous unit hydrograph and SCS Triangular Hydrograph.

UNIT-V

Flood Routing: Flood Routing-introduction, two broad categories of flood routing and channel routing, hydrologic routing and hydraulic routing, basic equations. Hydrologic storage routing, Schematic representation of storage routing, modified Pul's method (semi-graphical method). Explanation of the features of the modified Pul's method. Flood routing through a reservoir by modified Pul's method. Applications of Hydrology in land and water management, watershed management, Flood mitigation, Floodplain mapping, Retards, Flood control and Regulation.

Text Books:

1. Engineering Hydrology, Raghunath H.M., Willey Eastern Limited, New Delhi, 3rd Edition. (ISBN: 978-9393159045)
2. Watershed Hydrology, Suresh R., Standard Publisher and Distributors, New Delhi. (ISBN: 978-8186308233)

Reference Books:

1. Engineering Hydrology, Subramanyam K., Tata Mc. Graw – Hill Publishing Co., Limited, New Delhi. (ISBN: 978-1259029974)
2. Hydrology for Engineers, Linsley R.K. Kholar A. & Paul Hus J.L.H., Mc-Graw Hill Book Co. New Delhi. (ISBN-13. 978-0070379565)
3. Watershed Management, Dhruvanarayana, VV., ICAR Publication, New Delhi. (ISBN: 978-8120346765)

Web Links:

1. <http://www.nptelvideos.in/2012/11/advanced-hydrology.html>
2. <https://www.slideshare.net/MohammedSalahat1/chapter-3-surface-water-hydrolo>
3. <https://theconstructor.org/water-resources/types-of-rain-gauges/12801/>
4. <http://nptel.ac.in/downloads/105101002/>

Land & Water Management Engineering

	L	T	P	C
Course Code: 241AE087	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Apply methods for assessing and mitigating soil erosion to enhance soil conservation and sustainable land management.
- CO2:** Design, implement, and evaluate various water erosion control measures, incorporating both agronomical and engineering approaches to enhance soil conservation and land sustainability.

- CO3:** Apply energy and momentum principles in open channels, design soil erosion control structures, and implementing permanent gully control structures, ensuring hydrologic, hydraulic, and structural integrity.
- CO4:** Demonstrate wind erosion control measures, land use capability classification and sedimentation of reservoirs.
- CO5:** Classify water harvesting techniques, design and construct various structures such as farm ponds and percolation ponds, and apply design considerations for nala bunds.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2			2	3		2	1	2
CO2	2	3	3			2	3		2	1	2
CO3	2	3	3			2	3		2	1	2
CO4	2	2					2				
CO5	2	2	2				2			1	

UNIT – I

Soil Erosion: Causes, Types, Mechanisms, and Measurement

Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion; Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by $KE > 25$ and EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

UNIT – II

Water Erosion Control Measures and Techniques

Water erosion control measures- agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design.

UNIT – III

Hydraulic Principles and Soil Erosion Control Structures

Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump; Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis.

UNIT – IV

Wind Erosion and Sedimentation Control in Agriculture

Wind erosion- factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes; Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

UNIT – V**Water Harvesting Techniques and Structures for Agricultural Use**

Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short- term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Text Books:

1. Open-Channel Hydraulics, Chow V T, McGraw- Hill Book Company, Inc.(ISBN: 9780070107762)
2. Manual of Soil and Water Conservation Practices, Singh. G., Venkataraman C, Sastry G and Joshi B P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.(ISBN: 978-8120405523)

Reference Books:

1. Land and Water Management Engineering, Murthy V V N., Kalyani Publishers, New Delhi, 4th Edition, (ISBN: 978-9327214659)
2. Principles of Agricultural Engineering, Michael A M and Ojha T.P, Volume II. Jain Brothers, New Delhi, 4th Edition. (ISBN: 978-8183601849)

Web Links:

1. Course: Soil & Water Conservation Engg. 3(2+1) (iasri.res.in)
2. Soil-and-Water-Conservation-Engineering.pdf (agrimoon.com)

Agricultural Process Engineering & Food Quality

Course Code: 241AE088

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Explain the functions of various unit operations and working of size reduction equipments for processing of fibrous and dry size reduction in processing of agriculture produce.
- CO2:** Explain the design and working of mixing equipments for powder, high and low viscosity liquids.
- CO3:** Classify separator equipment based on physical characteristics of grains.
- CO4:** Identify various methods for determining moisture content, EMC and drying process.
- CO5:** Explain the importance, design and working of milling and material handling devices, food quality control, food laws, food standards and HACCP.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	1	-	-	-	-	-	-	-
CO2	3	1	2	2	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-
CO4	3	1	1	1	-	-	-	-	-	-	-
CO5	3	2	2	2	-	-	-	-	-	-	-

UNIT-I

Unit operation in agricultural Processing:

Scope and importance crop processing – principles and methods of food processing, cleaning, grading, screening, scalping, sorting, size reduction, mixing, separation, drying, storage, milling, material handling, packaging, baking.

Size reduction:

Size reduction –principle of comminution/size reduction, particle shape, average particle size, crushing efficiency. Determination and designation of the fineness of ground material, screen analysis, Empirical relationships (Rittinger's, Kick's and Bond's equations) and related problems. Size reduction equipment – Crushers (Jaw crusher, Gyratory crusher, Crushing rolls), Grinders (Attrition mill, Hammer mill, Ball mill), Fine grinders (Rietz mill or disintegrator, Dispersion and colloid mills) and Cutting machines (Rotary knife cutter).

UNIT-II

Mixing:

Mixing –Introduction, theory of solids mixing, Mixing of low and moderate viscosity liquids (paddle mixer, turbine mixer, propeller mixer) its applications. Mixing of high viscosity liquids, pastes and plastic solids (pan mixer, kneaders) its applications.

Mixers for dry powders and particulate solids (Horizontal screw and ribbon mixer, Vertical screw mixer, Tumbling mixer) and its applications, mixing index,

Separator units:

Theory of separation, types of separators, separator based on length, width, shape of the grains, specific gravity, density, cyclone separators, Pneumatic separator. Air-screen grain cleaner principle and types, Design considerations of air-screen grain cleaners, Sieve analysis- particle size determination, Ideal screen and actual screen–effectiveness of separation and related problems.

UNIT-III**Drying:**

Moisture content and its representation (wet basis, dry basis), methods for determination moisture content (direct and indirect methods) and related problems, Importance of EMC and methods of determination (static-dynamic methods), EMC models, hysteresis effect, bound, unbound and free moisture. Principles of drying, theory of diffusion, mechanism of drying, falling rate, constant rate period, thin layer, deep bed drying methods, Effect of different factors on the drying process, types of dryers.

UNIT-IV**Milling and Material handling devices:**

Rice milling, principles and equipments, paddy parboiling methods and milling equipment, milling of pulses and oilseeds. Scope and importance of material handling devices, Belt Conveyor– idlers, idler spacing, belt tension, Bucket elevator–classification, operation, capacity, drive mechanism, advantages and disadvantages. Screw conveyor – Principle of operation, capacity, and power requirement. Pneumatic conveying system- types, limitations of pneumatic conveying system.

UNIT-V

Food Quality: Concept, objectives and importance. Sensory evaluation or organoleptic evaluation of food quality, Food laws and regulations in India. Food grade and standards –BIS, AGMARK, PFA, FPO. Hazard analysis and critical control point (HACCP) – objectives, principles, Steps involved in implementation of HACCP

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN: 978-8125911425)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta. (ISBN: 978-8120409699)
3. Unit operations in Food processing, Earle R L, Pergamon Press, New York. (ISBN: 978-0080255361)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-Hall Inc., New Jersey. (ISBN: 978-0134181028)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P McGraw-Hill Book Co., Boston. (ISBN: 978-0072848236)

Web Links:

1. <http://www.cigr.org/documents/CIGRHandbookVol4.pdf>
2. <http://www.rpaulsingh.com/Learning and teaching resources>
3. <http://ecoursesonline.iasri.res.in/course/view.php?id=22>
4. https://moodle.ufsc.br/pluginfile.php/772348/mod_resource/content/0/UnitOperations_in_Food_Engineering_-_A._Ibarz_G._BarbosaCanovas_CRC_2003_WW.pdf
5. <http://www.nzifst.org.nz/unitoperations/matleneg2.htm>

Post Harvest Engineering for Horticultural Produce**Course Code:** 241AE089

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Explain about various properties and factors affecting quality of fruits and vegetables.
- CO2:** Classify various post harvest operations involved in horticulture processing.
- CO3:** Identify various preservation techniques for processed foods.
- CO4:** Apply the advanced packaging technology in food preservation.
- CO5:** Categorize different beverages based on method of preparation and explain the procedure for extraction of oleoresins and essential oils.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	2	2							
CO2	3	1	1	1							
CO3	3	2	2	2							
CO4	3	2	2	2							
CO5	3	1	1	1							

UNIT-I

Properties of Fruits and Vegetables: Engineering properties of fruits and vegetables - physical, aerodynamic, rheological and thermal properties. Electrical properties- Near Infrared reflectance (NIR), radiation, dielectric properties and optical properties: Light transmittance, Light reflectance, machine vision. Quality parameters of fruits and vegetable for processing: sensory, biochemical and nutritional characteristics.

Factors affecting fruits and vegetables quality: Pre-harvest factors, environmental factors, cultural factors and post-harvest factors. Harvesting indices of different horticultural produce, modern techniques for determination of harvesting indices. Handling and transportation of fruits and vegetables. Determination of quality parameters for fruits and vegetables: aroma, fruit ripening, leaf changes, firmness, juice content, sugar content, skin color, total soluble solids, pH and acidity.

UNIT-II

Post-Harvest Operations: Cleaning of fruits & vegetables: soaking, rinsing, sanitizing, washing methods: agitating, spraying water, wet and dry brushing, chemical washing. Peeling of fruits and vegetables: hand peeling, mechanical peeling, peeling by heat treatment and lye peeling. Grading of fruits & vegetables, factors affecting grading, types of graders: screen grader, roller grader, rope and cable type grader and weight grader. Canning of fruits & vegetables: grading, washing, peeling, cutting, blanching, cooling, filling, syruping/brining, exhausting, sealing, retorting, cooling, storage, labeling. Cans making, causes of spoilage of canned foods.

UNIT-III

Principles of Preservation of Fruits & Vegetables: Asepsis, preservation by high temperature: pasteurization, flash pasteurization, sterilization. Chemical preservation with sulphur dioxide and benzoic acid, advantages, disadvantages. Drying and dehydration of fruits & vegetables (flow chart), types of dryers: cabinet dryer, tray dryers, tunnel dryer, freeze drying. Rehydration, ratio of rehydration coefficient. Freezing: Definition and methods - slow freezing, quick freezing and IQF, advantages and disadvantages. Types of freezing - direct immersion, indirect contact with refrigerant, air blast, cryogenic and de-hydro freezing. Cooling methods - pre-cooling, room cooling, hydro cooling, refrigerated trucks.

UNIT-IV

Packaging of Horticultural crops: Controlled atmospheric storage (CAS), factors effecting on CAS, additional benefits, limitations, maintaining CAS, modified atmosphere storage/packaging (MAS/MAP), maintenance of MAP, active modification, passive modification, requirements of fresh fruits package under CAS or MAS. Packaging of fruits and vegetables, advantages and disadvantages. Packaging materials: cellophane, poly vinyl chloride, polyethylene, ethyl vinyl alcohol. Packaging of horticultural crops.

UNIT-V

Preparation and Preservation of Beverages: Preservation of unfermented fruit beverages: apple juice, grape juice, pineapple juice, citrus juice, mango juice with all flow sheets. Fermented beverages: wine, grape wine with all flow charts. Preparation of vinegar - alcoholic fermentation and acetic acid fermentation.

Oleoresin and Essential Oil Extraction: Turmeric oleoresin and chilli oleoresin. Solvents used for oleoresin extraction, advantages and disadvantages. Extraction of essential oil from spices by steam distillation.

Text Books:

1. Food Science by Potter N. and Hotchkiss J. H, An Aspen Publication, 5th Edition. (ISBN:978-8123904726)
2. Fruits and Vegetable Preservation: Principles and Practices, Srivastava, R.P. & Kumar, S. CBS Publishing, 3rd Edition. (ISBN: 978-8123924373)
3. The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits & Vegetables by NIIR Project Consultancy Services, 3rd Edition. (ISBN: 978-9381039694)

Reference Books:

1. Fruits: Tropical and subtropical, Bose T. K & Mitre, S. K. Naya Prakash, 3rd Edition. (ISBN: 978-8185971810)
2. Fruits and Vegetable processing, Bhatti, S. and Varma U., CBS Publishers, 1st Edition. (ISBN: 978-8123904047)
3. Food Processing and Preservation, Sivasenkar, B., CBS Publications. (ISBN: 978-8120320864)

Web Links:

1. http://www.rpaulsingh.com/animations/animaitons_master3.html
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1098>
3. https://onlinecourses.nptel.ac.in/noc18_ar08/preview

Agricultural Machinery & Equipment

	L	T	P	C
Course Code: 241AE090	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Explain the process of selection, cost estimation and methods of ploughing of farm mechanization.
- CO2:** Calculate the forces acting on tillage implements.
- CO3:** Explain inter-culture equipments and understand the sowing, planting and transplanting operation with various implements used for these operations.
- CO4:** Explain the harvesting and threshing operation with various implements used for these operations.
- CO5:** Explain the operation of grain combines harvesting mechanism.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3			2	2						1
CO2		1			3						2
CO3	3										
CO4	3				1						
CO5	3	1									

UNIT-I

Introduction to farm mechanization: Classification of farm machines. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Selection of farm machinery and cost estimation. Hitching systems and controls of farm machinery. Introduction to seed-bed preparation. Familiarization with land reclamation and earth moving equipment. Methods of Ploughing.

UNIT-II

Tillage Practices: Definition, primary tillage, secondary tillage, rotary tillage, deep tillage, minimum tillage and conservation tillage. Draft measurement of tillage equipment, Identification and major functional components of mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, levelling, Forces acting on tillage implements. Cost of operation of farm machinery.

UNIT-III

Introduction to inter-culture equipments: Weeder – manual and powered, main components and their functional requirement.

Introduction to sowing, planting & transplanting equipment: Study of working of seed drills, no-till drills, happy seeder and strip-till drills. Brief description and working of planters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to plant protection equipment – sprayers and dusters.

Classification of sprayers. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.

UNIT-IV

Study of harvesting operation – methods and terminology. Study of Reapers, Mowers and windrowers – types, working and adjustments. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, factors affecting thresher performance. Chaff cutters and capacity calculations.

UNIT-V

Study of grain combines (Wheat and Paddy) - Combine terminology, Computation of combine losses, study of combine troubleshooting. Study of Root crop diggers –potato and groundnut. Cotton harvesting mechanisms, study of cotton pickers and strippers. Introduction to vegetables and fruit harvesting equipment and tools.

Reference Books:

1. Agricultural Machines, Theory and Construction (Vol. 1 & 2). Kanafoshi, C.Z. and Karwawshi T. (ISBN: 9388399838)
2. Agricultural Machines, Kelnin, N.I., Popov, I.F., and Sakun, V.A Amerind Publishers, New Delhi. (ISBN: 978-9061914488)

Web Links:

1. <https://nptel.ac.in/courses/126/105/126105009/>
2. <http://www.hillagric.ac.in/edu/coa/agengg/lecture/243/agriengg-243.htm>

Text Books:

1. Principles of Agricultural Engineering (Vol. II). A. M. Michael and T.P. Ojha, Jain brothers, New Delhi. (ISBN: 8183601849)
2. Principals of Farm Machinery, R.A. Kepner, Bainer Roy, and E.C. Barges, Publishers and Distributors, Delhi-17. (ISBN: 8123909772)
3. Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2), Bosoi, E.S., Oxonion Press Pvt. Ltd., New Delhi. (ISBN: 9383692378)

Design of Bio-Energy Systems

Course Code: 241AE091	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Comprehend Biomass Sources and Fermentation Processes
- CO2:** Explore Biomass Production and Preparation
- CO3:** Analyze Biomass Conversion Technologies
- CO4:** Evaluate Biofuel Production Processes and Applications
- CO5:** Assess Environmental and Economic Aspects of Bio-Energy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2					2	3				
CO2	3	2		1		2					
CO3	2	1				2	3				
CO4	2	1				3	1				
CO5	2	1				3	1				

UNIT – I

Biomass sources and characteristics. Fermentation processes and its general requirements. Aerobic and anaerobic fermentation processes and their industrial applications. Heat transfer processes in anaerobic digestion systems.

UNIT – II

Biomass production- wastelands, classification and their use through energy plantation. Selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

UNIT – III

Bio-energy

Properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs.

UNIT – IV

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Producer gas- type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Applications, shaft power generation, thermal application and economics.

UNIT – V

Trans-esterification for biodiesel production and application in CI engines. production process, properties and application of ethanol. Bio-hydrogen production routes. Environmental aspect of bio-energy. Assessment of greenhouse gas mitigation potential. Cost economics of bio-energy systems.

Text Books:

1. Biomass Gasification, Pyrolysis and Torrefaction, Basu P, Academic Press, 2018. (ISBN: 10-10128129921)
2. Renewable Energy Academy Training wood energy professionals, Butler S. (ISBN: 13-978-0128129920)

Reference Books:

1. The Biodiesel Handbook, Knothe G, Gerpen J V, Krah J. (Eds.), AOCS Press. (ISBN: 9781893997622)
2. Non-Conventional Energy Sources, Rai G D, Khanna Publishers, New Delhi. (ISBN: 978-8174090737)

Web links:

1. <https://elearning.icar.gov.in/>
2. https://saveetha.ac.in/images/sec/2021/Syllabus/Agriculture/19AG423-_BIO-ENERGY_SYSTEM_DESIGN_AND_APPLICATIONS.pdf

Minor Degree in Entrepreneurship Development & Incubation

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MB007	New Product Development	FC	3			3	50	50	100	-
241MB008	Entrepreneurship & Small Business Management	IC	2			2	50	50	100	-
241MB009	Insurance & Risk Management	IC	3			3	50	50	100	-
241MB010	Change & Innovations Management	IC	3			3	50	50	100	-
241MB011	Personal Financial Planning (or) E-Business management	IC	3			3	50	50	100	-
241MB012										
241MB013	Business Policy & Strategic Management (or) Green Marketing	AC	3			3	50	50	100	-
241MB014										
241MB015	Startup Management (or) Venture Management	AC	3			3	50	50	100	-
241MB016										
Total			20			20				

New Product Development

Course Code: 241MB007

L T P C
3 0 0 3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** To learn how to develop and implement a new product or service to an existing and potential target market.
- CO2:** Understand the importance of new product development to firm performance
- CO3:** To help the student to prepare a Business Plan for a new product or service.
- CO4:** Learn methods of generating, evaluating and testing product ideas.
- CO5:** Understanding the impact of intellectual property and patents on new product development and management

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1							1				
CO2								1	1		
CO3								2			
CO4							3				
CO5							2				

UNIT – I

Introduction- Types of products – Product development - Factors contributing to New Product Development - New product development process – product life cycle in theory and practice - Invention Vs Innovation.

UNIT – II

Strategic Planning for New Product - Sources of new product ideas - Generation of ideas - Criteria for screening – understanding customer needs – need assessment based on secondary and primary research - Concept generation

UNIT – III

Business Analysis – Purpose, Stages of Business analysis - Market potential and Demand - Estimating first time sales - Replacement Sales - Repeat Sales - Estimating costs, Sales and Profit – Business plan preparation

UNIT – IV

Product testing - Test Marketing, its advantages and disadvantages - Test marketing strategies
- Launch cycle - Managing Growth and Maturity - Commercialization

UNIT – V

Defining Intellectual Property and Patents—Patent application—ownership and transfer of patent
– infringements - The future of New Product management – Contemporary issues

Text Books:

1. Product Management in India, Ramanuj Manjumdar, Prentice Hall Publication, 3rd Edition, ISBN: 9788120312524.
2. Business plan template and example: How to write a Business Plan, Alex Genadinik, ISBN: 9781519741783.

Reference Books:

1. Production design and Development, Karl T Ulrich, Steven D. Eppinger and Amita Goyal, Tata Mc GrawHill, 5th Edition, ISBN: 9781260566437.
2. New Products Management, Crawford, Merle and Di Benedetto, Anthony, McGraw-Hill/Irwin, 10th Edition, ISBN: 9781260575088.

Web Links:

1. <https://www.youtube.com/watch?v=QxQfAw1049M>
2. https://ocw.mit.edu/courses/15-783j-product-design-and-development-spring-2006/resources/clas7_cncpt_genr/

Entrepreneurship & Small Business Management

Course Code: 241MB008

L	T	P	C
2	0	0	2

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the nature of entrepreneurship and how it relates to small business.
- CO2:** Develop and demonstrate competence in basic business and marketing planning
- CO3:** Explain factors related to readiness for entrepreneurship and getting started in entrepreneurship career.
- CO4:** Identify the factors affecting choice of a business location and explain how layout of physical facility and equipment could lead to efficiency
- CO5:** Explore techniques for improving quality and productivity.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1								3			
CO2									1		
CO3								2			
CO4							1				
CO5						1					

UNIT – I

Fundamentals of Business: Forms of business organization, Small-scale industrial undertakings with particular reference to India, and Government incentives for entrepreneurial ventures.

UNIT – II

Business Model and Business Plan: Business plan, Business description, Business environment analysis, SWOT analysis, Competitor analysis, Market analysis, and Marketing, Operations and Financial plan.

UNIT – III

Funding new ventures: Fixed and working capital needs, Capital structure, Public and private sources of capital, Equity and debt financing, Terms loans, Private placements, Project finance, Miscellaneous sources, Special institutional schemes, Venture capital.

UNIT – IV

Launch of a Startup: Location, Facility planning, Resource acquisition, Business operations, Costing and pricing of product/service, and Marketing strategy.

UNIT – V

Managing and Growing the Enterprise: Transition to managerial approach and Functions of Management; Operations, quality and productivity management; Market segmentation, Product positioning.

Text Books:

1. Entrepreneurship and Small Business Management, Dr.P.T.Vijayshree & Dr. M.Alagammai, Margham Publication, 2021
2. Essentials of Entrepreneurship and Small Business Management, M. Scarborough , Jeffrey R. Cornwell, Pearson Education, ISBN: 9780134741086.

Reference Books:

1. Entrepreneurship And Small Business, Dr. B. K. Mehta, Prof. R. C. Agarwal, SBPD Publishing House 1st Edition, ISBN: 9789350470688.
2. Entrepreneurship And Small Scale Business, Sanjeet Sharma, VK Global Publications Pvt Ltd, 1 January 2020, ISBN: 9780000861917.

Web Links:

1. <http://digimat.in/nptel/courses/video/110106141/L06.html>
2. <https://www.coursera.org/learn/fundamentals-of-management>

Insurance & Risk Management

Course Code: 241MB009

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Identify and assess various types of risks, and develop strategies to mitigate or manage them.
- CO2:** Explain the principles of insurance, including types of insurance, policy terms, and claims processing.
- CO3:** Conduct risk assessments and analyses to determine potential losses and develop strategies to minimize them.
- CO4:** Develop and implement risk management strategies, including risk avoidance, transfer, mitigation, and acceptance.
- CO5:** Understand the differences between personal and commercial insurance, including types of policies and coverage.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1						1				1	
CO2							2		2		
CO3								2			
CO4							2				
CO5							1				

UNIT – I

Insurance: Concept, Nature of Insurance, Functions of Insurance, Importance of Insurance, Principles of Insurance Contract; Features of Life and Non-life Insurance.

UNIT – II

Insurance and IRDA: IRDA Act 1999, Provisions, Duties, Powers and Functions of IRDA.

UNIT – III

Risk and risk management process - Concept of risk, risk vs. Uncertainty, types of risks, risk identification and evaluation.

UNIT – IV

Risk management objectives-selecting and implementing risk management techniques. Commercial risk management applications.

UNIT – V

property, liability, commercial property insurance, different policies and contracts–business liability and risk management.

Text Books:

1. Life and Health Insurance, Black K. Jr., Skipper. H. D. Jr, Pearson Education, ISBN: 9780138912505.
2. Insurance in India, Response Books, Palande P.S., Shah R.S. and Lunawat M.L., Sage Publications Ltd, ISBN: 9780761997481.

Reference Books:

1. Insurance and Risk Management, Gupta, P.K., Himalaya Publishing House, New Delhi, ISBN: 978-9350246726.
2. Business Policy And Strategic Management, Vipin Gupta, Kamala Gollakota, R. Srinivasan, Phi Learning Pvt. Ltd, ISBN: 9788120328624.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105160/>
2. https://ocw.mit.edu/courses/15-997-practice-of-finance-advanced-corporate-risk-management-spring-2009/resources/mit15_997s09_lec01_3/

Change & Innovations Management

Course Code: 241MB010

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand innovation, innovative models and implementing those Models in organization.
- CO2:** Understand Intervention techniques and implement it effectively at the workplace.
- CO3:** Appreciate resistance-to-change, and strategies to overcome those resistances.
- CO4:** Enable learners with in-depth understanding of individual, team, work-group or organizational interventions to work successfully.
- CO5:** Develop and Enhance Competencies to use the Innovative and Change Management techniques effectively at workplace.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1								2		1	
CO2									3		
CO3								2			
CO4							1				
CO5						2					

UNIT – I

Defining innovation, understanding the role of innovation, Understanding innovation, innovation and organizational performance, Understanding how to use innovation as strategy, Defining exploration vs. exploitation in innovation, and Defining disruptive, destructive, and displacement innovation.

UNIT – II

Frameworks for Creating Innovation & The Product Development Process: Identifying and understanding the sources of innovation, Defining and discussing a standard PDP phase gate methods vs. spontaneous methods for managing innovation and product development, Leading practices designed to foster creativity, open innovation vs. closed innovation, Understanding internal barriers to innovation and how to best address resistance, and Assessing the strategic and financial impact of innovation.

UNIT – III

Leading Innovation & Change: How to form innovation teams, Understanding team behavior & dynamics, How to manage innovation teams for high-performance results, How to best measure team performance, Discussion various tips & traps for leading innovation, Factors and considerations in selecting team members and managing innovation teams.

UNIT – IV

Implementation consideration in using incubators and accelerators, Understanding how and when to use DARPA, “Skunk Works,” and Accelerators for innovation, How to identify, assess and address organizational, legal, and cultural impediments to innovation, Assessing environmental factors and how they affect innovation.

UNIT – V

Social Implications of Innovation: Understanding how innovation and society interact, Examining ethical issues of innovation, Determining the role of social entrepreneurship and innovation Creating social innovation.

Text Books:

1. Managing change, bernard burnes, seventh edition, pearson education, 30 june 2020, ISBN: 9780273033769.
2. Change Management for Beginners, Steffen Lobinger, Tim Ongpublisher,2021, ISBN: 9781687022622.

Reference Books:

1. Innovation Management: Strategies, Concepts and Tools for Growth and Profit, Shlomo Maital , D V R Seshadri , SAGE Publications Pvt. Ltd, ISBN-13: 9788132107224.
2. Managing Innovation and Change, David Mayle, SAGE Publications, ISBN: 9781412922500.

Web Links:

1. <https://hits.digimat.in/nptel/courses/video/110107094/L31.html>
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/01_intro/

Personal Financial Planning

Course Code: 241MB011

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** To provide basic principles for managing personal finance.
- CO2:** To help individual learn investment decisions
- CO3:** Identify and describe various types of risk associated with investments, such as market risk, credit risk, liquidity risk, and operational risk.
- CO4:** Calculate interest, dividend, and capital gains on personal investments, including bonds, stocks, and mutual funds.
- CO5:** To mitigate old age financial planning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1											1
CO2							2				
CO3								2			
CO4							3				
CO5						1	1				

UNIT – I

Basics of Personal Financial Management: Basics of Personal Financial Management: Budget, The Personal Financial Planning Process, Preparation of Personal Budget, Personal Financial Statements, Personal Income Tax Planning. Case studies on personal financial planning of individuals.

UNIT – II

Personal Savings & Investment: Investment Criteria- liquidity, safety and profitability. Savings instruments of Post Office and Banks. Chit Funds. Investment in Shares, Debentures, Corporate and Government Bonds, Mutual Fund. Investment in Physical Assets – Real Estate, Gold and Silver, Gold certificates.

UNIT – IV

Computation of Return and Risk of Personal Investment: Present Value and Future Value of a Single Amount and an Annuity. Computation of interest, dividend and capital gains on personal investments. Impact of leverage on return. Personal tax planning.

UNIT – V

Retirement Savings Plans: Retirement Savings Plans: Gratuity plans from the government. Life Insurance types. Health insurance. Pension Plans- Defined Contribution Plan and Defined

Benefit Plan. Provident Fund, Gratuity. Life Insurance Plans. General Insurance Plans. Reverse Mortgage Plans.

Text Books:

1. Personal Financial Planning, CS Monika Saini, Dr. Neerza, Scholar Tech Press, 1 January 2024.
2. Personal Financial Planning, Dr Shalu Garg, Sultan Chand & Sons, 1 January 2024, ISBN: 9780357987872.

Reference Books:

1. 5 W's of Financial Planning: Master the Art of Personal Finance Strategy, Dr Vimal Krishna Rajput, Sultan Chand & Sons 5 November 2021, ISBN: 9781685388850.
2. Personal Financial Planning, Dr kamal Garg, Sultan Chand & Sons, 1 January 2020.

Web Links:

1. <https://archive.nptel.ac.in/courses/122/106/122106031/>
2. <https://www.coursera.org/learn/fundamentals-of-management>

E-Business Management

Course Code: 241MB012

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the concept and significance of e-business.
- CO2:** Evaluate and select appropriate hardware and software components for e-business.
- CO3:** Apply e-business technologies to enhance marketing strategies.
- CO4:** Design hybrid distribution networks that optimize cost and customer experience.
- CO5:** Understand the role of smart cards in payment systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1								1			1
CO2										1	
CO3									2		
CO4											
CO5							2				

UNIT – I

Introduction Concept of e-business: Nature, scope, and impact of e-business; Difference between e-business and ecommerce; History and development of e-business; Advantages of e-business; Business models for e-products and e-services

UNIT – II

Technologies in e-business Introduction: e-business technologies - hardware, e-business software applications, internet and World Wide Web; Database management system; e-business security; Online payment technology

UNIT – III

Digital Marketing Concept: Effects of e-business technologies on marketing strategy, customer retention and e-CRM; Measuring the extent of digital marketing activity; Market analysis; Digital marketing tools

UNIT – IV

Online Distribution Components of a distribution system: Characterization of online distribution; hybrid distribution networks; Model for electronic software distribution.

UNIT – V

E-Payment System Characteristics of payment system; Classification of payment systems - E-

cash, E-check, overview of smart card; Applications of IPSec.

Text Books:

1. E- Business & E- Commerce, Dr. P. Rizwan Ahmed, Margham Publication, ISBN: 978-9383242320.
2. E-Business and E-Commerce Management, Chaffey Dave, Pearson Education India, 2020, ISBN: 978-0273707523.

Reference Books:

1. E-Business 2.0: Roadmap for Success, Kalakota, Pearson, 2nd Edition.
2. Entrepreneurship And Small Business, Dr. B. K. Mehta, Prof. R. C. Agarwal, SBPD Publishing House 1 Edition.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105083/>
2. <https://srmuniv.digimat.in/nptel/courses/video/110105083/L57.html>

Business Policy & Strategic Management

	L	T	P	C
Course Code: 241MB013	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply the concepts in strategy and their application under various management functions.
- CO2:** Understand the importance of analyzing external factors that impact an organization.
- CO3:** Understand how organizations maintain their current position by focusing on existing products and markets.

CO4: Learn how to turn strategic plans into executable steps, ensuring alignment with organizational goals and objectives.

CO5: Explore the opportunities and threats posed by digital disruption.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1											2
CO2										1	
CO3									3		
CO4								2			
CO5							1				

UNIT – I

Strategic Management: Meaning, Historical Development, Nature, Scope and Significance; Strategic Decision Making; Enterprise Strategists; Strategic Management Model; Strategic Intent- Vision, Mission and Objectives.

UNIT – II

External Environmental Appraisal: Meaning, Significance and Forces. Environmental Scanning: Process and Techniques; Corporate Appraisal- Meaning; Process; Significance & Techniques; Porter's Generic Strategies

UNIT – III

Strategy Alternatives, Variation and Choices: Stability, Growth, Retrenchment and Combination Strategies, Strategic Alliances, Mergers, Acquisitions, Diversification, Integration, Liquidation; Corporate Portfolio Analysis; Strategic Choices Models- BCG Matrix.

UNIT – IV

Strategic Implementation: Strategy Implementation Process, Issues in Strategy Implementation: Behavioral, Functional, Operational and Functional Implementation

UNIT – V

Strategy, Evaluation and Control : Process and Methods. Strategic Management in internet era.

Text Books:

1. Business Policy and Strategic Management, Dr. Sangeeta & Dr. Neeraj, Rigi Publication, 7th Edition, ISBN : 978-9391041656.
2. Business Policy (Strategic Management), by Shiva Manoj Bimal Jaiswal, New Royal Book Company, 1 January 2021, ISBN: 978-8195175215

Reference Books:

1. Business Policy And Strategic Management, Vipin Gupta, Kamala Gollakota, R. Srinivasan, Phi Learning Pvt. Ltd, ISBN:978-8120332447.

2. Business Strategies in Times of Crisis, Dr. Charles O. Usigbe, New Royal Book Company, ISBN : 978-1514431771.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105161/>
2. <https://ocw.mit.edu/courses/15-904-strategic-management-ii-fall-2005/resources/strag/>

Green Marketing

Course Code: 241MB014	L	T	P	C
	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** To impart knowledge on this area of environmental marketing
- CO2:** To analyse the Environmental Ethics
- CO3:** To gain the knowledge in the area of environmental marketing.
- CO4:** Understand how CDM credits can be used by industrialized countries to meet their emission reduction targets.
- CO5:** Identify marketing opportunities in different countries and regions.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1								1			
CO2										1	
CO3									2		
CO4								1			
CO5							2				

UNIT – I

Environment-Pollution, cause, and remedy, Biodiversity, Environmentalism- Definition, concepts, its impact and relationship to businesses, need to study environment in the modern era, environment- an interdisciplinary approach.

UNIT – II

Environment and its relevance to marketing- ethical products, creating awareness about Green Products, Green Labeling of products, Standards- environment audit- Global environmental challenges. Environment conscious customer and consumer segment.

UNIT – III

Environment- Developed and developing countries- Influence of Green Marketing on corporate social responsibility, marketing ethical products- challenges and opportunities, promoting green products- advertising on the green platform, Environmental marketing strategies.

UNIT – IV

Building Green Brands, transforming non-green organizations to green organizations- greening the organization structure- building green business- challenges, international organizations, standards, Clean Development Mechanism (CDM), guides for the use of environmental marketing claims.

UNIT – V

The influence of global environmental issues on international business, international marketing opportunities, Project- mini- project- Business process reengineering with the introduction of green technologies, developed and developing markets, environmental marketing of services.

Text Books:

1. Environmental marketing- strategies, Practice, Theory and Research by Michael J. Polansky, and Alma T. Wimsatt, Kogan Page Publishers, ISBN: 9781136590337.
2. Environmental Marketing – positive strategies for reaching the green consumer by Walter Codrington Peter Florain, McGraw Hill Professional, 2020, ISBN: 9780070115996

Reference Books:

1. Green Marketing and management- A global perspective by John. F. Wasik , Blackwell publisher, 2022, ISBN: 9781557866349.
2. Marketing, Morality, and the natural environment by Andrew Crane Routledge publishers, ISBN: 9780415439619.

Web Links:

1. <https://www.youtube.com/watch?v=LxxpEKyu134>

2. <https://www.teachmint.com/tfile/studymaterial/b-com/management/unit-7lecture-14greenmarketingpdf/b3248a3e-01af-4f2a-bb41-695c71975ec1>

Startup Management

	L	T	P	C
Course Code: 241MB015	3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Develop a start-up Enterprise with Big Idea Generation.
- CO2:** Analyze start-up capital requirement by analyzing legal factors.
- CO3:** Interpret feasibility Analysis towards funding issues.
- CO4:** Access growth stages in new venture and reasons for scaling ventures.
- CO5:** Evaluate financial stability and decide on expansion possibilities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1							1		1	1	1
CO2											
CO3									2		
CO4								3			
CO5							1				

UNIT – I

Start-up opportunities: The New Industrial Revolution – The Big Idea- Generate Ideas with Brainstorming- Business Start-up - Ideation- Venture Choices - The Rise of The start up

Economy - The Six Forces of Change- The Start-up Equation – The Entrepreneurial Ecosystem – Entrepreneurship in India. Government Initiatives.

UNIT – II

Startup Capital Requirements and Legal Environment: Identifying Startup capital Resource requirements - estimating Startup cash requirements - Develop financial assumptions- Constructing a Process Map - Positioning the venture in the value chain - Launch strategy to reduce risks- Startup financing.

UNIT – III

Starting up Financial Issues: Feasibility Analysis - The cost and process of raising capital – Unique funding issues of a high-tech ventures - Funding with Equity – Financing with Debt- Funding startups with bootstrapping- crowd funding- strategic alliances.

UNIT – IV

Start-up Survival and Growth: Stages of growth in a new venture- Growing with the market - Growing within the industry- Venture life patterns- Reasons for new venture failures- Scaling Ventures – preparing for change - Leadership succession. Support for growth and sustainability of the venture.

UNIT – V

Planning for Harvest and Exit: Dealing with Failure: Bankruptcy, Exit Strategies- Selling the business - Cashing out but staying in-being acquired- Going Public (IPO) – Liquidation.

Text Books:

1. Launching New Ventures, An Entrepreneurial Approach, Kathleen R Allen, CengageLearning, ISBN: 9780357039175.
2. Managing New Ventures Concepts and Cases, AnjanRaichaudhuri, Prentice Hall International, ISBN:978-8120341562.

Reference Books:

1. Entrepreneurship, S. R. Bhowmik& M. Bhowmik, New Age International, ISBN: 9788122419061.
2. The Startup Equation -A Visual Guidebook for Building Your Startup, Indian Edition, Steven Fisher, Ja-nae' Duane, Mc Graw Hill Education India Pvt. Ltd, ISBN: 9780071832366.

Web Links:

1. <http://tjsec.digimat.in/nptel/courses/video/110106141/L57.html>
2. <https://archive.nptel.ac.in/courses/127/105/127105007/>

Venture Management

Course Code: 241MB016

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Describe the role of venture managers in promoting entrepreneurship.
- CO2:** Learn how to secure and manage IP assets within a venture.
- CO3:** Analyse and assess risks associated with ventures.
- CO4:** Evaluate and choose appropriate exit strategies based on venture goals and market conditions.
- CO5:** Develop a comprehensive plan for scaling and entering global markets.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1									2		
CO2										2	
CO3									2		
CO4								3			
CO5							2				

UNIT – I

Introduction to Venture Management: Understanding the concept of venture management, Role of entrepreneurship and innovation in creating ventures,

Market Research and Opportunity Identification: Techniques for market research and identifying business opportunities, Analyzing customer needs, market trends, and competitive landscape.

UNIT – II

Legal and Regulatory Aspects: Legal structures for ventures (sole proprietorship, partnership, corporation, etc.). Intellectual property rights, contracts, and compliance.

Financial Management for Ventures: Budgeting, financial forecasting, and managing startup costs, Sources of funding (bootstrapping, angel investors, venture capital).

UNIT – III

Risk Management and Decision Making: Assessing and mitigating risks associated with ventures. Making informed decisions under uncertainty.

UNIT – IV

Exit Strategies and Succession Planning: Options for exiting the venture (selling, merging, going public), Planning for the long-term sustainability of the venture.

UNIT – V

Venture Scaling and Internationalization: Learn strategies for scaling ventures beyond their initial markets, Understand the challenges and opportunities of international expansion.

Text Books:

1. New Venture Creation: A Framework for Entrepreneurial Start-ups, Paul Burns, MacMillan publication, Latest Edition, ISBN: 9781350321793.
2. Entrepreneurship: New Venture Creation, David H. Holt, Pearson publication, Latest Edition, ISBN: 9780132826747.

Reference Books:

1. Entrepreneurship and new Venture Creation, Excel publication, Latest edition, A Sahay, V Sharma, ISBN: 978-9332568730.
2. Entrepreneurship: Successfully Launching New Ventures, Bruce R. Barringer, R. Duane Ireland, Pearson publication, Latest Edition, ISBN: 978-935306649.

Web Links:

1. <https://hits.digimat.in/nptel/courses/video/109105098/L17.html>
2. <https://ocw.mit.edu/courses/15-351-managing-the-innovation-process-fall-2002/resources/lecture2021/>
3. <https://ocw.mit.edu/courses/15-351-managing-the-innovation-process-fall-2002/resources/lecture2324/>

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	241EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	241EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	241EC099	Basic Programming Lab (or)	1	0	2	3	V
	241EC100	Basic Laboratory Course for Quantum Technologies					
4	241EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII
Any One course from the below							
5	241EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	241EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	241EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	241EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	241EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	241EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	241EC108	Quantum Optics	3	0	0	3	VII
12	241EC109	Quantum Cybersecurity	3	0	0	3	VII
13	241EC110	Quantum Machine Learning	3	0	0	3	VII
Total			18	0	0	18	

Survey of Quantum Technologies and Applications

Course Code: 241EC097

L T P C
3 0 0 3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain the core quantum mechanical principles relevant to qubits and quantum technologies.
- CO2** Analyze and compare major qubit hardware platforms used in quantum computation.
- CO3** Describe the principles and operating mechanisms of quantum sensing techniques.
- CO4** Evaluate practical applications of quantum sensing in measurement and metrology.
- CO5** Explain and assess quantum communication protocols over fibre-based and free-space channels.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2	2						2
CO3	2	2		2	2						2
CO4	2	2		3	2	2					2
CO5	3	3		2	3	2	1				2

UNIT – 1: Quantum Technologies – four verticals: Motivation for Quantum Technologies A qualitative overview of salient aspects of quantum physics: Quantum States, Wavefunctions, Probabilistic interpretation, Physical observables, Hermitian operators, expectation values, Heisenberg uncertainty principle, Schrodinger equation, Time evolution; distinction from classical physics; Heuristic description of Superposition, Tunnelling and entanglement; No cloning theorem; Simulating classical systems – Feynman’s idea of a quantum simulator and the birth of the field.

UNIT-II: Quantum Computation: Basics of qubits -- what is a qubit?, How is it different from a classical bit? – Review of classical logic gates; Di Vincenzo criteria for realising qubits; Basics of qubit gates and quantum circuits; Physical implementation of qubits (very qualitative description); Solid State Qubits: Semiconducting Qubits – quantum dots, spins, Superconducting Qubits – charge, flux and phase, Topological Qubits – proposals and advantages; Atoms and Ions: Trapped ions, Rydberg atoms, Neutral atoms; Photonic Qubits: Conventional linear optical setups, Integrated Photonics; NMR qubits: Conventional NMR qubits, NV centres Overview of applications and recent achievements: RSA and Shor’s algorithm, Quantum Advantage; Long term goals and strategies being followed : Error correction

UNIT-III: Quantum Sensing: Basics of quantum sensing, Basics of Photon (single and entangled) generation and detection, Gravimetry, Atomic clock, Magnetometry, State of the art in Quantum Sensing

UNIT-IV: Quantum Communications: Basics of digital communication, Quantifying classical information – Shannon entropy, Basic ideas of quantum communication, security, eavesdropping, Overview of quantum communication achievements : Terrestrial – fibre-based, Free space, Satellite-based

UNIT-V: Introduction to Quantum Materials: What are quantum materials, Why are they important, Applications (quantum computing, spintronics, etc.)

Overview of Key Classes of Quantum Materials: Topological Insulators, Superconductors, Mott Insulators, 2D Materials and Quantum Spin Liquids.

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. Elements of Quantum Computation and Quantum Communication, A. Pathak, Boca Raton, CRC Press (2015)
4. An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, and Michele Mosca, Oxford University Press (2006)
5. Quantum computing explained, David McMahon, Wiley (2008)

Foundations of Quantum Technologies

Course Code: 241EC098

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Apply mathematical tools to model and analyze classical and quantum physical systems.
- CO2** Explain and apply the postulates of quantum mechanics to solve elementary quantum system problems.
- CO3** Analyze statistical physics concepts and differentiate classical and quantum statistical distributions.

- CO4** Explain and interpret information-theoretic concepts in classical and quantum information systems.
- CO5** Analyze and compare classical and quantum computational complexity classes with reference to post-quantum cryptography.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			1						2
CO2	3	3		2	1						2
CO3	3	2		2							2
CO4	2	2			2						2
CO5	2	3			1	1	1				2

UNIT-I: Brief overview of classical physics (This segment is meant for the student to understand what a Hamiltonian is, which will feature later in quantum mechanics) : Hamiltonian function and Hamilton's equations, Phase-space description of a system, Connection and Equivalence with Newton's laws for simple systems – free particle, particle moving in a conservative potential, examples of Harmonic oscillator, hydrogen atom. Historical evolution of quantum mechanics: Planck's quantum hypothesis, Photo electric effect, Atomic spectra, Bohr's quantisation principle, De Broglie's Wave particle duality

UNIT-II Postulates of Quantum Mechanics: State vectors and Hilbert Space, Dirac Bra-Ket notation, Measurables and Hermitian Operators, Unitary Transformations, Schrodinger. Equation and Time evolution of quantum states, Measurement Postulate, Schrodinger, Heisenberg and Interaction pictures, Eigen values, Expectation values and Matrix elements, Heisenberg's Uncertainty principle

UNIT-III:

Density operator formalism of quantum mechanics – pure and mixed states; Superposition and Entanglement in quantum mechanics; No cloning theorem; Applications of postulates – Particle in a box, Hydrogen atom, Harmonic Oscillator. Number states, ladder operators and Coherent states of a harmonic oscillator; Spin and Angular momentum – spin half particles; Rabi problem of a spin-half particle in a rotating magnetic field; Bosons and Fermions

UNIT-IV:

Statistical Physics: Quick review of first and second laws of thermodynamics, Thermal Equilibrium and Gibbs principle, Applying Gibbs principle to Classical and Quantum harmonic oscillators, Bosons and Fermions and Quantum statistics – Fermi-Dirac and Bose- Einstein distributions

UNIT - V: Information Science: Digital communication and information: Quantifying information in terms of Shannon entropy; Basic ideas of quantum information; Decoherence and noise;

Introductory ideas of Kraus operators Brief overview of Computational Complexity: Qualitative ideas of a Turing machine: Types of Turing machines; Time and Space complexity – P vs NP, PSPACE; Quantum complexity classes – Q, EQP, BQP, BPP, QMA; Post Quantum Cryptography (PQC)

Course References:

1. Introduction to Quantum Mechanics, Griffiths D. J., 3rd Edition, Cambridge University Press (2024)
2. Introduction to Electrodynamics, Griffiths D. J., 4th edition, Cambridge University Press (2020)
3. Principles of Quantum Mechanics, Shankar, R., 2nd edition, Springer (2014)
4. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
5. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
6. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
7. Information Theory, Robert B. Ash, Dover Publications (2003)
8. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014) Statistical Mechanics, Pathria R. K., Paul D. Beale, 4th edition, Academic Press, (2021)

Basic Programming Lab

Course Code: 241EC099

L	T	P	C
1	0	2	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Apply basic programming concepts and object-oriented principles to develop scientific programs.
- CO2** Implement and analyze simple algorithms and evaluate their computational performance.
- CO3** Apply numerical methods to solve differential equations and linear algebra problems.
- CO4** Analyze probabilistic and statistical data using numerical and simulation techniques.
- CO5** Develop computational models for quantum mechanics and electromagnetism applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2						2
CO2	3	3			2						2
CO3	3	2		2	2						2
CO4	2	3		2	2						2
CO5	3	3	2	3	2	1		1			2

Course Content and syllabus:

- Basics of programming
 - Data structures, classes, Object-oriented programming
 - Data storage and retrieval, Memory allocation
 - Scientific plotting, documentation of codes
- Simple algorithms and benchmarking run time
 - Sorting
 - Searching
 - Arithmetic algorithms like GCD, Prime factorisation
- Numerical Integration and differential equations
 - Linear 2nd Order ODEs with constant coefficients
 - Linear 2nd order ODEs with variable coefficients
 - Boundary value problems
 - Poisson equation
 - Laplace equation
 - Wave equation
 - Diffusion Equation
- Numerical techniques in linear algebra

- Matrix inverse
- Eigenvalue problem
- Diagonalisation of matrices
- Singular value decomposition
- Numerical techniques in Probability and Statistics
 - (Pseudo) Random number generation
 - Computing statistical moments for data samples
 - Least Squares fitting
 - Error Analysis
 - Hypothesis Testing
 - Monte Carlo sampling
- Applications to Quantum Mechanics (can be done using openly available modules in languages like Python, Julia etc.)
 - Eigen energies of coupled two level systems
 - Eigen energies of two-level system coupled to oscillator (Jaynes-Cummings Model)
 - Driven two-level system – Rabi Problem
 - Driven damped oscillator — coherent states
- Applications to EM theory (e.g. magnetic field simulation)
 - Electrostatic charge distributions
 - Magnetostatic current distributions
 - Finite Element techniques for electromagnetic simulations

Course References:

Computational Physics, Nicholas Giordano, Hisao Nakanishi, 2nd edition, Pearson-Addison Wesley (2005)

Basic Laboratory Course for Quantum Technologies

Course Code: 241EC100

L	T	P	C
1	0	2	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Apply optical experimental techniques to measure wavelength, diffraction, polarization, and imaging parameters.
- CO2** Analyze and characterize RLC circuits and resonators to determine quality factor and losses.
- CO3** Implement and verify basic digital circuits using standard ICs and laboratory instruments.
- CO4** Operate RF and microwave instruments to measure transmission, reflection, noise, and network parameters.
- CO5** Acquire, process, and interpret experimental data using computer interfacing and quantum simulation tools.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		2	2						2
CO2	3	3		2	2						2
CO3	3	2	2		2		1				2
CO4	3	3		2	2	1					2
CO5	3	3	2	2	2	1	1				2

Course Content and syllabus:

- Optics
 - Interferometry – wavelength measurements, intensity measurements
 - Diffraction – single slit, grating
 - Microscopy – magnification, aberration
 - Polarization optics – PBS, HWP, QWP
- RLC circuits
 - Series and parallel RLC circuits – Verifying the quality factor formulae
 - Extracting intrinsic losses
- Digital circuits
 - Adder, Multiplier
 - Encoder, Decoder
 - D flipflop, shift registers
 - How to use common Integrated Circuit chips
- Radio Frequency Technology:
 - Using Oscilloscope
- Ring-up and ring-down time measurements of RLC circuits

- Measurements of different pulse-shapes generated by a function generator
 - Using Vector Network Analyser
- Transmission and reflection measurements of coaxial cable in open, short and matched termination
- Voltage standing wave ratio measurement
- Amplitude and Phase quadrature, In-phase and Out-of-phase quadrature plots and Quality factor measurement of RLC circuits
- Characterising S-parameters, ABCD and Z matrices of common 2 port networks – coaxial cable, attenuator, low pass high pass bandpass filters etc.
- Characterising 3 port networks – directional couplers, circulators, isolators
 - Using a spectrum analyser
- Noise from a resistor at different temperatures
- Interfacing instruments with a computer
- Data acquisition
 - Signal demodulation – heterodyne vs Homodyne, Mixing of signals
 - Sampling, digitisation using ADCs – under-sampling and aliasing, oversampling and noise
 - Averaging and interpolation techniques
- Quantum Simulators
 - Running quantum protocols in a quantum simulator
 - Implementing simple quantum algorithms on cloud-based quantum computers (depending on availability of time on such machines)
- Running simple algorithms on cloud-based quantum processors (optional)

Course References:

1. Optics, Eugene Hecht, A. R. Ganesan, 5th edition, Pearson (2019)
2. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
3. Digital Design, Morris Mano, Michael D. Ciletti, 6th edition, Pearson Education (2018)
4. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
5. Discrete-time signal processing, Alan V. Oppenheim and Ronald W. Shaffer, 4th edition, Pearson (2009)
6. Optical quantum information and quantum communication, A. Pathak and A. Banerjee, SPIE Spotlight Series, SPIE Press (2016)

Introduction to Quantum Computation

Course Code: 241EC102

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain the principles of qubits and compare their physical realizations with classical bits.
- CO2** Analyze quantum correlations, entanglement, and Bell-type inequalities in quantum systems.
- CO3** Apply universal quantum gates and circuits to construct basic quantum computational models.
- CO4** Analyze and explain the working of fundamental quantum algorithms such as Grover's and Shor's algorithms.
- CO5** Explain quantum computational complexity, error correction techniques, and the limitations of NISQ-era processors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	2			2						2
CO4	3	3		2	2						2
CO5	2	3		2	2	2	1		1		2

Course Content and syllabus:

- Qubits versus classical bits
 - Spin-half systems and photon polarizations
 - Trapped atoms and ions
 - Artificial atoms using circuits
 - Semiconducting quantum dots
 - Single and Two qubit gates – Solovay - Kitaev Theorem
- Quantum correlations
 - Entanglement and Bell's theorems
- Review of Turing machines and classical computational complexity
 - Time and space complexity (P, NP, PSPACE)
- Reversible computation
- Universal quantum logic gates and circuits
- Quantum algorithms
 - Deutsch algorithm
 - Deutsch Josza algorithm
 - Bernstein - Vazirani algorithm
 - Simon's algorithm
- Database search

- Grover's algorithm
- Quantum Fourier Transform and prime factorization
 - Shor's Algorithm.
- Quantum complexity classes – Q, EQP, BQP, BPP, QMA
- Additional Topics in Quantum Algorithms
 - Variational Quantum Eigensolver (VQE)
 - HHL
 - QAOA
- Introduction to Error correction
 - Fault-tolerance
 - Simple error correcting codes
- Survey of current status
 - NISQ era processors
 - Quantum advantage claims
 - Roadmap for future

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
4. Quantum error correction and Fault tolerant computing, Frank Gaitan, 1st edition, CRC Press (2008)
5. Quantum computing explained, David McMahon, Wiley (2008)
6. Introduction to Quantum Computing: From a lay person to a programmer in 30 steps, Hui Yung Wong, 1st edition, Springer-Nature Switzerland AG (2022)

Introduction to Quantum Communication

Course Code: 241EC103

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain the principles of polarization optics and photodetection relevant to quantum communication systems.
- CO2** Analyze classical and quantum information concepts including entropy, noise, and channel capacity.
- CO3** Explain and analyze quantum correlations, Bell measurements, and fundamental quantum communication protocols.
- CO4** Analyze the working of quantum communication protocols such as teleportation, dense coding, and quantum key distribution.
- CO5** Evaluate quantum communication architectures, hardware implementations, and the concept of quantum networks and internet.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3			2						2
CO3	3	3		2							2
CO4	3	3		2	2		1		2		2
CO5	2	2		2	3	2	1		2		2

Course Content and syllabus:

- Basics of Polarization optics
 - Quarter and half-wave plates
 - Polarizing beam splitters
- Basics of linear and square-law detectors
 - Quadrature amplitude modulation
 - Heterodyne and Homodyne demodulation and linear detectors
 - Intensity measurements and square law detectors
 - Photomultipliers, Avalanche Photo diodes
- Digital communication – information theory (basics)
 - Information entropy
 - Noiseless channel encoding
 - Noisy channel encoding
- No cloning theorem
- Quantum Memories
- Quantum repeaters
- Entanglement and Bell Theorems
- Bell Measurements and Tests
- Quantum Teleportation protocol

- Quantum Dense coding
- Quantum Key Distribution protocols
 - BB84
 - E91
 - BBM92.
 - B92
 - COW
 - DPS
- Quantum Networks and Quantum Internet
- Survey of Hardware implementations
 - Free space communications
 - Satellite based communications
 - Fibre optics-based communications

Course References:

1. Quantum computation and quantum information – Nielsen and Chuang
Cambridge University Press, Cambridge (2010)
2. A Pathak, Elements of Quantum Computation and Quantum
Communication, Boca Raton, CRC Press (2015)

Introduction to Quantum Sensing

Course Code: 241EC104

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain the principles of classical sensing, noise mechanisms, and measurement sensitivity limits.
- CO2** Analyze quantum measurement processes including projective, weak, and non-demolition measurements.
- CO3** Apply information-theoretic bounds to quantify and optimize quantum sensing performance.
- CO4** Analyze quantum states of light and photodetection techniques used in precision measurements.
- CO5** Evaluate photon-, entanglement-, atomic-, and spin-based quantum sensing applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	3		2	2						2
CO4	3	3		2	2				2		2
CO5	2	3		3	2	2			2		2

Course Content and syllabus:

- Classical sensing
 - photo detection
- Classical Noise
 - Johnson Noise, Telegraph noise, flicker or 1/f noise
- Sensitivity of classical measurements
 - Classical Fisher information
 - Cramer - Rao bounds (information theory basics may be required here).
- Quantum measurements
 - projective/orthogonal measurements
 - Approximate/non-orthogonal measurements
 - Weak continuous measurements
 - Error-disturbance relations
 - Standard quantum limits
 - Quantum non-demolition measurements
- States of light
 - fock states
 - Coherent states

- Squeezed states
- Tomography
- Wigner quasi-probability distribution
- P-distribution
- Husimi Q function
- Quantum photo detection
 - Square-law detectors, Intensity measurements and Photo-detection
 - Linear Detectors and Quadrature Measurements
- Quantum Cramer-Rao bounds
- Single photon-based sensing applications
- Entanglement based sensing applications
- Atomic state-based sensing, solid-state spin-based sensing applications (gravimetry, magnetometry)

Course References:

1. Quantum Measurement and Control , Howard Wiseman and David Milburn, Cambridge University Press (2014)
2. Quantum Measurement , Vladimir Braginsky and Farid Ya Khalili, Cambridge University Press (1995)
3. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)

Introduction to Quantum Materials

Course Code: 241EC105

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain the fundamental concepts of band theory and electronic structure in solids.
- CO2** Analyze correlated systems and magnetic phenomena using basic experimental and theoretical principles.
- CO3** Explain the principles of superconductivity and the operation of superconducting devices.
- CO4** Analyze the electronic and optical properties of two-dimensional materials such as graphene and TMDCs.
- CO5** Explain topological phases of matter and assess material growth techniques relevant to quantum technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	2		2							2
CO4	3	3		2	2				2		2
CO5	2	2		2	2	2			2		2

Course Content and syllabus:

- Band theory basics
 - Metals, Semiconductors and Insulators
 - Band structure of solids
 - Survey of semiconducting devices for quantum technologies (electronic, quantum optical devices and principle of operation)
- Correlated systems
- Magnetism
 - Para, ferro magnetism basics
 - Magnetic measurements, hall effect, magnetoresistance
 - Faraday and Kerr effects
- Superconductivity
 - BCS theory
 - Ginzburg Landau
 - Josephson Effect – AC and DC Josephson effects
 - Survey of superconducting devices for quantum technologies
- 2D materials

- Graphene and its properties – single and few layers
- Transition Metal Dichalcogenides – Electronic and Optical Properties
- Topological Phases of matter
 - Basics of Topology
 - Geometric phases - Berry Phase
 - Aharonov Bohm effect
 - Topological phases of matter
- Survey of material growth techniques
 - Molecular beam epitaxy
 - Chemical vapor deposition, MOVPE
 - Pulsed laser deposition, etc.
 - Crystal growth techniques

Course References:

1. Condensed Matter Physics , M P Marder, 2nd Edition, John Wiley and Sons, 2010
2. Introduction to Superconductivity, Michael Tinkham, standard ed., Medtech, (2017)

Engineering Foundations of Quantum Technologies

Course Code: 241EC106

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Apply principles of electrical networks and transmission lines to analyze resonant circuits and signal propagation.
- CO2** Explain abstract models of computation and analyze algorithmic complexity using classical computation theory.
- CO3** Analyze analog and digital communication techniques with respect to modulation, noise, and information capacity.
- CO4** Apply noise analysis and signal conditioning principles to evaluate system performance and quantum noise limits.
- CO5** Explain cryptographic principles and analyze classical and post-quantum cryptographic protocols.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2		2						2
CO2	3	3									2
CO3	3	3		2	2			2			2
CO4	3	3		2	2						2
CO5	2	3			2	2		2			2

Course Content and syllabus:

- Electrical Networks (4 hours)
 - Analog RLC circuits – resonances, impedances, quality factors
 - Transmission line basics (2 hours)
 - Telegrapher equations, wave impedance, impedance matching, transmission line resonators
- Computer Science (15 hours)
 - Basics of computer architecture (1 hour)
- Arithmetic Logic Unit
- Memory
 - Abstract models of computation (12 hours)
 - Finite State Machine
 - Turing Machines
 - Overview of Hierarchy of languages – Regular, Context-Free, Turing Decidable and Turing Recognisable
 - Complexity Theory (2 hours)
 - Time and Space complexity
 - P vs NP, NP-completeness
- Electrical Communications (1 hour)

- Analog Communications (1 hour)
 - Quadrature amplitude modulation
 - Heterodyne and Homodyne demodulation
- Noise and Signals (6 hours)
 - Characterising Noise
 - Types of Noise
 - Shot Noise
 - Johnson-Nyquist Noise
 - Telegraphic noise or flicker or $1/f$ noise
- Signal conditioning and noise mitigation
- Amplification and Added Noise
 - Linear Amplifier theory
 - Signal-Noise Ratio, Added Noise, Noise Figure of amplification
 - Dynamic Range
 - Noise temperature
 - Quantum limits on noise in linear amplifiers
- Digital Communications (4 hours)
 - Information entropy
 - Noiseless channel encoding
 - Noisy channel encoding
- Basics of cryptography (6 hours)
 - Basics of Number Theory
 - Random Number Generation
 - One time pad, Private key, public key, symmetric and asymmetric cryptography protocols
 - RSA and DH
 - Post Quantum Cryptography (PQC)

Course References:

1. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
2. Digital Design, Morris Mano, Michael D. Ciletti, 6th edition, Pearson Education (2018)
3. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
4. Information Theory, Robert B. Ash, Dover Publications (2003)
5. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014)
6. Protecting Information – From Classical error correction to quantum cryptography, Susan Loepp and William K. Wootters, Cambridge University Press (2006)

Solid State Physics for Quantum Technologies

Course Code: 241EC107

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain crystal structures, symmetry, diffraction principles, and bonding mechanisms in solids.
- CO2** Analyze electronic properties of solids using free-electron, band theory, and tight-binding models.
- CO3** Analyze lattice vibrations and phonon dynamics to explain vibrational and thermal properties of solids.
- CO4** Explain and analyze magnetic phenomena in solids using classical and quantum models.
- CO5** Explain superconducting phenomena and analyze superconducting materials and devices relevant to quantum technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	3		2							2
CO4	3	2		2							2
CO5	3	3		2	2	2					2

Course Content and syllabus:

- Structure of solids –
 - Symmetry, Bravais lattices
 - Laue equations and Bragg's law,
 - Brillouin Zones
 - Atomic scattering and structure factors.
- Characterisation of crystal structures – XRD etc.
- Bonding in solids –
 - van der Waals and Repulsive interactions,
 - Lennard Jones potential,
 - Madelung constant
- The Drude theory of metals –
 - DC & AC electrical conductivity of a metal;
 - Hall effect & magnetoresistance,
 - Density of states, Fermi-Dirac distribution, Specific heat of degenerate electron gases
 - Free electron model
- Beyond the Free electron model
 - Kronig-Penney Model

- Periodic potential – Bloch Theorem
- Band theory
- Tight binding model
- Phonons in Solids
 - One dimensional monoatomic and diatomic chains
 - Normal modes and Phonons
 - Phonon spectrum
 - Long wavelength acoustic phonons and elastic constants
 - Vibrational Properties- normal modes, acoustic and optical phonons.
- Magnetism
 - Dia-, Para-, and Ferromagnetism
 - Langevin's theory of paramagnetism
 - Weiss Molecular theory
- Superconductivity:
 - Phenomenological description – Zero resistance, Meissner effect
 - London Theory
 - BCS theory
 - Ginzburg-Landau Theory
 - Type-I and type-II superconductors
 - Flux quantization
 - Josephson effect.
 - High T_c superconductivity

Course References:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition (2019)
2. Condensed Matter Physics, M P Marder, 2nd Edition, John Wiley and Sons (2010)
3. Introduction to Superconductivity, Michael Tinkham, standard edition, Medtech (2017)

Quantum Optics

Course Code: 241EC108

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1** Explain the quantization of the electromagnetic field and the properties of non-classical states of light.
- CO2** Analyze optical coherence phenomena and interferometric techniques using quantum optical principles.
- CO3** Analyze phase-space representations of quantum states of light to identify non-classical features.
- CO4** Analyze classical, semi-classical, and quantum models of light-matter interaction in atomic systems.
- CO5** Apply open quantum system models to describe decoherence and dissipation in quantum optical systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2					1		2
CO3	3	3		2					1		2
CO4	3	3		2	2				1		2
CO5	3	3		2	2				1		2

Course Content and syllabus:

- Quantization of the electromagnetic field
 - Number states, coherent states, squeezed states
 - Hanbury-Brown and Twiss experiments – Photon bunching, Photon anti bunching
 - Hong-Ou-Mandel interference
- Theory of Optical coherence
 - Young's double slit experiment and first order coherence
 - Coherence functions of arbitrary order
 - Normal ordering, symmetric ordering and anti-normal ordering of operators Interferometry
- Phase-space representations of states of light
 - Wigner distribution
 - P-function and the notion of non-classicality with some examples of nonclassical states like squeezed states and their applications
 - Husimi Q function
- Light-matter interaction
 - Classical model of light-matter interaction

- Semi-classical model of light-matter interaction-
- Quantum light-matter interaction
- Rabi Model
- Jayne's-cummings model
- Open quantum systems
 - Fermi golden rule
 - Born-Markov Lindblad Master Equation

Course References:

1. Introductory Quantum Optics, Christopher Gerry and Peter Knight, Cambridge University Press (2004)
2. Quantum Optics, D. F. Walls, Gerard J. Milburn, 2nd Edition, Springer (2008)
3. Quantum Optics: An introduction, Mark Fox, Oxford University Publishers (2006)
4. Quantum Optics for Beginners, Z. Ficek and M. R. Wahiddin, 1st edition, Jenny Stanford Publishing (2014)