

B. TECH. FOUR YEAR DEGREE

PROGRAM CURRICULUM

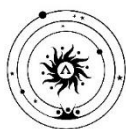
(Applicable for the batches admitted from A.Y 2025-26)

**ELECTRICAL & ELECTRONICS
ENGINEERING**



A D I T Y A
U N I V E R S I T Y

Aditya Nagar, ADB Road, Surampalem - 533 437



ADITYA UNIVERSITY

Department of EEE

Vision

To become a global leader in Electrical Engineering with innovation for sustainable development.

Mission

M1: Impart quality education and entrepreneur skills through cutting-edge technologies.

M2: Encourage innovation, interdisciplinary collaboration, and industry engagement.

M3: Promote ethics, social responsibility, and environmental awareness.

Graduates of the B.Tech. (Electrical and Electronics Engineering) will

PEO 1: Excel as professionals with leadership in industry, academia, and research.

PEO 2: Adapt emerging technologies to design complex systems with innovation.

PEO 3: Pursue lifelong learning with integrity, professionalism, and sustainability.

At the end of the program the students will be able to:

PSO 1: Apply power electronics for efficient energy conversion and automation.

PSO 2: Design and manage reliable, sustainable power systems.

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 of Electrical and Electronics Engineering

B. Tech (EEE) Program Curriculum – 2025 (Applicable for the students admitted from the A.Y. 2025-26)

UG Program Offered

- B.Tech in (Electrical and Electronics Engineering)
- B.Tech in (Electrical and Electronics Engineering) with
 - Minor Degree in Civil Engineering
 - Minor Degree in Mechanical Engineering
 - Minor Degree in Electronics and Communication Engineering
 - Minor Degree in Computer Science and Engineering
 - Minor Degree in Data Science
 - Minor Degree in Artificial Intelligence and Machine Learning
 - Minor Degree in Petroleum Engineering
 - Minor Degree in Mining Engineering
 - Minor Degree in Agricultural Engineering
 - Minor Degree in Entrepreneurship Development and Incubation
 - Minor Degree in Quantum Technologies

Minor Streams offered in B.Tech (Electrical and Electronics Engineering)

- Minor Stream in Intelligent and Integrated Power Systems
- Minor Stream in Power Electronics and Energy Systems
- Minor Stream in Advanced Specialization on Electric Vehicles (Industry Integrated Program- L & T)
- Minor Stream in Design of Electrical System for Smart Buildings (Industry Integrated Program- L & T)

Credit Division Category Wise

S.No	Broad Category of Course	UGC	Credits
1	Major Core Courses (MCC)	80	81
2	Minor Stream Courses (MSC) (or) University Open Elective Courses (UEC)	32	32
3	Multidisciplinary Courses (MDC)	09	10
4	Ability Enhancement Courses (AEC)	08	09
5	Skill Enhancement Courses (SEC)	09	08
6	Value Added Courses (VAC)	06-08	04
7	Summer Internships (SI)	02 - 04	04
8	Full Semester Internship (PROJ)	12	12
9	Mandatory Courses (MC)		-
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
2501MA01	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
2501CH02	Applied Chemistry	FC	2		1	3	50	50	100	-
2501ME01	Engineering Graphics	FC	1		2	3	50	50	100	-
2501ME03	Engineering Workshop	FC			1	1	100	-	100	-
2501PH02	Modern Physics	FC	2		1	3	50	50	100	-
2501MA02	Differential Equations & Vector Calculus	FC	2	1		3	50	50	100	-
2501EE02	Electromagnetic Theory	FC	2	1		3	50	50	100	-
2501EE03	Electrical Network Analysis-I	FC	2		2	4	50	50	100	-
2501MA05	Numerical Methods & Integral Transforms	IC	2	1		3	50	50	100	DEVC
2501EE04	DC Machines & Transformers	IC	2		2	4	50	50	100	ENA-I
2501EE05	Electrical Network Analysis-II	IC	2		2	4	50	50	100	ENA-I
2501MA06	Complex Variables & Statistical Methods	IC	2	1		3	50	50	100	LAC
2501EE06	Electric Power Generation & Distribution Systems	IC	2			2	50	50	100	ENA-I/BEEE
2501EE07	Induction & Synchronous Machines	IC	2		2	4	50	50	100	EMT
2501EE08	Analog Electronic Circuits	IC	2	1	1	4	50	50	100	-
2501EC01	Digital Electronics & Logic Design	IC	2		2	4	50	50	100	-
2501EE09	Microprocessor & Interfacing	IC	2	1	1	4	50	50	100	DELD
2501EE10	Power Electronics	IC	2	1	1	4	50	50	100	-
2501EE11	Control Engineering	IC	2		2	4	50	50	100	-
2501EE12	Electric Power Transmission Systems	IC	2	1		3	50	50	100	EPGDS

2501EE13	Electrical Measurements & Instrumentation	IC	2	1	1	4	50	50	100	-
2501EE14	Power System Analysis	AC	2		2	4	50	50	100	EPTS
2501EE39	Energy converters	AC	2	1		3	50	50	100	PE
2501EE16	Power System Operation & Control	AC	2		2	4	50	50	100	PSA
Total			45	11	25	81				

Multidisciplinary Courses (MDC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS01	Programming for Problem Solving Using C	FC	2		2	4	50	50	100	-
2501CS03	Data Structures	IC	2		2	4	50	50	100	PPSC
2501MB01	Engineering Economics & Management	IC	2			2	50	50	100	-
Total			06		04	10				

Ability Enhancement Courses (AEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EN01	Essential Cognitive skills for Engineers	FC			1	1	100	-	100	-
2501EN02	Advanced Cognitive Skills for Engineers (or) Proficiency in Sanskrit / Hindi / Foreign language (Japanese/German/Spanish/ French)	FC			1	1	100	-	100	-
2501UC01										
2501UC02										
2501UC05										
2501UC04										
2501UC06										
2501UC07	Design Thinking using AI	FC			1	1	100	-	100	
2501UC08	Universal Human Values	FC	2			2	50	50	100	
2501UC09	Technical Paper Publication	AC			2	2	100	-	100	-

2501EE57	Student Activity Based Learning	AC				2	100	-	100	-
	Total		02		05	09				

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501IT01	Business Intelligence Lab	FC			2	2	50	50	100	-
2501EE17	Smart Technology & Applications Lab	IC			2	2	50	50	100	-
2501CS05	Machine Learning with Python	IC			2	2	50	50	100	-
2501EE18	Intelligent Algorithms for Power Systems	AC			2	2	50	50	100	-
	Total				08	08				

Value Added Courses (VAC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS04	Internet of Things	FC			1	1	100	-	100	-
2501UC11	Employability skills -1	FC			3	0	100	-	100	-
2501UC13	Employability skills -2	FC			3	0	100	-	100	ES-1
2501CS02	Data Analysis Using Python	IC			2	2	50	50	100	PPSC
2501UC14	Employability skills -3	IC			3	0	100	-	100	ES-2
2501UC15	Employability skills -4	IC			3	0	100	-	100	ES-3
2501UC16	Employability skills -5	AC			3	1	100	-	100	ES-4
2501AC06	Advanced Data Structures & Algorithm	AC	2		1	0	100	-	100	DS
	Total		2		19	04				

Summer Internships (SI)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE19	Summer Internship-I	IC			2	2	100	-	100	-
2501EE20	Summer Internship-II	AC			2	2	100	-	100	-
	Total				04	04				

Full Semester Internship (PROJ)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE21	Full Semester Internship	AC			12	12	50	50	100	-
	Total				12	12				

Mandatory Courses (MC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501AC01	Environmental Science	FC	2			0	100	-	100	-
2501AC02	Constitution of India	FC	2			0	100	-	100	-
2501AC03	Research Methodology	FC	2			0	100	-	100	-
2501AC04	Intellectual Property Rights & Patents	FC	2			0	100	-	100	-
2501AC05	Indian Knowledge Systems	FC	2			0	100	-	100	-
	Total		10			0				

Minor Stream Courses: Intelligent and Integrated Power Systems

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE22	Electrical Machine Design	FC	3			3	50	50	100	-
2501EE27	Utilization of Electrical Energy	FC	3			3	50	50	100	DCMT
2501EE24	Electrical Distribution System	IC	2	1		3	50	50	100	EPGDS
2501EE26	HVDC Transmission	IC	3			3	50	50	100	PE
2501EE30	Methods & Algorithms for Intelligent Control	IC	2	1		3	50	50	100	-
2501EE23	High Voltage Engineering	IC	3			3	50	50	100	EPTS
2501EE28	Restructured Power Systems	AC	3			3	50	50	100	EPTS
2501EE31	Advance Control Systems	AC	2	1		3	50	50	100	CE
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
2501EE25	Flexible Alternating Current Transmission Systems	AC	3			3	50	50	100	PE
2501EE29	Soft Computing Techniques in Power Systems	AC	2		1	3	50	50	100	PSA
	Total		28	3	1	32				

Minor Stream Courses: Power Electronics and Energy Systems

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE22	Electrical Machine Design	FC	3			3	50	50	100	-
2501EE34	Alternative Energy Sources	FC	3			3	50	50	100	-
2501EE27	Utilization of Electrical Energy	FC	3			3	50	50	100	DCMT
2501EE35	Special Electrical Machines	IC	2	1		3	50	50	100	ISM
2501EE36	Electric Energy Storage Systems	IC	3			3	50	50	100	AES
2501EE38	Digital Control Systems	AC	2	1		3	50	50	100	CE
2501EE15	Switch Gear & Protection	AC	3			3	50	50	100	EPTS
2501EE33	Energy Audit, Conservation & Management	AC	2	1		3	50	50	100	EPGDS
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
2501EE40	Power Quality	AC	3			3	50	50	100	EPGDS
2501EE37	Hybrid Electric Vehicles	AC	3			3	50	50	100	PE
Total			29	3		32				

Minor Stream Courses: Advanced Specialization on Electric Vehicles (Industry Integrated Program- L & T)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE43	Electrical safety	FC	3			3	50	50	100	-
2501EE47	Finance for Professionals	FC	3			3	50	50	100	
2501EE41	Foundations of EV & Hybrid Vehicles	FC	3			3	50	50	100	PE
2501EE35	Special Electrical Machines	IC	2	1		3	50	50	100	ISM
2501EE44	EV Power Electronics & Embedded Systems	IC	3			3	50	50	100	EVBT
2501EE42	EV Battery Technology & Power train Development	IC	3			3	50	50	100	PE
2501EE45	EV Design & Analysis	IC	3			3	50	50	100	
2501EE33	Energy Audit, Conservation & Management	AC	2	1		3	50	50	100	EPGDS
2501ME43	EV Charging Infrastructure, Vehicle Testing & Homologation	AC	3			3	50	50	100	-
2501EE46	EV PCB Design & Data Analytics	AC	3			3	50	50	100	
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
Total			30	2		32				

Minor Stream Courses: Design of Electrical System for Smart Buildings (Industry Integrated Program- L & T)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE43	Electrical safety	FC	3			3	50	50	100	-
2501EE47	Finance for Professionals	FC	3			3	50	50	100	
2501EC65	Applied Industrial IoT	FC	3			3	50	50	100	IOT
2501EE48	Electrical Power Distribution & Automation	IC	3			3	50	50	100	EPGDS
2501EE35	Special Electrical Machines	IC	2	1		3	50	50	100	ISM
2501EE49	Integrated Approach to Building Services	IC	3			3	50	50	100	-
2501EE33	Energy Audit, Conservation & Management	AC	2	1		3	50	50	100	EPGDS
2501EE50	Building Information Modelling	AC	3			3	50	50	100	-
2501EE51	Advanced Electrical System Design for Builders	AC	3			3	50	50	100	
2501EE52	Extra Low Voltage System Design for Buildings	AC	3			3	50	50	100	
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
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	CIE	SE E	Total	Offered to Programs	Pre-requisite
2501AI02	Artificial Intelligence	FC	2		1	3	50	50	100	CE,EEE, ME, ECE, PT,Min.E	DAP
2501AI05	Machine Learning	FC	2		2	4	50	50	100	CE,EEE, ME, ECE, PT,Min.E	DAP
2501AI27	AI & Data Science	IC	2		1	3	50	50	100	CE,EEE, ME, ECE, PT,Min.E	DAP
2501AI28	AI in Healthcare	IC	2		1	3	50	50	100	CE,EEE, ME, ECE,CSE, IT, AIML,CS E (DS) PT,Min.E	DAP
2501AI11	Deep Learning	IC	2		2	4	50	50	100	CE,EEE, ME, ECE, PT,Min.E	DAP
2501AI10	Natural Language Processing	IC	2		1	3	50	50	100	CE,EEE, ME, ECE, PT,Min.E	DAP
2501AI09	Reinforcement Learning	AC	1		2	3	50	50	100	CE,EEE, ME, ECE, PT,Min.E	DAP
2501AI29	AI in Agriculture	AC	2		1	3	50	50	100	CE,EEE, ME, ECE,CSE, IT, AIML,CS E(DS) PT,Min.E	DAP
2501AI30	Robotics & AI	AC	2		1	3	50	50	100	CE,EEE, ME, ECE,CSE, IT, AIML,CS E(DS) PT,Min.E	DAP

2501AI31	AI in Finance & Economics	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CS E(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
2501ME81	Fundamentals of Production Excellence	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
2501ME82	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
2501ME83	Quality Excellence in Production	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME84	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
2501ME85	Agile Production Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME86	Process Excellence & Optimization	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME87	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

2501ME88	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
2501ME89	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
2501ME58	Industry 5.0 for Engineers	AC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
2501ME90	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	SE	Total	Offered to Programs	Pre-requisite
2501MB17	Introduction to Supply Chain Management	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
2501MB18	Logistics & Distribution Management	FC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB19	Supply Chain Project Management	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB20	Supply Chain Innovation & Trends	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM

2501MB21	Supply Chain Analytics	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB22	Demand Planning & Forecasting	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB23	Supply Chain Risk Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB24	Inventory Management & Control	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB25	E-Commerce & Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB26	Operations Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB27	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
2501CE74	Introduction to Sustainable Development	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-

2501CE66	Natural Disaster Management & Mitigation	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE81	Waste Water Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE82	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	-
2501CE83	Watershed Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EE33	Energy Audit, Conservation & Management	IC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE53	Electric Power Generation, Transmission & Distribution Systems	AC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501CE75	Sustainable Agriculture & Food Systems	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE76	Sustainable Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE77	Sustainable Production Excellence	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE78	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

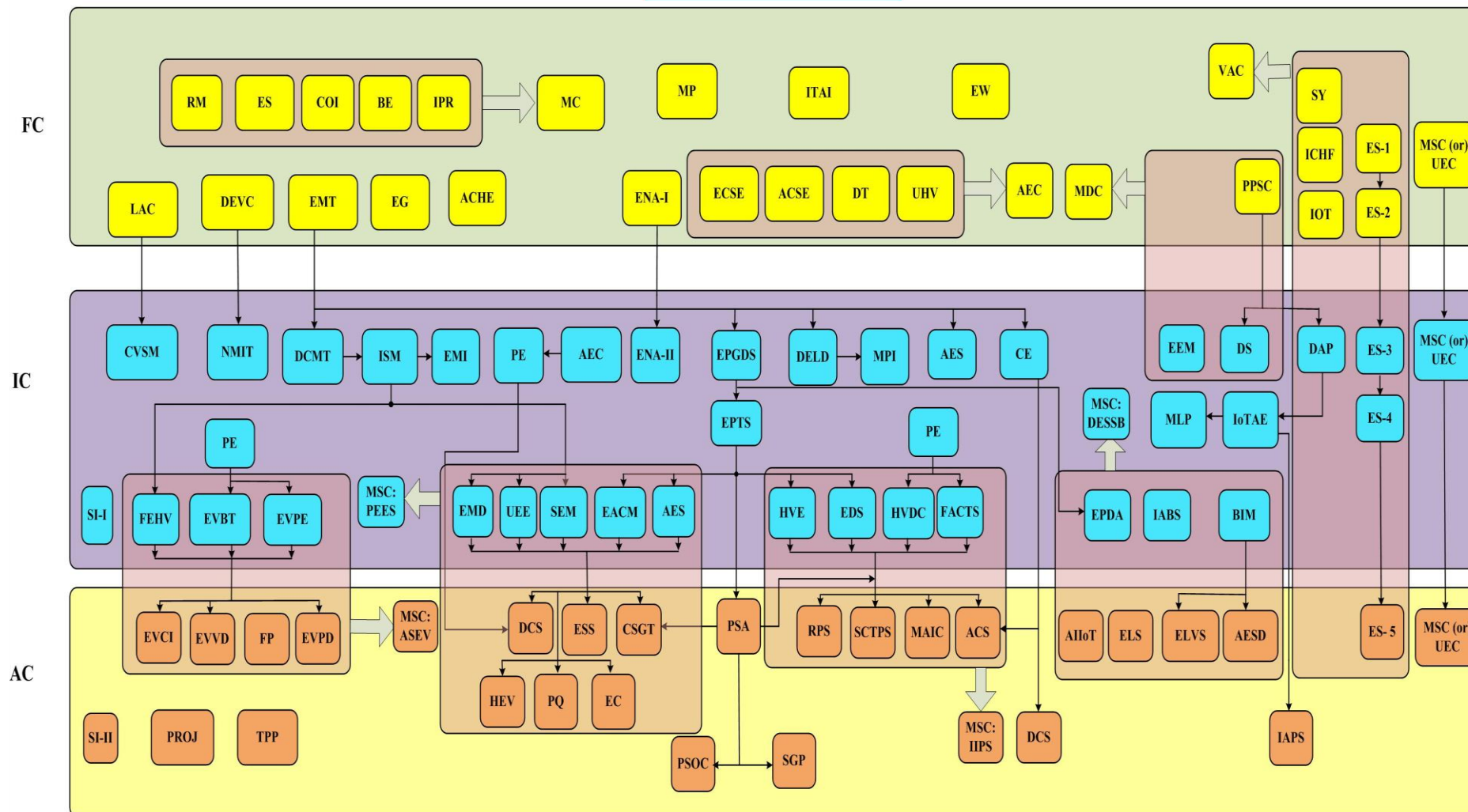
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
2501CS32	Cybersecurity Essentials	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT35	Security in Software Development	FC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS28	Ethical Hacking	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS69	Cloud Security	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT36	Security & Compliance in Business	IC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT37	Cryptography & Data Security	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT38	Security Awareness & Social Engineering	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT39	Cybersecurity Policy & Strategy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT40	Security in Emerging Technologies	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS30	Information Security Analysis & Audit	AC	2			2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT41	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
2501CE80	Remote Sensing & GIS Applications	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EE36	Electric Energy Storage Systems	FC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE43	Electrical safety	IC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE54	Hybrid & Electric Vehicles	IC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501ME73	Organizational Behaviour	FC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME36	Sustainable Energy Systems	FC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME37	Solar Energy Systems	FC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME60	Composite Materials	IC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	SSP/M P
2501EC82	Communication Systems	FC	3			3	50	50	100	CE,EEE,ME,C SE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC83	Electronic Measurements & Instrumentation	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EC84	Introduction to Embedded Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC85	Fundamentals of Image Processing	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	

2501EC77	Sensors and Transducers	IC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
2501CS03	Data Structures	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS65	Computer Organization	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS13	Operating Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT05	Database Management Systems	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS07	Computer Networks	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT06	Java Programming	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS68	Fundamentals of RedHat Enterprise Linux	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS67	AWS Cloud Foundations	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS66	AWS Cloud Development	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS70	Continuous integration & delivery using DevOps	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT24	Fundamentals of Salesforce Administration	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT34	Advanced Salesforce Administration	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT23	Principles of Pega Systems	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT26	Pega System Architecture & Design	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501MB04	Entrepreneurship Development & Incubation	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-

2501MB05	Business Ethics & Corporate Governance	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501MB06	Entrepreneurship Development & Business Management	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC29	SoC Design	AC	3			3	50	50	100	CE, EEE, ME, CSE, IT, AIML, CSE (DS), PT, Min.E.	MPMC
2501CS23	Cloud Computing	FC	2		2	4	50	50	100	CE, EEE, ME, ECE, PT, Min.E.	-

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



FC: Foundation Courses

LAC	: Linear Algebra & Calculus	ACHE	: Applied Chemistry	EMT	: Electromagnetic Theory
MP	: Modern Physics	DEVC	: Differential Equations & Vector Calculus	EW	: Engineering Workshop
ENA-I	: Electrical Network Analysis-I	EG	: Engineering Graphics		

SEC: Skill Enhancement Courses

BIL	: Business Intelligence Lab	MLP	: Machine Learning with Python	IoTAE	: IoT Applications of Electrical Engineering
IAPS	: Intelligent Algorithms for Power Systems				

AEC: Ability Enhancement Courses

ECSE	: Essential Cognitive Skills for Engineers	ACSE	: Advanced Cognitive skills for Engineers	DT	: Design Thinking using AI
				UHV	: Universal Human Values

VAC: Value Added Courses

ICHF	: Indian Cultural Heritage & Fine Arts	SY	: Sports & Yoga	IOT	: Internet of Things
ES-2	: Employability Skills - 2	DAP	: Data Analysis Using Python	ES-1	: Employability Skills - 1
ES-5	: Employability Skills - 5	ES-3	: Employability Skills - 3	ES-4	: Employability Skills - 4

MC: Mandatory Courses

ES	: Environmental Science	COI	: Constitution of India	IPR	: Intellectual Property Rights & Patents
RM	: Research Methodology	BE	: Biology for Engineers		

MDC: Multidisciplinary Courses

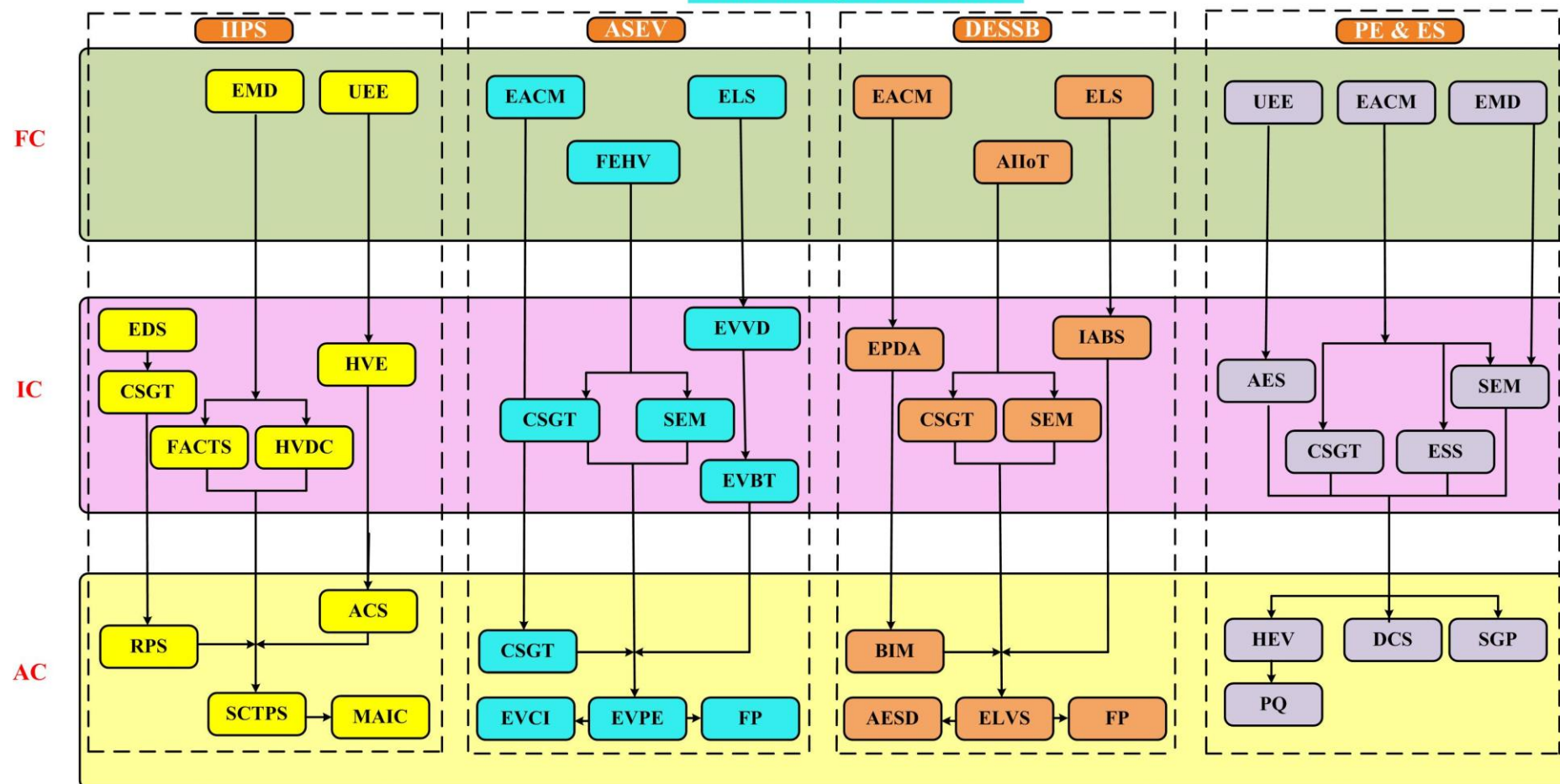
PPSC	: Programming for Problem Solving Using C	DS	: Data Structures	EEM	: Engineering Economics & Management

IC: Intermediate-level courses

ISM	: Induction Synchronous Machines	CVSM	: Complex Variables & Statistical Methods	NMIT	: Numerical Methods & Integral Transforms
DCMT	: DC Machines & Transformers	PE	: Power Electronics	AEC	: Analog Electronic Circuits
ENA-II	: Electrical Network Analysis-II	CE	: Control Engineering	SI-I	: Summer Internship-I

EMI	: Electrical Measurements & Instrumentation	EPGDS	: Electric Power Generation & Distribution Systems	EPTS	: Electric Power Transmission Systems
DELD	: Digital Electronics & Logic Design	MPI	: Microprocessor & Interfacing		
AC: Advanced Courses					
PSA	: Power System Analysis	EC	: Energy Converters	TPP	: Technical Paper Publication
PSOC	: Power System Operation & Control	SI-II	: Summer Internship-II	PROJ	: Full Semester Internship
SABL	: Student Activity Based Learning				

**2024 B.Tech. EEE Curriculum
Minor Prerequisite Flowchart**



MSC: Minor Stream Courses

IIPS: Intelligent and Integrated Power Systems

HVE:	: High Voltage Engineering	EDS	: Electrical Distribution System	HVDC	: HVDC Transmission
FACTS	: Flexible Alternating Current Transmission Systems	SCTPS	: Soft Computing Techniques in Power Systems	MAIC	: Methods & Algorithms for Intelligent Control
RPS	: Restructured Power Systems	EMD	: Electrical Machine Design	ACS	: Advance Control Systems

PEES: Power Electronics and Energy Systems

EACM	: Energy Audit, Conservation & Management	CSGT	: Concept of Smart Grid Technology	UEE	: Utilization of Electrical Energy
SEM	: Special Electrical Machines	ESS	: Electric Energy Storage Systems	AES	: Alternative Energy Sources
DCS	: Digital Control Systems	PQ	: Power Quality	HEV	: Hybrid Electric Vehicles
				SGP	: Switch Gear & Protection

ASEV: Advanced Specialization on Electric Vehicles

FEHV	: Foundations of EV & Hybrid Vehicles	EVBT	: EV Battery Technology & Powertrain Development	ELS	: Electrical Safety
EVPD	: EV PCB Design & Data Analytics	EVPE	: EV Power Electronics & Embedded Systems	EVCI	: EV Charging Infrastructure, Vehicle Testing & Homologation
EVVD	: EV Design & Analysis	FP	: Finance for Professionals		

DESSB: Design of Electrical System for Smart Buildings

EPDA	: Electrical Power Distribution & Automation	IABS	: Integrated Approach to Building Services	BIM	: Building Information Modelling
ELVS	: Extra Low Voltage System Design for Buildings	AESD	: Advanced Electrical System Design for Builders	AIIoT	: Applied Industrial IoT

Suggestive Semester-wise Curriculum

I SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501MA01	Linear Algebra & Calculus	MCC	FC	2	1		3	3
2501PH02	Modern Physics	MCC	FC	2		1	3	4
2501ME01	Engineering Graphics	MCC	FC	1		2	3	5
2501CS01	Programming for Problem Solving Using C	MDC	FC	2		2	4	6
2501UC08	Universal Human Values	AEC	FC	2			2	2
2501EN01	Essential Cognitive Skills for Engineer	AEC	FC			1	1	2
2501IT01	Business Intelligence Lab	SEC	FC			2	2	4
2501ME03	Engineering Workshop	MCC	FC			1	1	2
	Total			09	01	09	19	26

II SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501EE03	Electrical Network Analysis-I	MCC	FC	2		2	4	6
2501MA02	Differential Equations & Vector Calculus	MCC	FC	2	1		3	3
2501CH02	Applied Chemistry	MCC	FC	2		1	3	4
2501CS03	Data Structures	MDC	IC	2		2	4	6
2501MB01	Engineering Economics & Management	MDC	IC	2			2	2
2501EC01	Digital Electronics & Logic Design	MCC	IC	2		2	4	6
2501UC07	Design Thinking using AI	AEC	FC			1	1	2
2501EN02	Advanced Cognitive Skills for Engineers	AEC	FC			1	1	2
2501UC11	Employability skills -I	VAC	FC			3	0	3
2501AC01	Environmental Science	MC	FC	2			0	2
	Total			14	01	12	22	36

III SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501MA05	Numerical Methods & Integral Transforms	MCC	IC	2	1		3	3
2501EE04	DC Machines & Transformers	MCC	IC	2		2	4	6
2501EE02	Electromagnetic Theory	MCC	FC	2	1		3	3
2501EE05	Electrical Network Analysis-II	MCC	IC	2		2	4	6
2501EE08	Analog Electronic Circuits	MCC	IC	2	1	1	4	5
	Minor Stream Course –1/ University Elective Course – 1	MSC/UEC	FC/IC	3			3	3
2501CS04	Internet of Things	VAC	FC			1	1	2
2501UC13	Employability skills -2	VAC	FC			3	0	3
2501AC06	Advanced Data Structures & Algorithm	VAC	AC	2		1	0	4
2501AC02	Constitution of India	MC	FC	2			0	2
	Total			17	02	12	22	40

IV SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501MA06	Complex Variables & Statistical Methods	MCC	IC	2	1		3	3
2501EE06	Electric Power Generation & Distribution Systems	MCC	IC	2			2	2
2501EE07	Induction & Synchronous Machines	MCC	IC	2		2	4	6
2501EE10	Power Electronics	MCC	IC	2	1	1	4	5
	Minor Stream Course –2/University Elective Course – 2	MSC/ UEC	IC/AC	3			3	3
2501CS02	Data Analysis Using Python	VAC	IC			2	2	4
2501UC14	Employability skills -3	VAC	IC			3	0	3
2501AC03	Research Methodology	MC	FC	2			0	2
	Total			13	02	9	18	30

V SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501EE11	Control Engineering	MCC	IC	2		2	4	6
2501EE13	Electrical Measurements & Instrumentation	MCC	IC	2	1	1	4	5
	Minor Stream Course – 3/ University Elective Course –3	MSC/ UEC	IC	2	1		3	3
	Minor Stream Course – 4 /University Elective Course –4	MSC/ UEC	IC	3			3	3
	Minor Stream Course – 5/University Elective Course –5	MSC/ UEC	FC/IC	3			3	3
2501EE17	Smart Technology & Applications Lab	SEC	IC			2	2	4
2501UC15	Employability skills -4	VAC	IC			3	0	3
2501EE19	Summer Internship-I	SI	IC			2	2	4
2501AC04	Intellectual Property Rights & Patents	MC	FC	2			0	2
	Total			15	01	10	21	33

VI SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501EE09	Microprocessor & Interfacing	MCC	IC	2	1	1	4	5
2501EE12	Electric Power Transmission Systems	MCC	IC	2	1		3	3
2501EE14	Power System Analysis	MCC	AC	2		2	4	6
2501CS05	Machine Learning with Python	SEC	IC			2	2	4
2501UC16	Employability skills -5	VAC	AC			3	1	3
2501AC05	Indian Knowledge Systems	MC	FC	2			0	2
	Minor Stream Course – 6/ University Elective Course – 6	MSC/ UEC	IC/AC	3			3	3
	Minor Stream Course – 7/ University Elective Course – 7	MSC/ UEC	IC/AC	3			3	3
	Minor Stream Course – 8/ University Elective Course –8	MSC/ UEC	IC/AC	3			3	3
	Total			17	02	8	23	29

VII SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501EE39	Energy converters	MCC	AC	2	1		3	3
2501EE16	Power System Operation & Control	MCC	AC	2		2	4	6
	Minor Stream Course – 9/ University Elective Course –9	MSC/ UEC	AC	2			2	2
	Minor Stream Course – 10/ University Elective Course - 10	MSC/ UEC	AC	3			3	3
	Minor Stream Course – 11/ University Elective Course –11	MSC/ UEC	AC	3			3	3
2501EE18	Intelligent Algorithms for Power Systems	SEC	AC			2	2	4
2501EE20	Summer Internship-II	SI	AC			2	2	4
	Total			12	01	6	19	25

VIII SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501UC09	Technical Paper Publication	AEC	AC			2	2	4
2501EE21	Full Semester Internship/Project	PROJ	AC			12	12	24
2501EE57	Student Activity-Based Learning		AC				2	4
	Total					16	16	32

Total Credit: 160.

Minor Degree in Electrical and Electronics Engineering
(offered to other branches students)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE55	Operation & Control of Electric Machines	FC	2			2	50	50	100	BEEE
2501EE56	Fundamentals of Power Electronics	FC	2			2	50	50	100	BEEE
2501EE13	Electrical Measurements & Instrumentation	FC	2	1	1	4	50	50	100	ENA-1/BEEE
2501EE53	Electric Power Generation, Transmission & Distribution Systems	IC	3			3	50	50	100	ENA-1/BEEE
2501EE34	Alternative Energy Sources (or)	IC	3			3	50	50	100	EPGDS / BEEE/ISM
2501EE27	Utilization of Electrical Energy									
2501EE37	Hybrid Electric Vehicles (or)	AC	3			3	50	50	100	FPE/OCCEM
2501EE35	Special Electric machines									
2501EE43	Electrical Safety (or)	AC	3			3	50	50	100	EPGDS/PSA
2501EE30	Methods & Algorithms for Intelligent Control									
	Total		18		2	20				

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	251EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	251EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	251EC099	Basic Programming Lab (or)	1	0	2	3	V
	251EC100	Basic Laboratory Course for Quantum Technologies					
4	251EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII
Any One course from the below							
5	251EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	251EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	251EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	251EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	251EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	251EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	251EC108	Quantum Optics	3	0	0	3	VII
12	251EC109	Quantum Cybersecurity	3	0	0	3	VII
13	251EC110	Quantum Machine Learning	3	0	0	3	VII
Total			18	0	0	18	

Major Core Courses (MCC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MA01	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
2501CH02	Applied Chemistry	FC	2		1	3	50	50	100	-
2501ME01	Engineering Graphics	FC	1		2	3	50	50	100	-
2501ME03	Engineering Workshop	FC			1	1	100	-	100	-
2501PH02	Modern Physics	FC	2		1	3	50	50	100	-
2501MA02	Differential Equations & Vector Calculus	FC	2	1		3	50	50	100	-
2501EE02	Electromagnetic Theory	FC	2	1		3	50	50	100	-
2501EE03	Electrical Network Analysis-I	FC	2		2	4	50	50	100	-
2501MA05	Numerical Methods & Integral Transforms	IC	2	1		3	50	50	100	DEVC
2501EE04	DC Machines & Transformers	IC	2		2	4	50	50	100	ENA-I
2501EE05	Electrical Network Analysis-II	IC	2		2	4	50	50	100	ENA-I
2501MA06	Complex Variables & Statistical Methods	IC	2	1		3	50	50	100	LAC
2501EE06	Electric Power Generation & Distribution Systems	IC	2			2	50	50	100	ENA-I/BEEE
2501EE07	Induction & Synchronous Machines	IC	2		2	4	50	50	100	EMT
2501EE08	Analog Electronic Circuits	IC	2	1	1	4	50	50	100	-
2501EC01	Digital Electronics & Logic Design	IC	2		2	4	50	50	100	-
2501EE09	Microprocessor & Interfacing	IC	2	1	1	4	50	50	100	DELD
2501EE10	Power Electronics	IC	2	1	1	4	50	50	100	-
2501EE11	Control Engineering	IC	2		2	4	50	50	100	-
2501EE12	Electric Power Transmission Systems	IC	2	1		3	50	50	100	EPGDS
2501EE13	Electrical Measurements & Instrumentation	IC	2	1	1	4	50	50	100	-

2501EE14	Power System Analysis	AC	2		2	4	50	50	100	EPTS
2501EE39	Energy converters	AC	2	1		3	50	50	100	PE
2501EE16	Power System Operation & Control	AC	2		2	4	50	50	100	PSA
	Total		45	11	25	81				

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

Course Code: 2501MA01

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 Mean value theorems for given 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			1						
CO2	3	2			1						
CO3	3	2			1						
CO4	3	2			1						
CO5	3	2			1						

UNIT – I

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 differentialand 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

Students are advised to use any computational / AI Tool like Wolfrum Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

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 Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 5th Edition, 2018.ISBN-13. 978-1292174341

Reference Books:

- 1 Advanced Engineering Mathematics, Michael Greenberg, Pearson publishers, 9th edition.ISBN-13. 9788177585469
- 2 Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd 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>

Applied Chemistry

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

	L	T	P	C
CourseCode:2501CH02	2	0	1	3

Course Outcomes:

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

- CO1:** Explain the fundamentals of polymers and explore engineering applications.
- CO2:** Interpret the principles and applications of Electrochemical cells.
- CO3:** Summarize the fundamentals of Computational Chemistry and its applications.
- CO4:** Illustrate the fundamentals of nano and 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 1: 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 2: Electrochemistry and Applications

Electro chemical cell, Nernst equation, cell potential calculations and numerical problems,

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. Conduct metric 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 3: Computational Chemistry

Computational Quantum Chemistry and its applications, Prediction of Molecular Properties using Computational Chemistry, Molecular Modeling and Structure - molecular modeling 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 4: Nano and Smart Materials

Introduction to nano materials 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)

Characterization of nanomaterials 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

Textbooks:

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

Reference Books:

1. Uppal M.M, Jain and Jain. Engineering Chemistry, Khanna Publishers, 35th Edition, 2013.(ISBN 978-817-409-2625)
2. Dr. S.S. Dara, Dr. S.S. Umare, A Textbook of Engineering Chemistry, S.Chand Publication 2022 .(978-935—283-6068)
3. Andrew R. Leach Molecular Modelling Principles and applications. (201) 11ed. PrenticeHall. (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/11810203>

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

Course Code: 2501ME01

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: 97881225015452.

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/97808108391/engineering-drawing-from-thebeginning>

Engineering Workshop
(Common to CE, EEE, ME, ECE, PT & Min.E)

Course Code: 2501ME03

L T P C
0 0 1 1

Course Outcomes:

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 cross lap 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:

- Work shop Manual , P.Kannaiah & K.L.Narayana SciTech Publishers, 2nd edition, ISBN: 978-8183711302.
- Elements of Workshop Technology, Vol I 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/>

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

Course Code:2501PH02

L	T	P	C
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 fibres 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

Semiconductors Introduction – Intrinsic semiconductors – density of charge carriers (Qualitative only) – Electrical conductivity –Fermi level - extrinsic semiconductors - P-type & N-type semiconductors-Density of charge carriers (Qualitative only) - Dependence of Fermi energy on carrier concentration and temperature–Hall effect-Hall coefficient - Applications of

Hall effect–Drift and Diffusion currents - Einstein’s equation

Semiconductor Devices Working of PN junction diode – Forward and reverse bias

Zener diode -Metal-Oxide-Semiconductor (MOS) structure- Capacitance-voltage characteristics- MOSFET structure - I–V characteristics.

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" Authur Beiser, Shobhit Mahajan and S Rai Choudhary, McGraw Hill (2017). ISBN: 9789351341857
2. "Engineering Physics" by M.R. Srinivasan, New Age international publishers (209). ISBN: 978-1848290501
3. "Optics" by Ajoy Ghatak, 6th Edition McGraw Hill Education, 2017. ISBN: 978-939113590

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>

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

Course Code:2501MA02
Course Outcomes:

L	T	P	C
2	1	0	3

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, Legendere'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.

Students are advised to use any computational / AI Tool like Wolfram Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

Text Books:

- 1 Advanced Engineering Mathematics, E. Kreyszig, John Wiley & Sons, 10th Ed., 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 Ed., 2017. 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/111/101/11111153/>
- 5 <https://archive.nptel.ac.in/courses/111/105/111105122/>

Electromagnetic Theory

Course Code:2501EE02

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1** Apply the laws of Electrostatics to calculate electric field intensity.
- CO2** Analyze the behaviour of conductors, dielectrics & capacitors.
- CO3** Apply the laws of Magneto-statics to calculate field intensity.
- CO4** Explain the Self & Mutual inductances & energy stored in the magnetic field using laws of magneto-statics.
- CO5** Analyze the concepts of Faraday's laws, displacement current & poynting vector.

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	2	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-
CO5	2	3	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

Review of Coordinate systems & vector calculus

Electrostatics : Coulomb's Law, Electric field intensity – Field due to the continuous line, surface, & volume charges - Electric flux density – Gauss Law , Maxwell's first law i.e., $\text{div}(\mathbf{D}) = \rho_v$, Potential & potential gradient, Electric Dipole, Laplace and Poisson's equations

UNIT – II

Electrostatic boundary conditions : Current and Current Density, Dipole moment, Behavior of conductors in an electric field – Conductors & Insulators. Polarization - Boundary conditions between conductor to dielectric & dielectric to dielectrics,

Capacitance of parallel plate & coaxial cable -Energy stored & energy density in a static electric field.

UNIT – III

Magnetostatics : Biot-Savart's law ,Magnetic field intensity. Magnetic scalar & vector potentials, Maxwell's second Equation i.e., $\text{div}(\mathbf{B})=0$, Ampere's circuital law, Maxwell's third equation i.e., $\text{Curl}(\mathbf{H})=\mathbf{J}$.

Magnetostatic Force : Force on a moving charge (Lorentz force), Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long and parallel current carrying conductors.

UNIT – IV

Inductance & mutual inductance: Determination of self-inductance of a solenoid and Toroid, mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

UNIT – V

Time-varying Electromagnetic field : Faraday's law, Lenz's law, Maxwell's fourth equation i.e., $\text{Curl}(\mathbf{E})=-\partial\mathbf{B}/\partial t$, Statically and Dynamically induced EMFs, Maxwell's equations in point & integral forms.

Displacement current – Poynting Theorem and Poynting vector.

Text Books:

- 1 Engineering Electromagnetics, William Hayt & John Buck, 9th edition, Tata McGraw Hill, New Delhi, India, 2020 (ISBN: 978073380667).
- 2 Elements of Electromagnetics, Mathew O Sadiku, 7th edition, Oxford University Press, New York, USA, 2018 (ISBN: 9780190698614).

Reference Books:

- 1 Field and Wave Electromagnetics, D K Cheng, 2nd edition revised, Pearson Education, Noida, India (ISBN: 9789332535022).
- 2 Introduction to Electrodynamics, David. J. Griffiths, 4th edition, Pearson Education, Noida, India (ISBN: 978109397759).

Web Links:

- 1 <https://nptel.ac.in/courses/108106073/>
- 2 <https://ocw.mit.edu/courses/8-311-electromagnetic-theory-spring/>

Electrical Network Analysis-I

	L	T	P	C
Course Code:2501EE03	2	0	2	4

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

- CO1** Make use of network elements, types of sources, source transformation, mesh & nodal analysis for Electrical Circuits.
- CO2** Analyze the behavior of RLC networks.
- CO3** Apply the principles of network theorems to solve the electrical circuits.
- CO4** Determine the resonant frequency & Q factor of an AC Circuit.
- CO5** Identify magnetic circuits with various dot conventions.

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	
CO2	3	2	1						1	1	
CO3	3	2	1	2					1	1	
CO4	3	2	1						1	1	
CO5	2	1	1						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

Introduction to Electrical Circuits :Basic Electrical circuit elements and their V-I relations, Ohm's Law and its limitations, Types of Sources, kirchhoff's laws, network reduction techniques - source transformation technique, nodal analysis, mesh analysis.

PRACTICE:

1. Verification of ohm's law, KCL and KVL using simulation.

UNIT – II

AC Fundamentals: Concepts of AC circuits – RMS value, average value, form factor and peak factor, steady state analysis of RLC circuits, phasor diagrams – real & reactive power, power factor.

Graph Theory: Graph of a network, Incidence matrix, Cutset and Tieset matrices, Dual networks.

PRACTICE:

1. Measurement of Power and Power Factor of RLC Circuit.

UNIT – III

Network Theorems (With AC & DC Excitations): Superposition Theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Tellegen's Theorem, Substitution Theorem. (Including dependent sources).

Practice:

1. Verification of Superposition theorem.
2. Verification of Thevenins & Norton theorem .
3. Verification of Maximum Power transfer theorem.
4. Verification of Reciprocity theorem.
5. Verification of Compensation theorem.

UNIT – IV

Resonance: Resonant circuits - series, parallel, series-parallel circuits – effect of variation of Q on resonance. Relations between circuit parameters- Q, resonant frequency & bandwidth, locus diagrams.

Practice:

1. Determination of resonance frequency, Bandwidth, and quality factor of Series & parallel RLC circuit.
2. Draw Locus diagrams of RL and RC series circuit.

UNIT – V

Magnetic Circuit : Basic definition of Magneto Motive Force, flux and reluctance. Analogy between electrical & magnetic circuits. Faraday's laws of electromagnetic induction, concept of self and mutual inductance. Dot convention, coefficient of coupling, composite magnetic circuit-Analysis of series and parallel magnetic circuits.

Practice:

1. Determination of choke coil parameters.
2. Determination of self, mutual inductance, and coefficient of coupling.

Capstone Project:

Design a series or parallel RLC resonant circuit that can be tuned to a specific frequency range. This could be for an AM/FM radio receiver's tuning stage, a band-pass/band-stop filter, or a sensor application where resonance is used to detect changes (e.g., metal detection, simple proximity sensor).

Text Books:

- 1 Circuit Theory (Analysis & Synthesis) by A. Chakrabarthi, Dhanpat Rai & Co (ISBN: 9788177000009).
- 2 Electrical circuit analysis by A.Sudhakar & Shyammohan S Palli, Mc Graw Hill (ISBN: 9789339219604).

Reference Books:

- 1 Fundamentals of Electrical Circuits by Charles K.Alex&er & Mathew N.O.Sadiku, Mc Graw Hill Education (India) (ISBN: 978078028229).
- 2 Electric Circuits–(Schaum's outlines) by Mahmood Nahvi & Joseph Edminister, Adapted by K.UmaRao, 5th Edition – Mc Graw Hill (ISBN-13: 97812611968).

Web Links:

- 1 <http://www.nptelvideos.in/2012/11/circuit-theory.html>
- 2 <https://www.youtube.com/user/nptelhrd/videos>
- 3 [https://en.wikipedia.org/wiki/Network_analysis_\(electrical_circuits\)](https://en.wikipedia.org/wiki/Network_analysis_(electrical_circuits))

Numerical Methods and Integral Transforms
(Common to EEE, Min. E & PT)

Course Code:2501MA05

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Apply numerical methods to solve the solution of equations and interpolation of polynomials.
- CO2:** Apply numerical methods to solve problems involving differentiation, integration and initial value problems.
- CO3:** Compute Fourier series of a function.
- CO4:** Compute the Fourier transform of a function.
- CO5:** Apply Laplace transform to solve initial value problems.

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

Solution of Algebraic and Transcendental Equations and Interpolation:

Solution of Algebraic and Transcendental Equations: Errors in Numerical Computation, Bisection method, Method of false position, Secant method and Newton - Raphson method.

Interpolation: Unequal Intervals- Lagrange's interpolation, Newton's divided difference formulae, Equal Intervals-Newton's Forward and Backward difference formulae, Central difference, Relation between operators.

Practice(Using any computational tool): Find solution of equations and Newton's forward interpolation.

UNIT – II

Numerical Differentiation, Integration and Solutions of Ordinary Differential Equations:

Numerical Differentiation: Numerical differentiation using Newton's Forward, Backward and Newton's divided difference formula.

Numerical Integration: Simpson's 1/3rd and 3/8th rule.

Numerical solution of ordinary differential equations: Taylor's series method, Euler's method and Runge-Kutta method (second and fourth order).

Practice(Using any computational tool): Solving problems on above methods.

UNIT – III

Fourier Series: Fourier series of periodic functions, 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 – 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

Laplace Transforms : Laplace Transform of Standard functions, Properties, Inverse Laplace transform, Properties, Convolution theorem, Solving ordinary differential equations and Simultaneous equations with constant coefficients by using Laplace Transforms.

Practice(Using any computational tool): Finding Laplace Transform of functions.

Students are advised to use any computational / AI Tool like Wolfram Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

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 Advanced Engineering Mathematics with MATLAB, Dean G. Duffy, CRC Press.ISBN978-1498739641
- 2 Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN 9788121938907

Web Links:

- 1 https://swayam.gov.in/nd1_noc19_ma21/preview
- 2 https://onlinecourses.nptel.ac.in/noc20_ge20/preview
- 3 https://onlinecourses.nptel.ac.in/noc23_ma43/preview
- 4 https://onlinecourses.nptel.ac.in/noc22_ma62/preview

DC Machines & Transformers

Course Code:2501EE04

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1** Explain the concepts of electromechanical energy conversion and operation of the DC machines.
- CO2** Analyze starting methods and speed control of DC machines.
- CO3** Analyze the performance of DC machines by conducting various tests on DC machines.
- CO4** Analyze the performance of single-phase transformers.
- CO5** Explain the connections of three phase transformers, Scott connection and tap changers.

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	

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Electromechanical Energy Conversion & Introduction to DC machines: Principles of Energy conversion, singly excited and multi excited systems, torque production in rotating machines and general analysis of electromechanical system.

DC Generator: Construction, principle of operation, EMF equation, Types, Armature reaction, Characteristics, Applications.

PRACTICE:

1. Draw open circuit characteristic curves of a given DC shunt generator & to find critical speed & critical field resistance.
2. Draw the internal & external characteristic curves of the given DC Shunt generator by conducting load test.

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.

PRACTICE:

1. Speed control of a DC shunt motor by field control and armature control method.

UNIT – III

Testing of DC Machines & Single-phase Transformers: Testing of DC machines: Brake test, Swinburne's test, Hopkinson's test, retardation test, field test, separation of losses.

Single-phase Transformers: Types, constructional details, principle of operation, EMF equation, equivalent circuit, operation on no-load and on load, phasor diagrams of transformers.

Practice:

1. Draw the performance curves of the DC shunt motor by conducting brake test.
2. Determine the efficiencies of two identical shunt machines by conducting regenerative test (Hopkinson's test).
3. Predetermine the efficiency of DC shunt machine.
4. Separation of the losses in DC shunt motor.

UNIT – IV

Performance & Testing of Transformers: Performance of Transformers: Regulation, losses and efficiency, effect of variation of frequency and supply voltage on losses, All day efficiency.

Tests on single phase transformers – open circuit and short circuit tests.

Practice:

1. Perform OC & SC tests on a single phase transformer and evaluate efficiency, Regulation. Draw the equivalent circuit.

2. Conduct sumpner's test on a two identical single phase transformers and obtain copper losses, core losses and efficiency.

UNIT – V

Three Phase Transformers: Polyphase connections - Y/Y, Y/ Δ , Δ /Y, Δ / Δ & open Δ , Parallel operation of 3 phase transformers, third harmonics in phase voltages – three winding transformers—off load & on load tap changers, Scott connection, Switching in transients, inrush current.

Additional Practice:

1. Draw the internal & external characteristic curves of the given DC cumulative and differential compound generators by conducting load test.
2. Load test on single phase transformer.
3. Draw the internal & external characteristic curves of the given DC Series Generator by conducting load test.
4. Scott connection on two 1- $\emptyset$ transformers.

Capstone Project: Design and Performance Analysis of a Small-Scale DC Motor/Generator System

Description: Designing a conceptual small-scale DC motor or generator for a specific application (e.g., a simple electric vehicle prototype, a wind turbine generator). Students would determine the key design parameters, analyze its performance characteristics, and propose methods for control.

Text Books:

- 1 Electrical Machinery by P.S. Bhimbra, R.C. Khanna & Vineet Khanna, 1st edition, 2021 (ISBN: 9788174091734).
- 2 DC Machines & Transformers by Dr. K.N. Srinivas, Khanna Publishers, 1st edition, 2022 (ISBN: 9789392549199).

Reference Books:

- 1 Electrical Machines by D. P. Kothari, I. J. Nagarth, McGraw Hill Publications, 5th edition (ISBN: 978070699670).
- 2 Electrical Machines by R. K. Rajput, Lakshmi publications, 5th edition (ISBN: 9788131807460).

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>

Electrical Network Analysis-II

Course Code:2501EE05

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1** Analyze the three phase circuits with Star and Delta connected balanced and unbalanced loads
- CO2** Analyze the transient behaviour of electrical networks for DC excitation.
- CO3** Analyze the transient behaviour of electrical networks for AC excitation.
- CO4** Determine the parameters of given two port networks
- CO5** Develop electrical networks into different forms.

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	-
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	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-

UNIT – I

Three Phase circuits: Phase sequence – star and delta connection-relation between line, phase voltages and currents - analysis of balanced three phase circuits - measurement of active and reactive power. Analysis of three phase unbalanced circuits: Star-Delta transformation technique, Millman's Theorem, Two wattmeter method of 3 phase power measurement.

Practice:

1. Measurement of Reactive Power using one wattmeter method.
2. Measurement of Active Power for Star and Delta connected balanced loads.
3. Measurement of Active Power for Star and Delta connected unbalanced loads.

UNIT – II

Transient Analysis in DC circuits: Transient response of RL , RC and RLC circuits for DC excitation, Solutions using Differential equations and Laplace Transforms.

Practice:

1. Simulation of Transient Response of Series RLC Circuits with Step voltage input for under damp, critically damp and over damp cases.
2. Simulation of Transient Response of series RL and RC circuits with step voltage.

UNIT – III

Transient Analysis in AC circuits : Transient response of R – L , R – C & R – L – C circuits for AC excitation, Solutions using Differential equations & Laplace Transforms.

Practice:

1. Simulation of Transient response of Series RLC Circuit with Sinusoidal Input

UNIT – IV

Two Port Networks : Two Port network parameters - Z, Y, ABCD & Hybrid parameters & their relations, Cascaded networks. Poles & zeros of network functions.

Practice:

1. Calculation of Z parameters of a given two port network.
2. Calculation of Y parameters of a given two port network.
3. Calculation of ABCD of a given two port network.
4. Calculation of h-parameters of a given two port network.

UNIT – V

Network Synthesis : Positive real functions, Hurwitz polynomials, Realization of passive RL, RC & LC Networks using Foster & Cauer forms.

Additional Practice:

2. Simulation of Transient Response of series RL & RC circuits with Sinusoidal Input.
3. Verification of the Milliman's theorem.
4. Simulation of Transient Response of Series RLC Circuits Using Pulse Input

Capstone Project: Smart Home Energy Management System with Unbalanced Load Balancing

Design a conceptual system for a "smart home" that includes various single-phase and three-phase loads, potentially leading to an unbalanced load on the mains. The project would

involve real-time monitoring (simulated) of load conditions and suggesting or dynamically adjusting phases/loads to maintain balance and optimize power consumption.

Text Books:

- 1 Fundamentals of Electric Circuits by Charles K. Alexander, Matthew N.O. Sadiku, McGraw-Hill Publications (ISBN: 978078028229).
- 2 Engineering Circuit Analysis by Hayt, W.H, Kemmerly J.E. & Durbin, McGraw Hill Publications (ISBN: 978073529578).

Reference Books:

- 1 Electric Circuits Schaum's Outline Series, Joseph. A. Edminister, McGraw Hill Publications (ISBN: 978071393072).
- 2 Network Analysis & Synthesis, Ravish R Singh, McGraw-Hill publications (ISBN: 9789353166724).

Web Links:

- 1 [https://en.wikipedia.org/wiki/Network_analysis_\(electrical_circuits\)](https://en.wikipedia.org/wiki/Network_analysis_(electrical_circuits))
- 2 <https://nptel.ac.in/courses/108/105/108105159/>
- 3 <https://nptel.ac.in/courses/108/104/108104139/>

Complex Variables & Statistical Methods

(Common to EEE, PT, Min.E)

Course Code: 2501MA06

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Examine the continuity and analyticity of functions of complex variables and Evaluate different types of complex integrals
- CO2:** Expand a function of complex variable as Taylor and Laurent series and evaluate residues.
- CO3:** Apply various Probability distributions for both discrete and continuous random variables.
- CO4:** Compute mean and variance of sample means with replacement and without replacement and estimating maximum errors
- CO5:** Apply various tests to test the hypothesis concerning mean, Proportion, variance.

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

Functions of a complex variable and Complex integration:

Introduction – Continuity – Differentiability – Analyticity – Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne – Thompson method.

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula (without proofs)

UNIT – II

Series expansions and Residue Theorem:

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series.

Types of Singularities: Isolated – Essential – Pole of order m – Residues – Residue theorem (without proof)

UNIT – III

Random variables and Distributions:

Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution

functions – Mathematical Expectation and Variance –Binomial, Poisson and Normal distributions.

Practice(Using any computational tool): Fitting Binomial and Poisson distributions

UNIT – IV

Sampling Theory:

Introduction –Population and Samples–Sampling distribution of Means and Variance – Central limit theorem (without proof) –Point and Interval estimations –Maximum error of estimate.

Practice(Using any computational tool):Plotting of confidence intervals

UNIT – V

Tests of Hypothesis:

Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors –Level of significance – One tail and two-tail tests – tests for large samples (Z - test for single mean, difference of means, single proportion, difference of proportions) – tests for small samples (t-test for single mean and difference of means)– F-test for comparison of variances-Chi Square test for attributes.

Practice(Using any computational tool):F- test and t- test.

Students are advised to use any computational / AI Tool like Wolfram Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

Text Books:

- 1 Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021).ISBN 978-9383214204
- 2 Miller and Freund's, Probability and Statistics for Engineers, 9/e, Pearson, 2020.ISBN978-9353945237

Reference Books:

- 1 Complex Variables and Applications, J.W.Brown and R.V.Churchill, 9th edition , Mc-Graw Hill, 2021 .ISBN 978935460364.
- 2 Fundamentals of Mathematical Statistics, S.C. Gupta and V.K.Kapoor, 12th edition, Sultan Chand & Sons Publications, 2020.ISBN 978-9351611738

Web Links:

- 1 <https://archive.nptel.ac.in/courses/111/103/111103070/>
- 2 https://onlinecourses.nptel.ac.in/noc20_ma50/preview
- 3 https://onlinecourses.nptel.ac.in/noc21_ma74/preview
- 4 <http://mathworld.wolfram.com/topics/ProbabilityandStatistics.html>
- 5 <https://www.khanacademy.org/math/statistics-probability>

Electric Power Generation & Distribution Systems

Course Code:2501EE06

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1** Identify the different components of various power plants.
- CO2** Distinguish between AC/ DC distribution systems & also estimate voltage drops of distribution systems.
- CO3** Classify the different components of air & gas insulated substations.
- CO4** Analyze single core & multi core cables with different insulating materials.
- CO5** Analyze the different economic factors of power generation & 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								

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Power Stations: Principle of power generation, site selection, Components and layout of Thermal, Nuclear, Hydro power plant.

UNIT – II

Distribution Systems: Classification, radial distribution, ring main distribution, Design features, Voltage drop calculations: Radial DC distributor fed at one end & at both ends (equal / unequal voltages), Ring main distributor, stepped distributor & AC distribution, comparison of DC & AC distribution.

UNIT – III

Air & Gas Insulated Substations: Indoor & Outdoor substations, Substations layouts of 66/11 kV, Types of Bus bar arrangements in the Sub-Stations. Types, installation, maintenance, construction, advantages of GIS, Comparison of Air & Gas insulated substations.

UNIT – IV

Underground Cables: Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation & power factor of cable. Capacitance of single & 3- Core belted Cables, Grading of Cables-Capacitance grading.

UNIT – V

Economic Aspects of Power Generation & Tariff Methods:

Types of load, Load curve, load duration & integrated load duration curves, Important terms & factors in Load Curve. Costs of Generation & their division into Fixed, Semi-fixed & Running Costs, Characteristics & 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: 978817700207).
- 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: 978070151413).

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>

Induction & Synchronous Machines

Course Code:2501EE07

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1** Analyze the performance of induction motors & induction generator.
- CO2** Apply the methods of starting & speed control of Three phase Induction Motors
- CO3** Analyze the performance of synchronous generator.
- CO4** Analyze the Parallel operation of synchronous generators.
- CO5** Explain hunting phenomenon, implement methods of starting & correction of power factor with synchronous motor.

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	1	
CO2	3	2	1						1	1	
CO3	2	3							1	1	
CO4	2	3	1						1	1	
CO5	2	3	1						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Three Phase Induction Motors: Construction and types, concept of rotating magnetic field, principle of operation, rotor emf and rotor frequency, rotor current and pf at stand still and running conditions, rotor power input, rotor copper losses, mechanical power developed and their interrelationship, equivalent circuit, phasor diagram. Torque equation – expressions for maximum torque and starting torque, torque slip characteristic, double cage and deep bar rotors, crawling & cogging.

UNIT – II

Starting & Testing of Induction Motors: Speed control of induction motor with V/f method, no load and blocked rotor tests, circle diagram for predetermination of performance, methods of starting, starting current and torque calculations, induction generator operation (Qualitative treatment only).

Single phase induction motors: Concept of starting, Double revolving field theory, Types, equivalent circuit, Shaded pole motors, AC Series motor.

Practice:

1. Performance characteristics of a three- phase Induction Motor by conducting Brake test.
2. Determination of equivalent circuit parameters, efficiency & regulation of a three phase Induction motor by conducting No-load & Blocked rotor tests.
3. Speed control of three phase induction motor by V/f method.
4. Determination of equivalent circuit parameters of single phase induction motor.
5. Determination of efficiency of a single-phase Induction Motor by conducting Brake test.

UNIT – III

Synchronous generator: Operation, Construction, Types of Armature windings, Distribution, Pitch and winding factors, E.M.F equation, armature reaction, Voltage regulation by synchronous impedance method, MMF method and Potier triangle method, Two reaction theory, Slip test.

Practice:

1. Determination of Regulation of a three-phase alternator by using synchronous impedance method.
2. Determination of Regulation of a three-phase alternator by using M.M.F. method.
3. Determination of Regulation of a three-phase alternator by using Potier triangle method.
4. Determination of efficiency of three-phase alternator by loading with three phase induction motor

UNIT – IV

Parallel Operation of Synchronous Generators: Parallel operation with infinite bus & other alternators, Power flow equations, Synchronizing power, Load sharing, Control of real and reactive power.

UNIT – V

Synchronous Motor: Principle of operation, Starting torque, Variation of current and power factor with excitation, Synchronous condenser, mechanical power developed, Hunting and its suppression, Methods of starting, applications.

Practice:

1. Determination of V and Inverted V curves of a three phase synchronous motor.

Additional Practice:

1. Synchronize the Alternator to infinite bus by using dark lamp method
2. Determine the Efficiency of 3 phase alternator by loading with 3 phase resistive load
3. Determination of X_d & X_q of a salient pole synchronous machine

Capstone Project:

Simulate the Model two (or more) synchronous generators operating in parallel to supply a common load, possibly connected to an infinite bus or operating as an isolated microgrid. Focus on the control strategies for sharing real and reactive power among the generators. Investigate the effects of excitation and prime mover control on load sharing and system stability.

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: 978070699670).
- 2 Electrical Machinery by Abijith Chakrabarthy & Sudhipta Debnath, McGraw Hill, 1st edition (ISBN: 978125906456).

Web Links:

- 1 <https://nptel.ac.in/courses/108/105/108105131>
- 2 <https://www.electrical4u.com/parallel-operation-of-alternator>
- 3 <https://www.electrical4u.com/speed-control-of-three-phase-induction-motor/>.

Analog Electronic Circuits

	L	T	P	C
Course Code:2501EE08	2	1	1	4

Course Outcomes:

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

- CO1** Interpret the characteristics of semiconductor diodes & transistor.
- CO2** Explain the characteristics of uncontrolled rectifiers.
- CO3** Analyze biasing and small signal low frequency equivalent models of BJT and FET .
- CO4** Illustrate the Feedback Amplifiers ,Oscillators and multivibrator.
- CO5** Analyze operational amplifier circuits for various linear and non-linear 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	1
CO2	3	2	2						1	1	1
CO3	2	3	2						1	1	1
CO4	2	3	1						1	1	1
CO5	2	1	3						1	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Semiconductor devices and characteristics: Review of P-N junction operation, Open circuited PN junction, energy band structure of open circuited PN junction, drift and diffusion currents, law of junction, Breakdown mechanisms, V-I Characteristics, temperature dependence of V-I characteristics, Diffusion and Transition capacitances, Characteristics of Zener diode, regulated power supplies.

Practice:

1. Determination of VI Characteristics of a Diode.

2. Determination of V-I characteristics of Zener diode and Zener Diode-Voltage Regulator

UNIT – II

Uncontrolled Rectifiers: Types of rectifiers & their operation, input & output waveforms, parameters of rectifiers. Single phase half wave, full wave & bridge rectifiers with filters (L, C & π), comparison of various filter circuits in terms of ripple factor. clippers, clampers.

Practice:

1. Calculate the Ripple factor and percentage Regulation of Half-wave Rectifier
2. Calculate the Ripple factor and percentage Regulation of Full-wave bridge

UNIT – III

Transistors and FET: Construction and operation of BJT (3 configurations), FET & MOSFET, Hybrid- π model of transistor, Analysis of CE, CC & CB. Comparison of transistor amplifiers. Transistor biasing & thermal stabilization (self-bias).

Practice:

1. Determine h-parameters of CE Configuration from Input & Output Characteristics.
2. Determine h-parameters of CB Configuration from Input & Output Characteristics.
3. Studies on BJT CE Amplifier

UNIT – IV

Feedback Amplifiers & Oscillators: Classification, feedback concept, transfer gain & general characteristics of negative feedback amplifiers, effect of feedback on input & output resistances. Condition for oscillation, RC-phase shift oscillator.

Practice:

1. Determine the RC Frequency Response of Low pass filter and high pass filter

UNIT – V

Op-Amps: Block Diagram of an Op-Amp IC 741, AC & DC characteristics, Measurement of Op-Amp parameters.

Linear Applications of Op-Amps: Adder, subtractor, integrator, differentiator, & Logarithmic functions.

Non-Linear Applications of Op-Amps: Comparators, Multivibrators, Triangular & Square wave generators, Log & Antilog Amplifiers, Precision rectifiers.

Practice:

1. Study of basic properties of operational amplifier: inverting and non-inverting amplifiers
2. Design an Integrator & Differentiator Circuits using Op-Amp 741.

Additional Practice:

1. Study of voltage comparator.
2. Design astable multivibrator using 555 timer IC.
3. Analyse Function generator using operational amplifier (sine, triangular and square wave).
4. study log and antilog amplifier.

Capstone Project:

Design a circuit that automatically controls lighting based on ambient light intensity. This system would use an LDR as a sensor, a transistor (BJT) or an Op-Amp as a comparator to detect light levels, and a relay driver (using a BJT) to switch an LED or small lamp. The design should include a hysteresis mechanism to prevent rapid on/off switching near the threshold.

Text Books:

- 1 Electronic Devices & Circuits, R.L. Boylestad & Louis Nashelsky, Pearson Education, 11 th Edition, (ISBN: 9780133757422).
- 2 Electronic Devices & Circuits, Jacob Millman & Christos Halkias black edition , Tata McGraw Hill, 2018 (ISBN: 9789339219543).

Reference Books:

- 1 Electronic Devices & Circuits, David A. Bell, Oxford University Press, 5th Edition, (ISBN: 9780195693409).
- 2 Design with Operational Amplifiers analog Integrated Circuits, Sergio Franco, 4E, McGraw-Hill series (ISBN: 978070217997).

Web Links:

- 1 <https://drmcet.digimat.in/nptel/courses/video/11711106/L23.html>
- 2 <https://drmcet.digimat.in/nptel/courses/video/108102095/L01.html>

Digital Electronics & Logic Design

(Common to EEE & ECE)

Course Code:2501EC01

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:** Design different sequential logic circuits.
- CO5:** Implement logic functions using PLDs.

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-a-head 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

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.

UNIT – V

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.

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.

Capstone project:

1. Binary Calculator (4-bit)

Description:

Design a simple calculator that can perform **binary addition, subtraction, AND, OR** using switches and LEDs. (Optional Extension: Use a 7-segment display to show results)

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, 2ndEdition, ISBN: 978-0534378042.

Web Links:

1. <http://nptel.ac.in/courses/117/106/117106086/>
2. www.nptelvideos.in/2012/12/digital-circuits-and-systems.html
3. <https://www.smartworld.com/notes/switching-theory-and-logic-design-stld/>

Microprocessor & Interfacing

Course Code:2501EE09

L	T	P	C
2	1	1	4

Course Outcomes:

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

- CO1** Interpret the generalized concepts of 8085 microprocessors.
- CO2** Demonstrate programming proficiency using the various addressing modes & instructions of 8086 & distinguish the minimum & maximum mode of operations of 8086 .
- CO3** Interpret the basic concepts of interfacing memory & peripheral devices to a microprocessor.
- CO4** Develop the internal architecture of microprocessors systems, including counters, timers, ports, & memory.
- CO5** Distinguish the circuits for various interfacing using microcontrollers.

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	-	-	-	-	1	1	1
CO2	3	2	2	1	-	-	-	-	1	1	1
CO3	2	3	2	1	-	-	-	-	1	1	1
CO4	2	2	2	1	-	-	-	-	1	1	1
CO5	3	2	2	1	-	-	-	-	1	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction & evolution of Microprocessors : 8-Bit Microprocessor, 8085 architecture & memory interfacing (RAM & ROM), interfacing I/O devices, Instruction set, addressing modes, assembly language programming, interrupts, timing diagram.

Practice:

1. Write program using 8085 & verify for: a.addition of two 8-bit numbers, b.addition of two 16-bit number(with carry).

2. Write program using 8085 & verify for: a.subtraction of two 8-bit number(display of borrow) b. subtraction of two 16-bit numbers(display of borrow).
3. Write an 8085 assembly language program to add two decimal 8-bit numbers using DAA instruction. Store the result in Decimal number system.

UNIT – II

Microprocessor 8086 Architecture & Mode of Operations: Architecture, Memory Organization, Register Organization, Instruction sets, Addressing modes, Assembler directives, General bus operation of 8086, Minimum & Maximum mode operations, Control signal interfacing, Read & write cycle timing diagrams.

Practice:

1. 8 bit & 16 Bit Arithmetic operations using Assembly Language Programming
2. Multi byte addition & subtraction using Assembly Language Programming.
3. Code conversion – Binary to BCD using Assembly Language Programming
4. Sorting an array using Assembly Language Programming

UNIT – III

Peripherals & interfacing : 8255 PPI: Architecture, Modes of operation, Interfacing I/O devices to 8086, Interfacing A to D converters, Interfacing D to A converters, Stepper motor interfacing, Static memory interfacing with 8086.

Practice:

1. Parallel Communication between Two Microprocessors using 8255
2. Interface DAC to 8086 using Intel 8255.
3. Interface stepper motor to 8086.

UNIT – IV

Microprocessors I/O interfacing: Architecture & interfacing of 8250 USART, Architecture & interfacing of 8254 Timer/counter, Architecture & interfacing of DMA controller (8257), Architecture of Keyboard/display controller (8279), Modes of operation

UNIT – V

8051 Microcontroller & interfacing : Overview of 8051 Microcontroller, Architecture, Memory Organization, Register set, I/O ports & Interrupts, Timers & Counters, Serial Communication, LCD interfacing, Keyboard interfacing ADC, DAC & sensor interfacing.

Practice:

1. Interfacing LCD to 8051.
2. Write an ALP to verify timer/counter operation in 8051.
3. Interface ADC 8051 to 8086
4. Write an ALP for Arithmetic, logical & bit manipulation operations in 8051

Capstone Project:

Design a traffic light controller for a four-way intersection using an 8086 microprocessor, leveraging its timer (8254) and interrupt capabilities. The system should cycle through standard traffic light sequences with defined timings for each phase. Incorporate a push-button (external interrupt) for pedestrian crossing request that alters the sequence.

Text Books:

- 1 Advanced Microprocessor & Peripherals, 3rd Edition, By K M. Bhurchandi, A. K. Ray, Tata McGraw Hill Education Private Limited (ISBN: 9781259029776).
- 2 Microprocessor Architecture, Programming, & Applications with the 8085 By Ramesh S. Gaonkar, Prentice Hall (ISBN: 9780130195708).

Reference Books:

- 1 Microprocessors & Interfacing - Sie, 3rd Edn, by Douglas V Hall SSSP Rao Douglas V Hall, Mc Graw Hill Education (ISBN: 978070601673).
- 2 Microcontrollers – Theory & Applications, Ajay V. Deshmukh, Tata McGraw–Hill Education (ISBN: 978070585959).

Web Links:

- 1 <https://archive.nptel.ac.in/courses/108/103/108103157/>
- 2 <https://archive.nptel.ac.in/courses/108/105/108105102/>
- 3 <https://nptel.ac.in/courses/108103157>

Power Electronics

Course Code:2501EE10

L	T	P	C
2	1	1	4

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** Illustrate the operation of AC voltage controllers & cyclo-converters.
- CO4** Design DC-DC converter with given characteristics.
- CO5** Explain the operation of 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	

Mapping of Course Outcomes with Program Specific Outcomes:

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

Practice:

1. Study of Characteristics of Thyristor, MOSFET & IGBT.
2. Design & development of a firing circuit for Thyristor.
3. Design & development of gate drive circuits for IGBT.

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, Principles of three-phase fully controlled converter operation with RLE load, Effect of source inductance.

Practice:

1. Single -Phase half-controlled converter with R & RL load.
2. Single -Phase fully controlled bridge converter with R & RL loads.
3. Three- Phase fully controlled converter with RL-load.

UNIT – III

AC-AC converters: AC Voltage Controllers: Introduction, principle of operation with R, R-L loads & its applications.

Cycloconverters: Principle of operation of single-phase to single-phase, three-phase to single phase, three-phase to three-phase configurations.

Practice:

1. Single -Phase AC Voltage Regulator with R & RL Loads.

UNIT – IV

DC-DC Converters: Chopper classification, study of Buck, Boost & Buck-Boost regulators, Basic operation of forward & fly back converters.

Practice:

1. Design & verification of voltages gain of Boost converter in Continuous Conduction Mode (CCM).
2. Design & verification of voltages ripple in buck converter in CCM operation.

UNIT – V

Inverters: Principle of operation of single phase bridge inverters with R, RL & RLC loads, Voltage control of single-phase inverters: single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation, 3-phase bridge inverters: 180- & 120-degrees mode of operation.

Practice:

1. Single -phase PWM inverter with sine triangle PWM technique.

Additional Practice:

1. Simulation of Buck, Boost & Buck-Boost converter.
2. Simulation of SPWM controlled Three-phase voltage source inverter.
3. Simulation of 3 phases half & full wave converter with R, RL, RLE & RE loads.
plot the waveforms for Voltage across & current through the switch.

Capstone Project:

Design a simplified single-phase or three-phase grid-tied inverter system for a solar photovoltaic (PV) array. The project would focus on the inverter stage (DC-AC conversion) using appropriate power devices (IGBTs) and implement a basic control strategy to achieve a desired AC output that can be synchronized with the grid. Analyze harmonics, efficiency, and power quality.

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: 978074633694).

Web Links:

- 1 <https://nptel.ac.in/courses/108/101/10811038/>
- 2 <https://nptel.ac.in/courses/108/102/108102145/>
- 3 <https://nptel.ac.in/courses/108/102/108102145/>

Control Engineering

Course Code:2501EE11

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1** Determine the overall transfer function using block diagram algebra & signal flow graphs & Mechanical systems
- CO2** Determine time response specifications of second order systems & analyze the effect of PID controllers & Apply the Routh's stability criterion & the root locus method for stability of LTI systems
- CO3** Analyze the stability of LTI systems using frequency response methods.
- CO4** Design & compensation of LTI systems using Bode diagrams
- CO5** Analyze the state space representations of LTI 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							1	1	
CO2	2	3	2						1	1	
CO3	2	2	3						1	1	
CO4	2	2	3						1	1	
CO5	2	3	1						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Mathematical Modelling of Control Systems : Introduction of open loop & closed loop control systems, Transfer function -Feedback characteristics, differential equations translational & rotational mechanical systems, transfer function of DC servo motor & AC servo motor, block diagram algebra, signal flow graph, reduction using Mason's gain formula.

Practice:

1. Study the characteristics of Synchros - Transmitter & receiver.
2. Draw the speed - torque characteristics of AC servo motor.
3. Draw the speed - torque characteristics of DC servo motor.
4. Study the effect of feedback on DC servo motor.
5. Determine the transfer function of DC motor.
6. Draw the load Characteristics of magnetic amplifiers.

UNIT – II**Time Response & S-Domain Analysis:** Time Response Analysis

Standard test signals, time response of first & second order systems, time domain specifications, steady state errors & error constants, effect of PID controllers on systems.

Stability in S-domain:

The concept of stability, Routh's stability criterion, root locus concept, construction of root loci.

Practice:

1. Study the effect of P, PD, PI, PID Controller on a second order systems.
2. Study temperature controller using PID.

UNIT – III

Frequency Response Analysis : Introduction to frequency domain specifications, Bode diagrams, transfer function from the Bode diagram, Polar plots, Nyquist stability criterion, stability analysis.

UNIT – IV

Classical Control Design Techniques: Lag, lead, lag-lead compensators, physical realisation, design of compensators using Bode plots.

Practice:

1. Draw the magnitude & phase plots of lag & lead compensators.
2. Study & verify the truth table of logic gates using PLC.

UNIT – V

State Space Analysis of Linear Time Invariant (LTI) Systems: Concepts of state, state variables & state model, state space representation of transfer function, solving the time invariant state equation, State Transition Matrix & its properties, concepts of controllability & observability.

Additional Practice

1. Simulate Bode plot for the transfer functions of systems up to 3rd order using MATLAB.
2. Simulate Nyquist plots for the transfer functions of systems up to 3rd order using MATLAB.
3. Simulate Root locus for the transfer functions of systems up to 3rd order using MATLAB.
4. Simulate Controllability test using MATLAB.
5. Determine time response of Second order system.

Capstone Project:

Design and simulate a closed-loop control system for a DC servo motor to precisely control its speed and/or angular position. The project would involve deriving the motor's transfer function, designing a PID controller (and potentially a lead-lag compensator for improved performance), and analyzing the system's time domain (rise time, settling time, overshoot, steady-state error) and frequency domain characteristics. Compare the performance with and without the controller.

Text Books:

- 1 Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of india (ISBN: 978812034107).
- 2 Automatic control systems by Benjamin C.Kuo, Prentice Hall of India, 2nd Edition (ISBN-13: 9781259643835).

Reference Books:

- 1 Control Systems Engineering by I.J.Nagarath & M.Gopal, Newage International Publications, 5th Edition (ISBN: 9788195175581).
- 2 Control Systems Engineering by Norman S. Nise, Wiley Publications, 7th edition (ISBN: 9781119590132).

Web Links:

- 1 Control Systems principles & design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4thEdition
- 2 <http://engineering.electrical-equipment.org/panel-building/time-domain-analysis-of-controlsystems.htm>
- 3 http://www.cds.caltech.edu/~murray/amwiki/index.php/Frequency_Domain_Analysis

Electric Power Transmission Systems

Course Code:2501EE12

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1** Determine parameters of transmission lines for different circuit configurations.
- CO2** Analyze the performance of short, medium & long transmission lines.
- CO3** Analyze the effect of travelling waves on transmission lines
- CO4** Identify various factors related to sag & corona.
- CO5** Demonstrate the different types of Insulators & transmission line effects.

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	2	3	1	-	-	-	-	-	-	-	-
CO3	2	3	3	-	-	-	-	-	-	-	-
CO4	2	2	2	-	-	-	-	-	-	-	-
CO5	2	3	3	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Calculation of inductance & capacitance: Concept of GMR & GMD, single phase and three phase lines with symmetrical & unsymmetrical spacing, with & without transposition, bundled conductors, & effect of earth on capacitance.

UNIT – II

Performance of Lines: Classification of Transmission Lines, model representations, End condenser method, Nominal-T, Nominal-Pie, Rigorous solution and A, B, C, D Constants, regulation and efficiency, Surge Impedance & SIL of Long Lines, Wave Length and Velocity of Propagation of Waves .

UNIT – III

Transients of lines: Types of System Transients Travelling wave or Propagation of Surges, Attenuation, Distortion, Reflection and Refraction Coefficients Termination of lines with different types of conditions, Open Circuited Line, Short Circuited Line, T Junction, Lumped Reactive Junctions.

UNIT – IV

Corona & 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 – V

Insulators & Transmission line effects: Types of Insulators, String efficiency and Methods for improvement, Voltage distribution, Calculation of string efficiency, Capacitance grading and Static Shielding, Skin and Proximity effects, Description and effect on Resistance of Solid Conductors, Ferranti effect, Charging Current.

Text Books:

1	Electrical power systems – by C. L. Wadhwa, New Age International (P) Limited, Publishers. Eighth edition 2022 (ISBN: 9789393159175).
2	Modern Power System Analysis by I. J. Nagarath & D. P. Kothari, Tata McGraw Hill, 5th Edition. 2022 (ISBN-13: 978125903172).

Reference Books:

1	A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar A. Chakrabarty, Dhanpat Rai & Co Pvt. Ltd (ISBN: 978817700207).
2	Power system Analysis – by John J Grainger William D Stevenson, TMC Companies (ISBN: 978070612945).

Web Links:

1	https://www.electrical4u.com/performance-of-transmission-line/
2	https://gradeup.co/models-&-performance-of-transmission-lines-&-cables-iebfce936-c584-11e5-baa5-76addde8c47

Electrical Measurements & Instrumentation

Course Code:2501EE13

L	T	P	C
2	1	1	4

Course Outcomes:

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

- CO1** Understand different types of instruments for measurement of 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	0	-	-	-	-	-	-	-
CO2	3	2	1	0	0	-	-	-	-	-	-
CO3	3	2	1	0	0	-	-	-	-	-	-
CO4	2	3	1	0	0	-	-	-	-	-	-
CO5	3	2	1	0	0	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	1
CO2	0	1
CO3	0	1
CO4	0	1
CO5	0	1

UNIT – I

Analog Ammeter & Voltmeters: Classification, Construction of PMMC, Moving Iron and Electrostatic Instruments, deflecting, control and damping torques, Torque equation, Range extension, Errors and compensations.

Instrument transformers: Current and Potential transformers, Construction and Working.

UNIT – II

Measurement of Power & Energy: Electro dynamometer type wattmeter: LPF and UPF, Power factor meters: Dynamometer and MI type (Single phase and 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

Measurement of Electrical parameters:

DC Bridges - Wheat stone's bridge, Kelvin's double bridge, Loss of charge method, Megger.

AC Bridges - Measurement of inductance and quality factor: Maxwell's bridge, Hay's bridge, Anderson's bridge.

Measurement of capacitance and 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 Anderson Bridge.

UNIT – IV

Transducers: Definition, Classification, LVDT, Strain Gauge, Thermistors, Thermocouples, Piezo electric and 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 and Integrating type DVM, Digital frequency meter, Digital multimeter, Digital tachometer, Digital Energy Meter, CRO- measurement of phase difference and 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.

Capstone Project:

Design and program a simple digital frequency meter using a low-cost microcontroller (like an Arduino). The microcontroller would count pulses over a fixed time interval and calculate the frequency, displaying it on a small LCD or serial monitor.

Text Books:

- 1 Electrical Measurements & measuring Instruments by E.W. Golding & F.C.Widdis - 5th Edition - Wheeler Publishing (ISBN: 9780273402022).
- 2 Modern Electronic Instrumentation & Measurement Techniques by A.D. Helfrick & W.D. Cooper - 5th Edition, PHI (ISBN: 9788120307520).

Reference Books:

- 1 Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications (ISBN: 978609578337).
- 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/>

Power System Analysis

Course Code:2501EE14

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1** Explain the impedance diagram for a power system network and per unit quantities.
- CO2** Apply the different load flow methods to solve the power system problems.
- CO3** Explain the Formation of Z-bus.
- CO4** Evaluate the fault currents for all types faults to provide data for the design of Protective devices.
- CO5** Analyze the steady state, transient and dynamic stability concepts of a power 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		-	-	-	-	1	1	
CO2	3	2	1		-	-	-	-	1	1	
CO3	2	1	3	1	-	-	-	-	1	1	
CO4	1	3	2	2	-	-	-	-	1	1	
CO5	3	2	1	1	-	-	-	-	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

Per Unit Representation : Modeling of power system components, single line diagram, Impedance and Reactance diagrams, Per unit quantities, Bus impedance and Admittance matrix.

Practice:

1. Determination of Y bus using direct inspection method.

UNIT – II

Power Flow Studies: Necessity of power flow studies, Gauss-Seidel, Newton-Raphson and Fast decoupled methods.

Practice:

1. Load flow solution of a power system network using Gauss-Seidel method.
2. Load flow solution of a power system network using Newton Raphson method.

UNIT – III

Z-Bus Algorithm: Formation of Z-bus: Algorithm for the Modification of Z-bus Matrix (without mutual impedance).

Practice:

1. Calibration of Tong Tester.
2. Formation of Z-bus by building algorithm.

UNIT – IV

Fault analysis: Symmetrical fault analysis, Symmetrical components of unbalanced three phase systems, Sequence impedances and Sequence networks, Unsymmetrical Fault analysis.

Practice:

1. Estimation of Sequence impedances of 3phaseTransformer.
2. Estimation of sequence impedances of 3-phase Alternator by Fault Analysis.
3. Estimation of sequence impedances of 3-phase Alternator by Direct method.
4. Estimation of ABCD parameters on transmission line model.

UNIT – V

Power System Stability Analysis: Concepts of Steady state and transient stability, Swing equation, Equal area criterion, Introduction to Multi-Machine stability analysis.

Practice:

1. Power Angle Characteristics of 3-phase Alternator with infinite bus bars.

Additional practice:

1. Transient Stability analysis of single machine connected to an infinite bus (SMIB) using equal area criterion.
2. Estimation of fault currents for LG fault.
3. Estimation of fault currents for LL fault.
4. Develop a program for the solution of swing equation.

Capstone Project:

Develop a small program (e.g., in Python or MATLAB script) that takes power system component parameters (voltage, MVA, impedance in Ohms/percentage) and base values as input, then converts them to per unit values. Extend it to automatically calculate and display the per unit impedance diagram for a very simple power system (e.g., a generator, transformer, and load).

Text Books:

- 1 Electrical Power Systems - by C.L. Wadhwa: New Age International Pub. Co (ISBN: 9789393159175).
- 2 Modern Power system Analysis – by I. J. Nagrath & D. P. Kothari: Tata McGraw–Hill Publishing Company, 5th edition-2022 (ISBN: 978935460968)

Reference Books:

- 1 Elements of Power system Analysis -by W.D. Stevenson: McGraw Hill International Student (ISBN: 978070612822).
- 2 Power System Analysis -by Hadi Saadat: Tata Mc Graw Hill Pub.Co (ISBN: 9780984543861).

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc18_ee16/
- 2 <http://nptel.ac.in/courses/108105067/3>
- 3 <https://nptel.ac.in/courses/108104051/>

Switch Gear & Protection

Course Code: 2501EE15

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1** Apply the Knowledge of arc interruption for application to high voltage circuit breakers of oil, Vacuum & SF6 gas type.
- CO2** Explain the working principle & operation of different types of electromagnetic protective relays.
- CO3** Analyze the various protective schemes for power generators & transformers.
- CO4** Apply various types of protective schemes used for feeders & bus bar protection.
- CO5** Explain over voltage protection schemes & methods of neutral grounding.

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	3	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	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	1
CO3	2	1
CO4	2	
CO5	2	1

UNIT – I

Circuit Breakers: Elementary principles of arc interruption– Restriking Voltage & Recovery voltages– Restriking phenomenon - RRRV– Average & Max. RRRV– Current chopping & Resistance switching – Concept of oil circuit breakers – Vacuum & SF6 circuit breakers– Concept of Auto reclosing – Applications.

UNIT – II

Electromagnetic Protection: Balanced beam type attracted armature relay - induction disc & induction cup relays–Torque equation - Relays classification: –Instantaneous– DMT & IDMT types– Applications of relays: Over current & under voltage relays– Directional

relays– Differential relays & percentage differential relays–Universal torque equation– Distance relays: Impedance– Reactance– Mho & offset mho relays.

UNIT – III

Generator Protection: Protection of generators against stator faults– Rotor faults & abnormal conditions– restricted earth fault & inter turn fault protection.

Transformer Protection:

Percentage differential protection– Design of CT's ratio– Buchholz relay protection.

UNIT – IV

Feeder & Bus bar Protection: Over current Protection schemes – PSM – TMS – Carrier current & three zone distance relay using impedance relays - Protection of bus bars by using Differential protection.

UNIT – V

Protection against over voltage & grounding: Generation of over voltages in power systems– Protection against lightning over voltages – Valve type & zinc oxide lightning arresters.

Grounded & ungrounded neutral systems – Effects of ungrounded neutral on system performance – Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds & grounding Practices

Text Books:

- 1 Power System Protection & Switchgear by Badri Ram & D.N. Viswakarma - Tata McGraw Hill Publications – 3rd edition - 2023.
- 2 Power system protection- Static Relays with microprocessor applications by T. S. Madhava Rao - Tata McGraw Hill - 2nd edition.

Reference Books:

- 1 Fundamentals of Power System Protection by Y. G. Paithankar & S. R. Bhide – PHI.
- 2 Art & Science of Protective Relaying – by C R Mason - Wiley Eastern Ltd

Web Links:

- 1 <https://nptel.ac.in/downloads/10811039/>
- 2 <http://electrical-engineering-portal.com/>

Energy Converters

Course Code: 2501EE39

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Classify the different types of converters.
- CO2:** Explain the resonant converters.
- CO3:** Illustrate the steady state analysis of power factor corrected converter.
- CO4:** Identify the various modulation techniques for single phase inverter.
- CO5:** Explain the operation of various Multilevel Inverters and it's comparison.

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	

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Switching Voltage Regulators:

Isolated converters dc-dc converters: Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Cuk converter, SEPIC Converter, Comparison of isolated and non-isolated converters, Design criteria for SMPS, Multi-output switch mode regulator.

UNIT – II

Resonant Converters: Classification, Load resonant converters, Resonant switch converters, Zero voltage switching dc-dc converters, Zero current switching dc-dc converters, Clamped voltage topologies.

UNIT – III

Voltage control of PWM Inverters: Single-phase inverters - Sinusoidal PWM, Modified PWM, Phase displacement Control, Trapezoidal, Staircase, Stepped, Harmonic injection and delta modulation.

Three-Phase Inverters: Sinusoidal PWM, Third Harmonic PWM, Space Vector Modulation, Comparison of PWM Techniques.

UNIT – IV

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter.

UNIT – V

Multilevel Inverters: Types of Multilevel Inverters, Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter Switching Device Currents- Features of Multilevel Inverters Comparisons of Multilevel Converters.

Text Books:

- 1 Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland (ISBN: 9780471226932).
- 2 Power Electronics-Md.H.Rashid –Pearson Education Third Edition (ISBN: 9788120345317).

Reference Books:

- 1 Control in power electronics by Marian P. Kaźmierkowski, Ramu Krishnan, Frede Blabjerg Edition Published by Academic Press (ISBN: 9780124027725).
- 2 High Power Converters and AC Drives, Bin Wu, John Willey & sons, Inc (ISBN: 9781119156031).

Web links:

- 1 https://onlinecourses.nptel.ac.in/noc24_ee88/preview.
- 2 <https://archive.nptel.ac.in/courses/108/102/108102157/>.

Power System Operation & Control

Course Code:2501EE16

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1** Compute optimal load scheduling of Generators.
- CO2** Formulate hydrothermal scheduling & unit commitment problem
- CO3** Analyze effect of Load Frequency Control for single area systems
- CO4** Analyze effect of Load Frequency Control for two area systems
- CO5** Describe the effect of reactive power control for 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	2	3	1						1		
CO2	2	3	1						1		
CO3	2	3	1						1		
CO4	2	3	1						1		
CO5	2	3	1						1		

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Economic Operation of Power Systems : Optimal operation of Generators in Thermal power stations - – Heat rate curve – Cost Curve – Incremental fuel & Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

Practice:

1. Economic load dispatch with losses.
2. Economic load dispatch without losses.

UNIT – II

Hydrothermal Scheduling-Mathematical Formulation – Solution Technique. Unit Commitment-Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Dynamic programming.

Practice:

1. Unit commitment problem by using dynamic programming approach.

UNIT – III

Load Frequency Control-I: Modelling of steam turbine – Generator – Mathematical modelling of speed governing system – Transfer function. Definitions of Control area, Single area control system – Block diagram representation of an isolated power system – Steady state analysis -Dynamic response. Proportional plus Integral control of single area & its block diagram representation – Steady state response.

Practice:

1. Load frequency control of a Single area Power System without PI controller.
2. Load frequency control of a Single area Power System with PI controller.

UNIT – IV

Load Frequency Control-II: Block diagram development of Load Frequency Control of two area system – Load Frequency Control & Economic dispatch control.

Practice:

2. Load frequency control of a two area Power System without PI controller.
3. Load frequency control of a two area Power System with PI controller.

UNIT – V

Compensation in Power Systems: Overview of Reactive Power control – Reactive Power compensation in transmission systems. Introduction of FACTS devices – Need of FACTS controllers – Types of FACTS devices.

Practice:

1. Performance of long transmission line without compensation.
2. Performance of long transmission line without compensation.
3. Design of Thyristor controlled Series Reactor.

Additional practice:

1. Design a Thyristor Switched Capacitor.
2. Design a Thyristor Controlled Series Compensator.
3. Optimum generation for a hydro-thermal scheduling with inflow & without losses

Capstone Project:

Develop a program (e.g., in MATLAB script or Python) that performs economic dispatch for a small thermal power system (e.g., 2-3 generators). The program should take heat rate/cost curves (or simplified quadratic cost functions) as input and determine the optimal power generation for each unit to meet a given load, neglecting transmission losses.

Text Books:

- 1 Power Generation - Operation & Control by Allen J Wood - Bruce F WollenBerg 3rd Edition - Wiley Publication (ISBN: 9780471586999).
- 2 Modern Power System Analysis – by I.J.Nagrath & D.P.Kothari Tata McGraw Hill Publishing Company Ltd – 5th edition-2022 (ISBN: 978935460968).

Reference Books:

- 1 Power System Analysis & Stability by S.S.Vadhera - Khanna Publications - 7th edition – 2024 (ISBN: 9788174090591).
- 2 Power System stability & control - Prabha Kundur - TMH – 2nd edition -2022 (ISBN: 978070635159).

Web Links:

- 1 <https://nptel.ac.in/courses/108104052/>
- 2 <https://nptel.ac.in/downloads/10811040/>
- 3 <https://nptel.ac.in/courses/10811040/>

Minor Stream Courses: Intelligent and Integrated Power Systems

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE22	Electrical Machine Design	FC	3			3	50	50	100	-
2501EE27	Utilization of Electrical Energy	FC	3			3	50	50	100	DCMT
2501EE24	Electrical Distribution System	IC	2	1		3	50	50	100	EPGDS
2501EE26	HVDC Transmission	IC	3			3	50	50	100	PE
2501EE30	Methods & Algorithms for Intelligent Control	IC	2	1		3	50	50	100	-
2501EE23	High Voltage Engineering	IC	3			3	50	50	100	EPTS
2501EE28	Restructured Power Systems	AC	3			3	50	50	100	EPTS
2501EE31	Advance Control Systems	AC	2	1		3	50	50	100	CE
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
2501EE25	Flexible Alternating Current Transmission Systems	AC	3			3	50	50	100	PE
2501EE29	Soft Computing Techniques in Power Systems	AC	2		1	3	50	50	100	PSA
	Total		28	3	1	32				

Minor Stream Courses: Power Electronics and Energy Systems

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE22	Electrical Machine Design	FC	3			3	50	50	100	-
2501EE34	Alternative Energy Sources	FC	3			3	50	50	100	-
2501EE27	Utilization of Electrical Energy	FC	3			3	50	50	100	DCMT
2501EE35	Special Electrical Machines	IC	2	1		3	50	50	100	ISM
2501EE36	Electric Energy Storage Systems	IC	3			3	50	50	100	AES
2501EE38	Digital Control Systems	AC	2	1		3	50	50	100	CE
2501EE15	Switch Gear & Protection	AC	3			3	50	50	100	EPTS
2501EE33	Energy Audit, Conservation & Management	AC	2	1		3	50	50	100	EPGDS
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
2501EE40	Power Quality	AC	3			3	50	50	100	EPGDS
2501EE37	Hybrid Electric Vehicles	AC	3			3	50	50	100	PE
	Total		29	3		32				

Minor Stream Courses: Advanced Specialization on Electric Vehicles (Industry Integrated Program- L & T)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE43	Electrical safety	FC	3			3	50	50	100	-
2501EE47	Finance for Professionals	FC	3			3	50	50	100	
2501EE41	Foundations of EV & Hybrid Vehicles	FC	3			3	50	50	100	PE
2501EE35	Special Electrical Machines	IC	2	1		3	50	50	100	ISM
2501EE44	EV Power Electronics & Embedded Systems	IC	3			3	50	50	100	EVBT
2501EE42	EV Battery Technology & Power train Development	IC	3			3	50	50	100	PE
2501EE45	EV Design & Analysis	IC	3			3	50	50	100	
2501EE33	Energy Audit, Conservation & Management	AC	2	1		3	50	50	100	EPGDS
2501ME43	EV Charging Infrastructure, Vehicle Testing & Homologation	AC	3			3	50	50	100	-
2501EE46	EV PCB Design & Data Analytics	AC	3			3	50	50	100	
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
	Total		30	2		32				

Minor Stream Courses: Design of Electrical System for Smart Buildings (Industry Integrated Program- L & T)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE43	Electrical safety	FC	3			3	50	50	100	-
2501EE47	Finance for Professionals	FC	3			3	50	50	100	
2501EC65	Applied Industrial IoT	FC	3			3	50	50	100	IOT
2501EE48	Electrical Power Distribution & Automation	IC	3			3	50	50	100	EPGDS
2501EE35	Special Electrical Machines	IC	2	1		3	50	50	100	ISM
2501EE49	Integrated Approach to Building Services	IC	3			3	50	50	100	-
2501EE33	Energy Audit, Conservation & Management	AC	2	1		3	50	50	100	EPGDS
2501EE50	Building Information Modelling	AC	3			3	50	50	100	-
2501EE51	Advanced Electrical System Design for Builders	AC	3			3	50	50	100	
2501EE52	Extra Low Voltage System Design for Buildings	AC	3			3	50	50	100	
2501EE32	Concept of Smart Grid Technology	AC	2			2	50	50	100	PSA
Total			30	2		32				

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

Electrical Machine Design

Course Code:2501EE22

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1** Classify the materials used for construction of electrical machines.
- CO2:** Assess the overall dimensions of transformer.
- CO3:** Examine the design, performance of transformer.
- CO4:** Develop the overall dimensions of a rotating machine.
- CO5:** Analyze the design & performance of rotating 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	2	1	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Fundamental Aspects of Electrical Machine Design

Design of machines - design factors - limitation in design - modern trends in electrical machine design – types of magnetic, electric & insulating materials – modes of heat dissipation – cooling of rotating machines – methods of cooling.

UNIT – II

Design of Transformers

Transformer windings – output equation – design of main dimensions— design of core - choice of flux density – determination of number of turns & length of mean term - resistance & leakage reactance – no load current calculation –cooling of transformers- calculation of number of tubes.

UNIT -III

Design of DC Machines

Output equation –selection of specific magnetic & electric loadings - separation of D & L – estimation of number of conductors, armature slots & conduct dimensions – choice of number of poles & calculation of length of airgap – design of field systems, interpoles & brushes.

UNIT - IV

Design of Induction motors

Output equation -main dimensions – choice of average flux density & ampere conduction for meter — design of stator slots & rotor slots- design of rotor bars end rings– design of wound rotor –calculation of no-load current.

UNIT - V

Design of Synchronous Machines

Types of construction – output equation - main dimensions – short circuit ratio & its effects on the performance – design of rotor –Design of field winding – Design of turbo alternators – Rotor design temperature rise & its effects.

Text Books:

- 1 A Course in Electrical Machines Design by A.K.Sawhney, Dhan path Rai & Co (ISBN: 97881771013).
- 2 The Performance & Design of Direct Current Machines by AE Clayton & NN Hancock, CBS Publishers (ISBN-13: 9788123909271).

Reference Books:

- 1 Performance & Design of A.C. Machines by M.G. Say, ELBS & Pitman & Sons, 4th edition (ISBN:9788123910277).
- 2 Principles of Electrical Machine Design with computer programmes by S. K. Sen, Oxford & IBH Company Pvt. Ltd. New Delhi (ISBN:9788120415218).

Web Links:

- 1 <https://cusp.umn.edu/electric-machine-design-videos>
- 2 <https://nptel.ac.in/courses/108102146>
- 3 <https://nptel.ac.in/courses/108/105/108105017>

High Voltage Engineering

Course Code:2501EE23

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1** Recognise the dielectric properties of gaseous materials used in HV equipment.
- CO2** Differentiate the break down phenomenon in liquid & solid dielectric materials.
- CO3** Acquaint with the techniques of generation of high AC & DC voltages.
- CO4** Acquaint with the techniques of generation of high Impulse voltages & currents.
- CO5** Getting the knowledge of measurement of high AC - DC - Impulse voltages & current.

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	2	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	3	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

Break down phenomenon in Gaseous: Insulating Materials: Types - applications & properties. Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases & its limitations – Streamers Theory of break down – Paschen's law- Paschen's curve.

UNIT – II

Break down phenomenon in Liquids: Liquid as Insulator – Pure & commercial liquids – Breakdown in pure & commercial liquids. Break down phenomenon in Solids: Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of composite solid dielectrics.

UNIT – III

Generation of High DC voltages: Voltage Doubler Circuit - Voltage Multiplier Circuit – V&e- Graaff Generator. Generation of High AC voltages: Cascaded Transformers – Resonant Transformers – Tesla Coil.

UNIT – IV

Generation of Impulse voltages: Specifications of impulse wave – Analysis of RLC circuit only- Marx Circuit. Generation of Impulse currents: Definitions – Circuits for producing Impulse current waves – Wave shape control - Tripping & control of impulse

UNIT – V

Measurement of High DC & AC Voltages: Resistance potential divider - Generating Voltmeter - Capacitor Voltage Transformer (CVT) - Electrostatic Voltmeters – Sphere Gaps. Measurement of Impulse Voltages & Currents: Potential dividers with CRO - Hall Generator - Rogowski Coils.

Text Books:

- 1 High Voltage Engineering: Fundamentals by E.Kuffel - W.S.Zaengl - J.Kuffel Elsevier (ISBN: 9780750636346).
- 2 High Voltage Engineering & Technology by Ryan - IET Publishers (ISBN: 9780852967751).

Reference Books:

- 1 High Voltage Engineering by M.S.Naidu & V. Kamaraju – TMH Publications (ISBN: 9789383286515).
- 2 High Voltage Engineering by C.L.Wadhwa - New Age International (P) Limited (ISBN-13: 9781906574727).

Web Links:

- 1 <https://nptel.ac.in/courses/108104048>
- 2 <https://bharatsrajpurohit.weebly.com/high-voltage-engineering-course.html>
- 3 <http://biet.ac.in/pdfs/EEE-IV-HVE.pdf>

Electrical Distribution Systems

Course Code:2501EE24

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1** Identify various factors of distribution system
- CO2** Design the substation & feeders
- CO3** Determine the voltage drop & power loss
- CO4** Explain the different protection & its coordination
- CO5** Explain the effect of compensation for p.f improvement & different methods of voltage control

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	2	2								
CO3	2	3	2								
CO4	3	2	2								
CO5	3	2	2								

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

General Concepts: Introduction to distribution systems - Distribution system losses – Coincidence factor – Contribution factor loss factor – Numerical Problems – Load Modelling & Characteristics – Relationship between the load factor & loss factor – Classification & characteristics of loads (Residential, commercial, Agricultural & Industrial)

UNIT – II

Substations & Distribution Feeders: Location of substations: Rating of distribution substation – Service area with ‘n’ primary feeders – Benefits & methods of optimal location of substations.

Design Considerations of distribution feeders: Radial & loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

UNIT – III

System Analysis: Voltage drop & power loss calculations: Derivation for voltage drop & power loss in lines – Uniformly distributed loads & non-uniformly distributed loads - Three phase balanced primary lines.

UNIT – IV

Protection, Coordination & Automation: Objectives of distribution system protection schemes of parallel & Ring main feeders. Coordination of protective devices: General coordination procedure –Various types of coordinated operation of protective device

UNIT – V

Compensation for Power Factor Improvement & Voltage Control: Capacitive compensation for power factor control – Different types of power capacitors – shunt & series capacitors – Effect of shunt capacitors (Fixed & switched) – Effect of series capacitors – Power factor correction – Capacitor allocation – Procedure to determine the best capacitor location, Voltage Control: Equipment for voltage control– Effect of AVB/AVR – Line drop compensation

Text Books:

- 1 “Electric Power Distribution system, Engineering” – by Turan Gonen, McGraw hill Book Company. 3rd edition (ISBN: 978148220702).
- 2 Electric Power Distribution-by A. S. Pabla, Tata McGraw-Hill Publishing Company, 7th edition (ISBN: 9789389538397).

Reference Books:

- 1 Electrical Distribution Systems by Dale R. Patrick & Stephen W. Fardo, CRC press (ISBN: 9781439804728).
- 2 Electrical Power Distribution Systems by V. Kamaraju, Right Publishers (ISBN: 9781259081743).

Web Links:

- 1 nptel.ac.in/courses/108105067/
- 2 nptel.ac.in/courses/108102047/
- 3 nptel.ac.in/Clarify_doubts.php?subjectId=108106025

Flexible Alternating Current Transmission Systems

Course Code:2501EE25

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 FACTS controller & power flow control in transmission lines.
- CO2** Explain the operation & control of voltage & current source converters.
- CO3** Explain the different methods of compensations using shunt compensators.
- CO4** Explain the different methods of compensations using series compensators.
- CO5** Analyze the operation of the Unified Power Flow Controller (UPFC) & Interline power flow controller (IPFC).

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	3	1	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-
CO5	3	1	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

Introduction to FACTS: Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers – Requirements & characteristics of high-power devices – Voltage & current rating – Losses & speed of switching – Parameter trade-off devices.

UNIT – II

Voltage source converters (VSC): Voltage source converter (VSC) – Single phase full-wave bridge converter – Square wave voltage harmonics for a single-phase bridge converter – Three-phase full-wave bridge converter - Transformer connections for 12 pulse operation.

Current Source Converter (CSC): Three-phase current source converter– Comparison of current source converter with voltage source converter.

UNIT – III

Shunt Compensators: Objectives – Mid-point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – Improvement of transient stability – Power oscillation damping. Variable Impedance Type VAR Generator: Thyristor Switched/Controlled Reactor (TSR/TCR) – Thyristor Switched Capacitor (TSC) –Fixed Capacitor Thyristor Controlled Reactor (FC-TCR) - Thyristor Switched Capacitor & Thyristor Controlled Reactor (TSC–TCR) - Switching Converter type VAR generator. Principle of operation & comparison of SVC & STATCOM.

UNIT – IV

Series Compensators: Concept of series capacitive compensation – Improvement of transient stability Power oscillation damping – Functional requirements. Variable Impedance type series compensators – GTO Thyristor controlled Series Capacitor (GSC) – Thyris

UNIT – V

Combined Compensators: Schematic & basic operating principles of unified power flow controller (UPFC) & Interline power flow controller (IPFC) – Controller applications of transmission lines.

Text Books:

- 1 “Understanding FACTS” N.G.Hingorani & L.Guygi, IEEE Press. Indian Edition is available:– Standard Publications (ISBN: 9788186308790).
- 2 Flexible AC Transmission systems, Song.Y. H& Johns. A.T, IET Press (ISBN: 9788190858809).

Reference Books:

- 1 “Flexible ac transmission system (FACTS)” Edited by Yong Hue Song & Allan T Johns, Institution of Electrical Engineers, London (ISBN: 9788190858809).

- 2 Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R.MohanMathur & Rajiv k.Varma, Wiley (ISBN: 9788126532247).

Web Links:

- 1 <https://nptel.ac.in/courses/108/102/108102179/>
- 2 <https://nptel.ac.in/courses/108/107/108107157/>
- 3 <https://nptel.ac.in/courses/108/107/108107114/>

HVDC Transmission

Course Code:2501EE26

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1** Explain different types of HVDC levels & basic concepts
- CO2** Explain the operation of converters
- CO3** Explain the control concept of reactive power control & AC/DC load flow
- CO4** Explain the converter faults & protection methods.
- CO5** Explain the generation & calculation of harmonic effects & design low, high pass 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	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	1	-	-	-	-	-	-
CO3	3	2	1	-	1	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	3	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

Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC & DC Transmission, Application of DC Transmission System – Planning & Modern trends in D.C. Transmission.

UNIT – II

Analysis of HVDC Converters:

Choice of converter configuration – analysis of Graetz – characteristics of 6 pulse & 12 pulse converters – Cases of two 3 phase converters in star–star mode – their performance.

Converter & HVDC System Control:

Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current & extinction angle control – Effect of source inductance on the system – Starting & stopping of DC link - Power Control.

UNIT – IV

Converter Fault & Protection: Converter faults – protection against over current & over voltage in converter station – surge arresters –smoothing reactors – DC breakers –Audible noise-space charge field corona effects on DC Lines-Radio interference.

UNIT – V

Harmonics & Filters: Generation of Harmonics –Characteristics harmonics, calculation of AC Harmonics, Non Characteristics harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters –Design of High pass filters

Text Books:

- 1 “HVDC Power Transmission Systems”, K. R. Padiyar - New Age International (p) Limited – 4th edition, 2024.(ISBN: 978-8122437850)
- 2 HVDC Transmission by S.Kamakshaiah & V. Kamaraju-Tata McGraw–Hill(ISBN: 978-071072533)

Reference Books:

- 1 “HVDC Transmission”, J. Arrialga - Peter Peregrinus Ltd. – London. (ISBN:978-0852969410)
- 2 Direct Current Transmission – by E. W. Kimbark, John Wiley & Sons.(ISBN: 978-0471475804)

Web Links:

- 1 <https://nptel.ac.in/courses/108104013>
- 2 <http://nptel.ac.in/courses/10811040/22>

Restructured Power Systems

Course Code:2501EE28

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1** Illustrate the importance of power system deregulation & restructuring.
- CO2** Compute available Transfer Capability
- CO3** Analyse transmission congestion & Estimate loss allocation in Power System
- CO4** Compute electricity pricing in deregulated environment
- CO5** Analyse dem& response in smart grid 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	3	1	-	-	-	-	-	-	-	-
CO3	2	3	2	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction Philosophy of market models, Concepts in micro-economics, Centralized & de-centralized Dispatch Philosophies – Restructuring models – Independent system operator (ISO) – Power Exchange– Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion, Restructuring Issues in Indian Power Sector, Electricity Regulation Act 2003.

UNIT – II

Structure of OASIS – Processing of Information – Transfer capability on OASIS – Definitions Transfer Capability Issues – ATC – Total transfer capability between two points(TTC) – transmission reliability margin(TRM) – Capacity Benefit Margin(CBM) calculations –Methodologies to calculate ATC.

Introduction to congestion management – Methods to relieve congestion, Day Ahead Market- Online power trading.

UNIT – III

Introduction – Electricity price volatility electricity price indexes – Challenges to electricity pricing - Market clearing price– Construction of forward price curves – Short-time price forecasting, Locational Marginal Price (LMP) calculation & properties, Financial Transmission Rights (FTRs), Inverse dem& curves, supply curves, market clearing price, social benefit, deadweight loss, long-run & short-run costs. Transmission Pricing

Cost components, Postage Stamp Method, Megawatt Mile Method, Contract Path Method

UNIT – IV

Introduction – Operational planning activities of ISO – The role of ISO in pool & bilateral markets- experience of deregulation in some of the developed countries & Challenges in deregulating electric markets in developing countries – Operational plan

UNIT – V

Dem& response, Potential benefits of dem& response in smart grid, enabling smart technologies for dem& response, control devices for dem& response, Monitoring & communication system. Dem& response for Electric Vehicles, Examples. Ancillary Services within Smart Grid framework: Reactive power as an ancillary service.

Text Books:

- 1 Operation of Restructured Power System by Kankar Bhattacharya, Math. Bollen, Jaap E. Daalder, Kluwer Academic Publisher .(ISBN: 978-0792373971)
- 2 Restructured Power Systems: and It's Key Issues by J. Sreenivasulu, V. Sankar, Lambert Academic Publishing, 2022.(ISBN : 978-6139460441)

Reference Books:

- 1 Power System Deregulation by P Srinivasa Varma & V. Sankar, Lambert Academic Publishing.(ISBN : 978-6202071901)

- 2 “Power system Restructuring & Deregulation”, Loi Lei Lai ,John Wiley & Sons Ltd., England.(ISBN: 978-0471495000)

Web Links:

- 1 <https://archive.nptel.ac.in/courses/108/101/1081105/>
- 2 <https://www.yumpu.com/en/document/read/20681876/introduction-to-deregulation-in-power-industry-nptel>
- 3 <http://kcg.digimat.in/nptel/courses/video/108102047/L08.html>

Soft Computing Techniques In Power Systems

Course Code:2501EE29

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1** Underst& the concept of Artificial Intelligence
- CO2** Analyze & mathematically model Artificial Neural Network.
- CO3** Underst& the concept of Fuzzy Systems.
- CO4** Analyze the mathematically model & apply it for various optimization algorithms.
- CO5** Apply various intelligent algorithms to solve practical power system problems.

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	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction: Concept of artificial intelligence, Problem solving methods & searching techniques, classification of optimization techniques like conventional methods, heusrustic methods & meta- heuristic methods.

UNIT – II

Artificial Neural Networks: Fundamental concepts, basic models, Learning rules, multilayer feed-forward networks, back-propagation training algorithm, radial basis function & recurrent networks, supervised & unsupervised learning.

UNIT – III

Fuzzy control methods: Introduction to fuzzy logic controller, types of fuzzy logic controllers, basic structure of fuzzy knowledge based controllers, fuzzification & defuzzification methods, applications of fuzzy logic control.

UNIT – IV

Optimization algorithms: Search techniques, conventional & nonconventional optimization, implementation of genetic algorithm & particle swarm optimization using conventional & non conventional optimization techniques

UNIT – V

Applications in Power System: Short term & long term load forecasting, economic load dispatch scheduling, hydro thermal scheduling, optimal power flow, identification & classification of faults.

Text Books:

- 1 Understanding Neural Networks & Fuzzy Logic, Stamatios V. Kartalopoulos. IEEE Press.(ISBN: 9780780311282)
- 2 Neural Networks, Simon Haykin. Pearson Education Asia.(ISBN: 9789332570313)

Reference Books:

- 1 Hand book of Genetic Algorithms, L. Davis, Van Nostr& Reinhold.(ISBN: 97804420173)
- 2 Intelligent Control System, M. M. Gupta IEEE Press.(ISBN: 9780780310636)

Web Links:

- 1 <https://archive.nptel.ac.in/courses/106/105/106105173/>
- 2 https://onlinecourses.nptel.ac.in/noc24_ee32/preview

Methods & Algorithms for Intelligent Control

Course Code:2501EE30

L	T	P	C
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 & BioInspired algorithms with ANN.
- CO5** Formulate hybrid controllers by combining the concepts of Genetic Algorithm & 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						

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction: Introduction to intelligent control, comparison study between conventional & intelligent control, intelligent supervisory control, intelligent adaptive control.

UNIT – II

Neural network based control: Introduction to Neural Network, theory of neural network for classification & function approximation, supervised & unsupervised learning rules, RBF neural network, Support vector machines, intelligent control using Neural Network,

Approximation capabilities by feed-forward & 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 & logic, application of fuzzy logic in control system, fuzzy quantization of knowledge, fuzzy controller design, Fuzzy T-S modelling for dynamic system & stability using Lyapunov theory.

UNIT – IV

Genetic algorithm & control: Basic theory & operations of Genetic algorithm, GA based control system, optimization problem using GA related to control & 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 & case studies related control problems.

Text Books:

- 1 Intelligent Control: Power Electronic Systems (Monographs in Electrical and Electronic Engineering, Dote, Yasuhiko - Hoft, Richard G.(ISBN: 9780198564669) IEEE Pres.
- 2 Genetic Algorithms in Search, Optimization, and Machine Learning, Goldberg, Pearson Education.(ISBN : 978-021157673)

Reference Books:

- 1 Fuzzy logic (intelligence control & information), J. Yen & R. Langari, Pearson, first edition.(ISBN: 978-0135258170)
- 2 Methods & Applications of Intelligent Control, Spyros G. Tzafestas.

Web Links:

- 1 <https://archive.nptel.ac.in/courses/108/104/108104049/>
- 2 <https://archive.nptel.ac.in/courses/106/106/106106126/>

Concept of Smart Grid Technology

	L	T	P	C
Course Code:2501EE32	2	0	0	2

Course Outcomes:

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

- CO1** Explain the concepts of smart grid & its issues in interconnection.
- CO2** Explain various smart grid technologies & its usage in smart applications.
- CO3** Describe the concepts of smart substations.
- CO4** Analyze micro grids & distributed generation systems.
- CO5** Describe the different technologies in smart grid.

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	2	3	1								
CO4	2	3	1								
CO5	2	3	1								

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction to Smart Grid: Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid - Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid.

UNIT – II

Information & Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

UNIT – III

Smart Grid Technologies: Part 1: Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading (AMR) - Outage Management System (OMS) - Plug in Hybrid Electric Vehicles (PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Net Metering.

UNIT – IV

Smart Grid Technologies: Part 2: Smart Substations - Substation Automation - Feeder Automation. Geographic Information System (GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT – V

Micro grids & Distributed Energy Resources: Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources – Demand Response.

Text Books:

- 1 Integration of Green & Renewable Energy in Electric Power Systems - by Ali Keyhani – Mohammad, N. Marwali - Min Dai Wiley (ISBN: 9780470187760).
- 2 The Smart Grid: Enabling Energy Efficiency & Demand Response - by Clark W.Gellings – Fairmont Press (ISBN: 9781439815748).

Reference Books:

- 1 The Advanced Smart Grid: Edge Power Driving Sustainability by andres Carvallo - John Cooper - Artech House Publishers (ISBN: 9781608071272).
- 2 Smart Grid: Technology & Applications - by Janaka B. Ekanayake - Nick Jenkins -Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers (ISBN: 9780470974094).

Web Links:

- 1 <https://nptel.ac.in/courses/108104052/>

- 2 <https://nptel.ac.in/downloads/10811040/>
- 3 <https://nptel.ac.in/courses/10811040/>

Advanced Control Systems

Course Code: 2501EE31	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- CO 1:** To familiarize the state space representation in controllable, observable, diagonal & Jordan canonical forms
- CO 2:** Introduce the concept of controllability & observability tests through canonical forms & design of state feedback controller by pole placement technique & State Observer design.
- CO 3:** Analysis of a nonlinear system using a describing function approach
- CO 4:** Illustrate Lyapunov's stability analysis method for linear & non-linear continuous time autonomous systems.
- CO 5:** Formulation of Euler Lagrange equation for the optimization of typical functional & solutions.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I: State Space Analysis

State Space Representation – Canonical forms – Controllable canonical form – Observable canonical form - Jordan Canonical Form - Solution of state equation – State transition matrix

UNIT-II: Controllability - Observability & Design of Pole Placement

Tests for controllability & observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality - Effect of state feedback on controllability & observability – Design of state feedback control through pole placement.

UNIT-III: Nonlinear Systems

Introduction to nonlinear systems - Types of nonlinearities. Introduction to phase plane analysis -Singular points; Describing function - basic concepts - Describing functions of non- linearity's.

UNIT-IV: Stability analysis by Lyapunov Method

Stability in the sense of Lyapunov – Lyapunov's stability & Lyapunov's instability theorems – Direct method of Lyapunov for the linear & nonlinear continuous time autonomous systems.

UNIT-V: Calculus of Variations

Minimization of functional of single function – Constrained minimization – Minimum principle –Control variable inequality constraints – Control & state variable inequality constraints –Euler lagrangine equation

Text Books:

1. Modern Control Engineering – by K. Ogata - Prentice Hall of India - 3rd edition (ISBN :9789332550162).
2. Automatic Control Systems by B.C. Kuo - Prentice Hall Publication (ISBN: 9780471134763).

Reference Books:

1. Modern Control System Theory – by M. Gopal - New Age International Publishers (ISBN: 9780470274248).
2. Control Systems Engineering by I.J. Nagarath&M.Gopal - New Age International (P) Ltd(ISBN: 9788195175581).
3. Digital Control & State Variable Methods – by M. Gopal - Tata Mc Graw–Hill Companies (ISBN: 9781259083174).

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>

Energy Audit, Conservation & Management

Course Code:2501EE33

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, & various technologies.
- CO2** Design energy efficient lighting systems.
- CO3** Calculate power factor of systems & propose suitable compensation techniques.
- CO4** Explain energy conservation in HVAC systems.
- CO5** Calculate life cycle costing analysis & 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	-	-	-	-	-	-	-	-

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 Principles of Energy Audit:

Energy audit- definitions - concept - types of audit - energy index - cost index - pie charts - Sankey diagrams & 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 & functions - language - Questionnaire – check list for top management.

UNIT – III

Energy Efficient Motors & 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 & practice - lighting control - lighting energy audit.

UNIT – IV

Power Factor Improvement & 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 & 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: 978142088700).

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: 978077076788).

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 Energy Storage Systems

Course Code:2501EE36

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								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	2	
CO4	2	
CO5	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”, James M. Eyer, Joseph J. Iannucci & Garth P. Corey , Sandia National Laboratories.
- 2 The Electrical Energy Storage by IEC Market Strategy Board.

Reference Books:

- 1 “Jim Eyer, Garth Corey”, Energy Storage for the Electricity Grid: Benefits & Market Potential Assessment Guide, Report, Sandia National Laboratories.
- 2 Energy Storage by Mullick & Garg

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/10810309>

Energy Converters

Course Code:2501EE39

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Explain the different types of isolated & non isolated converters & their Comparisons.
- CO2:** Explain the resonant converters.
- CO3:** Explain the steady state analysis of power factor corrected converter.
- CO4:** Explain the various modulation techniques for single phase inverter.
- CO5:** Explain the operation of various Multilevel Inverters & it's comparison.

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	3	2	1								
CO5	3	2	1								

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Switching Voltage Regulators:

Linear power supply (voltage regulators); Switching voltage regulators; Isolated converters dc-dc converters like Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Cuk converter, Sepic Converter; Comparison of isolated & non-isolated converters; Design criteria for SMPS; Multi-output switch mode regulator.

UNIT – II

Resonant Converters: Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies.

UNIT – III

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, & steady state- analysis, three phase boost PFC converter.

UNIT – IV

PWM Inverters: Principle of operation-Voltage control of single-phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection & delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60° PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters Variable dc link inverter.

UNIT – V

Multilevel Inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters Comparisons of Multilevel Converters.

Text Books:

- 1 Power Electronics: Converters, Applications, & Design- Ned Mohan, Tore M. Undeland.(ISBN: 978-8126510900)
- 2 Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint.(ISBN: 978-93325018445)

Reference Books:

- 1 Control in power electronics” Marian P. Kazmierkowski, Ramu Krishnan, Frede Blabjerg Edition illustrated Published by Academic Press.
- 2 “High Power Converters & AC Drives”, Bin Wu, John Willey & sons, Inc.

Web links:

- 1 https://onlinecourses.nptel.ac.in/noc24_ee88/preview.
- 2 <https://archive.nptel.ac.in/courses/108/102/108102157/>.

Digital Control Systems

Course Code: 2501EE38

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1: To understand the concepts of digital control systems & assemble various components associated with it. Advantages compared to the analog type.
- CO 2: The theory of z-transformations & application for the mathematical analysis of digital control systems
- CO 3: To represent the discrete-time systems in state-space model & evaluation of state transition matrix, the design of state feedback control by “the pole placement method.”, design of state observers
- CO 4: To examine the stability of the system using different tests & study the conventional method of analyzing digital control systems in the w-plane.
- CO 5: Design of state feedback controller through pole placement.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I: Introduction to Signal Processing

Introduction to analog & digital control systems – Advantages of digital systems – Continuous & Discrete Time Signals – Sample & hold devices – Sampling theorem & data reconstruction – Frequency domain characteristics of zero order hold.

UNIT-II: Z-Transformations

Z-Transforms – Theorems – inverse Z-transforms – Formulation of difference equations & solving – Block diagram representation – Pulse transfer functions & finding open loop & closed loop responses.

UNIT-III: State Space Analysis & the Concepts of Controllability & Observability

State space representation of discrete time systems – Solving Discrete Time state space equations – State transition matrix & its properties – Concepts of controllability & observability

UNIT-IV: Stability Analysis

Mapping between the S-Plane & the Z-Plane – Primary strips & Complementary strips – Stability criterion – Modified Routh's stability criterion & Jury's stability -Design using frequency response in the w-plane for lag & lead compensators – Root locus technique in the z-plane

UNIT-V: State Feedback Controllers & State Observers

Design of state feedback controller through pole placement – Necessary & sufficient conditions –Ackerman's formula – Design of state observers

Text Books:

1. Discrete-Time Control systems – K. Ogata - Pearson Education/PHI - 2nd Edition.(ISBN: 978-8120327603)
2. Digital Control & State Variable Methods by M.Gopal - TMH - 4th Edition.(ISBN:978-07133327)

Reference Books:

1. Digital Control Systems - Kuo - Oxford University Press - 2nd Edition.(ISBN: 978-0195120646)
2. Digital Control & State Variable Methods – by M. Gopal - Tata Mc Graw-Hill Companies.(ISBN:978-07133327)

Web Links:

1. <https://nptel.ac.in/courses/10810308>
2. <https://ocw.mit.edu/courses/2-171-analysis-&-design-of-digital-control-systems-fall-206/>

Utilization of Electrical Energy

Course Code:2501EE27

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	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	1
CO2	-	1
CO3	-	2
CO4	-	1
CO5	-	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: 978938027845).
- 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

Alternative Energy Sources

Course Code:2501EE34

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					

Mapping of Course Outcomes with Program Specific Outcomes:

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

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).

Special Electrical Machines

Course Code:2501EE35

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								

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1		1
CO2		1
CO3		1
CO4		1
CO5		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

Permanent Magnet 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, Clarendon press, T.J.E.Miller, Oxford.
- 2 Special electrical Machines, K. VenkataRatnam, University press, New Delhi

Reference Books:

- 1 Special electrical machines, E.G. Janardhanan, PHI learning private limited.
- 2 Krishnan, R., “Permanent Magnet & BLDC Motor Drives”, CRC Press.

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/>

Power Quality

L	T	P	C
3	0	0	3

Course Code:2501EE40

Course Outcomes:

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

CO 1: Differentiate between different types of power quality problems.

CO 2: Explain the sources of voltage sag, voltage swell, interruptions, transients, long duration over voltages & harmonics in a power system.

CO 3: Analyze power quality terms & power quality standards.

CO 4: Explain the principle of voltage regulation & power factor improvement methods

CO 5: Demonstrate the relationship between distributed generation & power quality.

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	3	1								
CO2	3	2									
CO3	2	3	1	1							
CO4	3	2			2						
CO5	3	2									

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT-I

Introduction: Overview of power quality – Concern about the power quality – General classes of power quality & voltage quality problems – Transients – Long–duration voltage variations –Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations.

UNIT-II

Voltage imperfections in power systems: Power quality terms – Voltage sags – Voltage swells & interruptions – Sources of voltage sag, swell & interruptions – Nonlinear loads – IEEE standard 519-2014 & IEC standard 61000. Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection –Utility capacitor switching transients

UNIT-III

Voltage Regulation & power factor improvement: Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End-user capacitor application–Regulating utility voltage with distributed resources – Flicker – Power factor penalty – Static VAR compensations for power factor improvement.

UNIT-IV

Harmonic distortion & solutions: Voltage distortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors & meters – Point of common coupling – Passive & active filtering – Numerical problems.

UNIT-V

Distributed Generation & Power Quality: Resurgence of distributed generation – DG technologies – Interface to the utility system –Power quality issues & operating conflicts – DG on low voltage distribution networks.

Monitoring & Instrumentation: Power quality monitoring & considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data – Application of intelligent systems – PQ monitoring standards.

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, & Beaty H W, Second Edition, McGraw–Hill, 3rd edition (ISBN: 978125905572).
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley India publications (ISBN: 9780780347137).

Reference Books:

1. Power System Harmonics, Arrillaga J & Watson N R, Second Edition, John Wiley & Sons (ISBN: 9788126560431).
2. Electric Power Quality Control Techniques, W. E. Kazibwe & M. H. Sendaula, Van Nostrand Reinhold, New York (ISBN: 978044210935).

3. Power Quality by C.Shankaran, CRC Press (ISBN:9780849310409).

Web Links:

1. https://en.wikipedia.org/wiki/Electric_power_quality
2. <https://www.accessengineeringlibrary.com/browse/power-quality-in-electrical-systems>
3. www.p3-inc.com/images/what_is_power_quality.pdf

Hybrid Electric Vehicles

Course Code: 2501EE37

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								

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	2	
CO3	2	2
CO4		2
CO5	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, end-of-life battery for electric power grid support, vehicle to grid technology, 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, voltage source inverter, current source inverter, isolated bidirectional DCDC converter, PWM rectifier in HEVs, EV & PHEV battery chargers.

UNIT-V:

Battery & Storage Systems: Energy Storage Parameters; Lead–Acid 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:978-1466597693)
2. Electric & Hybrid Vehicles: Design Fundamentals by Iqbal Hussein , CRC Press.(ISBN: 978-143981175)

Reference Books:

1. Introduction to Hybrid Vehicle System Modelling & Control by Wei Liu, Wiley (ISBN:978-8126556205).
2. “Electric & Hybrid Vehicles Technologies, Modelling & Control: A Mechatronic Approach”, by Amir Khajepour, Saber Fallah& Avesta Goodarzi, John Wiley & Sons Ltd.(ISBN: 978-1118341513)

Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/10810309/>
2. https://ndl.iitkgp.ac.in/he_document/nptel/nptel/IN__N__1_E_E__12391_I_t_H_a_E_V__14024_D_o_H_E_v__14030_14031

UNIVERSITY OPEN ELECTIVE COURSES

AI & ML											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
2501AI02	Artificial Intelligence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI05	Machine Learning	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI027	AI & Data Science	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI028	AI in Healthcare	IC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI11	Deep Learning	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI10	Natural Language Processing	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI09	Reinforcement Learning	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI29	AI in Agriculture	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI30	Robotics & AI	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI31	AI in Finance & Economics	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI32	AI in Business & Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	DAP
Total			19		13	32					

Artificial Intelligence

Course Code: 2501AI02

L	T	P	C
2	0	0	2

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
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 :

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 logicStructured 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: 2501AI05

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 Jupitar/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.

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

AI & Data Science

Course Code: 2501AI027

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 MongoDB.

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: 2501AI028

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 : 978-303045050

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_hs40/preview
- 2 <https://nptel.ac.in/courses/109107190>

Deep Learning

(Common to CSE, IT, AIML & CSE(DS))

Course Code: 2501AI11

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		

Mapping of Course Outcomes with Program Specific Outcomes:

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

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 k-Means 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.

Capstone Project:

Face Mask Detection Using Convolutional Neural Networks

Objective: Detect whether a person in an image is wearing a mask or not using real-time webcam input.

Domain: Healthcare / Public Safety

Techniques & Concepts Used:

- * Image Classification (CNNs – using TensorFlow/Keras)
- * Data Augmentation & Preprocessing
- * Transfer Learning (e.g., MobileNetV2)
- * Real-time camera integration using OpenCV

Text Books:

- 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/>

Natural Language Processing

Course Code: 2501AI10

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:

- Word Analysis Learn about morphological features of a word by analysing it
- 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:

- Implement Porter Stemming Algorithm
- 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:

- 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: 978-93325018414
- 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/linguipediacodefestnaturallanguageprocessing1/?utm_source=ultimateguidetounderstandimplementnaturallanguageprocessingcodesinpython&utm_medium=blog

Reinforcement Learning

Course Code: 2501AI09	L	T	P	C
	1	0	2	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	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	1
CO3	3	1
CO4	2	-
CO5	3	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: 2501AI29

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 tilth; 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: 2501AI30

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: 2501AI31

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:

- 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:

- 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
2501ME81	Fundamentals of Production Excellence	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME82	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
2501ME83	Quality Excellence in Production	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME84	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
2501ME85	Agile Production Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME86	Process Excellence & Optimization	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME87	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
2501ME88	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
2501ME89	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
2501ME58	Industry 5.0 for Engineers	AC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
2501ME90	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					

Fundamentals of Production Excellence

Course Code: 2501ME81	L	T	P	C
	2	0	0	2

- CO1 Explain the key principles, evolution, and organizational relevance of production excellence
- CO2 Apply lean manufacturing tools and waste reduction techniques to improve production systems.
- CO3 Evaluate quality management strategies such as TQM and Six Sigma for continuous improvement.
- CO4 Analyze methods for resource efficiency and sustainability in production environments
- CO5 Assess the role of advanced manufacturing technologies, including Industry 4.0 and 3D printing, in achieving production excellence.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 978-071392310

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. 4. Production and Operations Analysis Steven Nahmias, Waveland Press, Inc., (7th Edition ,ISBN: 978-1478623069
3. 5. 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: 2501ME82

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Understand the Six Sigma fundamental principles, Frameworks, and Roles and Certifications and its importances.
- CO2:** Apply the Define and Measure phases by formulating problem statements, collecting data, and identifying by using various measurement tools.
- CO3:** Analyse production data to identify root causes of defects using tools and implement improvement strategies.
- CO4:** Develop and implement control plans using appropriate control charts, SOPs, and continuous improvement strategies.
- CO5:** Utilize advanced statistical tools, & software and understand future trends including Industry 4.0, AI, and sustainable manufacturing.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 978-071455480

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: 978-071418218

3. Design for Six Sigma: A Roadmap for Product Development, Kai Yang and Basem El-Haik, McGraw-Hill, ISBN: 978-071547673

Quality Excellence in Production

Course Code: 2501ME83	L	T	P	C
	2	0	1	3

Course Outcomes:

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

CO1: Explain key quality concepts, dimensions, and the importance of quality management in production systems.

CO2: Apply quality control tools to analyze and solve real-life production problems.

CO3: Explain the process of ISO certification and discuss its impact on production efficiency and organizational competitive.

CO4: Explain the Six Sigma methodology and its significance in systematic quality improvement.

CO5: Analyze case studies to identify the benefits and challenges of implementing QbD across different industries.

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		-
CO2	2	-	-	-	1	1	1	1	-	1	-
CO3	2	1	-	-	1	1	1	-	-	-	-
CO4	2	1	-	-	2	1	-	1	-	-	-
CO5	2	1	-	1	-	1	-	-	1	-	-

UNIT I: 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 II: 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 III: 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 901 improves production processes
- Group Project: Develop a quality audit plan for a manufacturing company

UNIT IV: 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 V: 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: 978-071441193
3. Total Quality Management and Operational Excellence: Text with Cases, John S. Oakland, Routledge, ISBN: 978-113819806.

Digital Transformation for Production Excellence

Course Code: 2501ME84	L	T	P	C
	2	0	1	3

Course Outcomes

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

- CO1 Understand and explain the key drivers, technologies, and implications of digital transformation in production systems.
- CO2 Analyze and apply data analytics, AI, and machine learning techniques for improving production processes and decision-making.
- CO3 Evaluate and design automation strategies, including robotics and collaborative technologies, to enhance production excellence.
- CO4 Develop digital solutions incorporating smart factory and digital supply chain concepts with cybersecurity considerations.
- CO5 Formulate strategies for successful digital transformation including change management and future-readiness in manufacturing environments.

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
CO2	3	-	2	-	1	-	-	-	1	-	2
CO3	3	-	1	2	1	-	-	2	2	-	1
CO4	3	-	-	2	1	-	1	-	2	2	1
CO5	3	1	-	-	1	-	1	-	1	1	1

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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

Course Code: 2501ME85

L	T	P	C
2	0	1	3

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 978-080435671

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: 978-184802661
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

	L	T	P	C
Course Code: 2501ME86	2	0	1	3

Course Outcomes:

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

- CO1:** Apply core concepts of TQM, Six Sigma, and Lean to map processes and evaluate performance using KPIs.
- CO2:** Implement Lean tools such as 5S, Kaizen, and Value Stream Mapping (VSM) to identify non-value-adding activities and enhance process efficiency.
- CO3:** Utilize Six Sigma methodologies and statistical techniques to minimize process variation and improve overall quality.
- CO4:** Apply optimization strategies using simulation models, data analytics, and benchmarking to enhance process performance.
- CO5:** Integrate sustainability into process improvements and assess the impact of Industry 4.0 and IoT on process excellence.

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	-	-	-	-	-	-	-	-
CO4	2	2	3	-	-	-	-	-	-	-	-
CO5	2	2	2	-	-	-	-	-	-	-	-

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 978-1447152928

Risk Management in Production Excellence

	L	T	P	C
Course Code: 2501ME87	2	0	1	3

Course Outcomes:

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

CO1: Explain Fundamentals of Risk Management

CO2: Apply risk identification tools like FMEA and HAZOP, and assess risks using Risk Matrix, FTA, and ETA methods.

CO3: Evaluate the effectiveness of risk controls through monitoring and real-world case studies.

CO4: Identify and assess risks in supply chain and operations using structured frameworks and tools.

CO5: Discuss the Future Trends and Challenges in Risk 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	2	-	-	-	-	2	1	-	-	1	-
CO2	2	-	-	-	-	2	1	-	-	1	-
CO3	2	-	-	-	-	2	1	-	-	1	-
CO4	2	-	-	-	-	2	1	-	-	1	-
CO5	2	-	-	-	-	2	1	-	-	1	-

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 978-1119477571.

Ethical & Social Responsibility in Production Excellence

Course Code: 2501ME88	L	T	P	C
	2	0	1	3

Course Outcomes:

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

CO1: Define basic ethical principles and explain the role of social responsibility in production activities.

CO2: Identify ethical issues in labour, environment, and supply chain operations.

CO3: Discuss the importance of CSR in improving production and company reputation

CO4: Apply legal and ethical standards to ensure compliance in production systems

CO5: Analyze future challenges for ethical and responsible production.

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	2				
CO3						2	2	2	2		
CO4		2		2		2	2		2		
CO5			2			2	2	2	2	2	1

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 2501ME89	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 data-driven decision making and identify key data sources in production.

CO2: Apply basic techniques to collect and manage production data using suitable tools.

CO3: Use simple statistical tools and visualizations to interpret production data.

CO4: Identify how data can support production decisions like quality control and scheduling.

CO5: Describe emerging technologies like IoT and AI in improving production decisions.

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				2	
CO2	2	2		1	3					1	
CO3	2	2		2	3					2	1
CO4	2	2	2	1	2				1	2	1
CO5	2	1	2		2	2				1	2

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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: 2501ME058

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 – III

Technology Evolution

Basics of cyber Physical Systems, Process Automations and Collaborative robots, Fundamental to artificial Intelligence, Mobile Computing, Cyber Security, Ethical technology, Responsive and distributed supply chain system, Human-centric and Value-oriented approaches.

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, 210.
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.etherncat.org/default.htm>

Cost Excellence in Production

Course Code: 2501ME90	L	T	P	C
	2	0	1	3

Course Outcomes:

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

CO1: Explain cost types and apply basic cost analysis tools in production.

CO2: Apply cost control and reduction techniques to improve production efficiency.

CO3: Use ABC and TCO methods to analyze and manage production costs.

CO4: Interpret financial metrics and perform cost-benefit analysis in production.

CO5: Assess emerging trends and develop strategies for cost excellence.

Mapping of Course Outcomes with Program Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	-	1	-	-	-	-	-	-
CO2	2	2	3	-	2	1	-	-	-	-	-
CO3	2	2	2	-	3	-	-	-	-	1	-
CO4	2	-	1	-	1	-	-	-	-	2	-
CO5	-	-	-	-	-	2	-	-	-	1	2

UNIT I: 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 II: 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 III: 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 IV: 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 V: 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
2501MB017	Introduction to Supply Chain Management	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
2501MB018	Logistics & Distribution Management	FC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB019	Supply Chain Project Management	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB020	Supply Chain Innovation & Trends	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB021	Supply Chain Analytics	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB022	Demand Planning & Forecasting	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB023	Supply Chain Risk Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB024	Inventory Management & Control	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB025	E-Commerce & Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB026	Operations Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB027	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					

Introduction to Supply Chain Management

Course Code: 2501MB17

Course Outcomes:

L	T	P	C
2	0	0	2

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

Mapping of Course Outcomes with Program Outcomes:

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

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-078096642
2. World Class Supply Management, Burt, Dobbler, Starling, TMH., 2019, ISBN-070499330.

Reference Books:

1. Logistical Management, Donald J Bowersox, David J Closs, TMH, 9th Edition, ISBN-978070435544
2. Reguram G, Rangaraj N., Logistics and Supply Chain Management Cases and Concepts: Macmillan India Ltd., New Delhi, ISBN-978070221635.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/11105141/>
2. <https://www.youtube.com/watch?v=Nrl0CtS1m8Y>

Logistics & Distribution Management

Course Code: 2501MB18

Course Outcomes:

L	T	P	C
3	0	0	3

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.

Mapping of Course Outcomes with Program Outcomes:

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

Unit I

Logistics: Definition - History and Evolution- Objectives – Elements- Activities Importance- The work of logistics-Logistics interface with marketing- Retail logistics-Emerging concept in logistics.

UNIT II

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-III:

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-IV:

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-V:

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, 204
2. Krishna K. Havaldar, Vasant M. Cavale Sales & Distribution Management McGraw Hill Latest Edition

Supply Chain Project Management

Course Code: 2501MB19

Course Outcomes:

L	T	P	C
3	0	0	3

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

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		2				1				2	
CO3	1	2	2			1				2	
CO4	2	2	2			1				3	
CO5	2	2			1	1				3	

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 delhi210

Supply Chain Innovation & Trends

Course Code: 2501MB20

L	T	P	C
3	0	0	3

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

- CO1:** Explain the fundamental concepts of innovation and R&D, including types, models, processes, and managerial aspects
- CO2:** Classify and analyze different innovation strategies and organizational structures for fostering creativity and managing innovation effectively.
- CO3:** Evaluate financial aspects of R&D projects using appropriate tools and techniques for budgeting, forecasting, and project selection
- CO4:** Design R&D organizational structures and formulate strategies to address leadership, HRM, and project management issues in innovation-driven environments.
- CO5:** Assess the national and institutional frameworks supporting R&D in India and recommend policies for commercialization and promotion of R&D activities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									
CO2	2	3	2								
CO3	2	3			2					3	
CO4	2		2		2			2			
CO5	2					3	2			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 208.

Supply Chain Analytics

Course Code: 2501MB21

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

Mapping of Course Outcomes with Program Outcomes:

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

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: 013380202
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: 2501MB22
Course Outcomes:

L	T	P	C
3	0	0	3

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.

Mapping of Course Outcomes with Program Outcomes:

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

Unit- I

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- II

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- III

Demand Forecasting: Concept of Demand Forecasting, objectives and Factors influencing Demand Forecasting, different types of Demand Forecasting, advantages and disadvantages of Demand Forecasting.

Unit- IV

Methods of Demand Forecasting: Need for Demand Forecasting, types of Demand Forecasting, different methods of Demand Forecasting.

Unit- V

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: 2501MB23

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.

Mapping of Course Outcomes with Program Outcomes:

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

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:978104084625.

Web Links:

1. http://ndl.iitkgp.ac.in/he_document/nptel/nptel/courses_110_108_11108056_video_1ec9
2. http://ndl.iitkgp.ac.in/he_document/nptel/courses_110_108_11108056_video lec11

Inventory Management & Control

Course Code: 2501MB24

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.

Mapping of Course Outcomes with Program Outcomes:

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

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-978-812030279
2. Handbook of Materials Management, Gopalakrishan 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-070370478

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/11105095/>
2. https://onlinecourses.nptel.ac.in/noc20_mg17/preview

E-Commerce & Supply Chain Management

Course Code: 2501MB25

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 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

Mapping of Course Outcomes with Program Outcomes:

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

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*: 978-074637425 *ISBN-10*: 074637428.
- 2 Wisner, Keong Leong and Keah-Choon Tan, PRINCIPLES OF SUPPLY CHAIN MANAGEMENT A BALANCED APPROACH, Thomson Press

Operations Management

Course Code: 2501MB26

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.

Mapping of Course Outcomes with Program Outcomes:

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

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-978070583559 .
- 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/110/107/11107141/>

Supply Chain Ethics & Corporate Social Responsibility (CSR)

Course Code: 2501MB27

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.

Mapping of Course Outcomes with Program Outcomes:

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

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 Ethis – 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/110/105/11105079/>
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
2501CE74	Introduction to Sustainable Development	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,CSE(DS) PT,Min.E	-
2501CE79	Natural Disaster Management & Mitigation	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE81	Waste Water Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE82	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	-
2501CE83	Watershed Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EE33	Energy Audit, Conservation & Management	IC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE53	Electric Power Generation, Transmission & Distribution Systems	AC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501CE75	Sustainable Agriculture & Food Systems	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE76	Sustainable Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE77	Sustainable Production Excellence	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE78	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: 2501CE74

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Describe the concept, nature, and scope of sustainable development and relate it to economic growth and poverty.
- CO2:** Interpret the dimensions of social development including exclusion, human development indices, and participatory approaches.
- CO3:** Explain the stages of human development and assess the impact of deprivation across the life span.
- CO4:** Analyze the role of governance, decentralization, and local policies in sustainable development.
- CO5:** Summarize the contributions of CBOs, NGOs, legal systems, education, media, and international bodies in promoting sustainable and inclusive development.

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	3	1	1	2	1	2
CO2	2	2	2	1	1	3	2	1	2	1	2
CO3	2	2	2	2	1	3	2	2	2	1	2
CO4	2	2	3	2	1	3	2	2	2	2	3
CO5	2	1	2	1	1	3	2	1	2	2	2

UNIT I:

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.

Unit2:

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. Millenium Development Goals, Sustainable development Goals

UNIT III:

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 IV:

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 V:

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

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

Course Code: 2501CE79

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	PO12
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: 13-978-813160337).
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:13-978074631881).
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose. (ISBN:13-978-095361411).
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

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

Course Code: 2501CE81

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: 13-978-07341188).
2. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill, 2018. (ISBN: 13-978-070495395).

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:13-978812033601)

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:978070620995).

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

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

Course Code: 2501CE82

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: 13-978-070632370).

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: 2501CE83

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: 2501EE33

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: 978142088700).

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: 978077076788).

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: 2501EE53

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: 978817700207).
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: 978070151413).

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: 2501CE75

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the principles and importance of sustainable agriculture in addressing environmental, social, and economic challenges.
- CO2:** Apply ecological principles to develop sustainable and resilient farming practices.
- CO3:** Acquire knowledge of soil health management, crop diversity, and rotation for sustainable agricultural productivity.
- CO4:** Evaluate sustainable water management practices, irrigation techniques, and watershed management in agriculture.
- CO5:** Analyse the interconnected components of food systems, from production to consumption and 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	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

Introduction to sustainable agriculture: understanding the principles, practices, and importance of sustainable agriculture in addressing environmental, social and economic Challenges.

Unit II

Agroecology: exploring the ecological principles underlying sustainable farming practices and their application.

UNIT III

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 IV

Water management: Examining sustainable water use practices in agriculture, irrigation methods, water conservation and water shed management.

Unit-V

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:2501CE76

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the concepts, principles, benefits, and challenges of Sustainable Supply Chain Management (SSCM) in a global context.
- CO2:** Apply sustainable procurement strategies, supplier management, and regulatory compliance in sourcing decisions.
- CO3:** Evaluate sustainable production, closed-loop supply chains, and environmental management practices in operations.
- CO4:** Assess green logistics, eco-friendly packaging, and sustainable distribution practices in supply chains.
- CO5:** Measure supply chain sustainability performance, enhance transparency, and analyze emerging trends and innovations in SSCM.

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: 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 II: 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 III: 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 1401, 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 IV: 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 V: 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 Trautrim, 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: 2501CE077

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the principles, importance, and triple bottom line dimensions of sustainable production in achieving global sustainability goals.
- CO2:** Apply lean, green, and circular economy strategies to improve resource, energy, and material efficiency in production systems.
- CO3:** Evaluate the role of advanced technologies, life cycle assessment, and innovations in promoting sustainable production.
- CO4:** Implement environmental management systems, sustainability reporting, and CSR initiatives in production environments.
- CO5:** Analyse future trends, global challenges, and climate-responsive strategies for advancing sustainable production 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	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: 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 II: 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 III: 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 IV: Environmental Management Systems and Certifications

Environmental Management Systems (EMS): ISO 1401 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 5001, 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 V: 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: 2501CE78

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the fundamentals of AI and its applications in addressing global sustainability challenges.
- CO2:** Apply AI techniques for climate prediction, environmental monitoring, and pollution control.
- CO3:** Develop AI-based solutions for sustainable agriculture, natural resource management, and food security.
- CO4:** Evaluate AI applications in optimizing renewable energy, smart grids, and carbon footprint reduction.
- CO5:** Analyse the ethical, social, and policy implications of AI applications in environmental sustainability.

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: 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 II: 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 III: 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 IV: 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 V: 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
2501CS32	Cybersecurity Essentials	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT35	Security in Software Development	FC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS28	Ethical Hacking	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS69	Cloud Security	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT36	Security & Compliance in Business	IC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT37	Cryptography & Data Security	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT38	Security Awareness & Social Engineering	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT39	Cybersecurity Policy & Strategy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT40	Security in Emerging Technologies	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS30	Information Security Analysis & Audit	AC	2			2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT41	Financial Information Security & Privacy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
Total			25		07	32					

Cybersecurity Essentials

Course Code:2501CS32

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.

2. 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:

1.
 - 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:2501IT35

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: 978-071776165
- 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:2501CS28

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: 2501CS69

L	T	P	C
0	0	3	3

Course Outcomes:

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

- CO1:** Explain basic cloud security principles, attack vectors, and access control methods in cloud environments.
- CO2:** Illustrate IAM roles, policies, and resource-based permissions used to secure cloud infrastructure.
- CO3:** Apply AWS security services and configurations to monitor, protect, and manage cloud network resources.
- CO4:** Implement data protection methods and access controls to secure cloud storage and network resources using AWS services.
- CO5:** Analyze monitoring, vulnerability assessment, and threat protection techniques to secure applications and resources in AWS.

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	1	-	-	2	1	-	-	1	-	2
CO3	3	2	2	-	3	-	-	-	1	-	2
CO4	3	2	2	-	3	-	-	-	1	-	2
CO5	3	3	2	-	3	-	-	-	2	-	2

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

Course Code: 2501IT36

L	T	P	C
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.

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	2	-	-	-	-	-	2
CO2	2	3	2	2	2	-	-	-	-	-	2
CO3	3	2	3	2	3	-	-	-	-	-	2
CO4	2	3	2	2	2	-	-	-	-	-	2
CO5	2	2	3	2	3	-	-	-	-	-	2

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:2501IT37

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.

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	2	-	-	-	-	-	2
CO2	3	3	2	2	2	-	-	-	-	-	2
CO3	3	2	3	2	3	-	-	-	-	-	2
CO4	3	3	2	3	3	-	-	-	-	-	2
CO5	3	3	3	3	3	-	-	-	-	-	2

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: 978-364204106
- 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 & Social Engineering

Course Code: 2501IT38

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.

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	-	-	-	-	2
CO2	3	3	2	2	2	2	-	-	-	-	2
CO3	2	1	-	-	1	2	-	-	-	-	2
CO4	3	2	2	1	2	2	-	-	-	1	2
CO5	2	2	3	-	2	2	-	-	-	2	2

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: 978-130550372
- 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: 2501IT39

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 2701, 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: 2501IT040

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: 2501CS30

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: 2501IT41

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 – III

Financial Data Privacy: Concepts and Frameworks

Understanding Privacy: Definitions and Importance, Privacy Laws and Regulations (e.g., GDPR, CCPA), Privacy by Design in Financial Systems, Data Anonymization and Masking Techniques, Privacy Risk Assessments

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: 978-303072306

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
2501CE80	Remote Sensing & GIS Applications	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EE36	Electric Energy Storage Systems	FC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE43	Electrical safety	IC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE54	Hybrid & Electric Vehicles	IC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501ME73	Organizational Behaviour	FC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME36	Sustainable Energy Systems	FC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME37	Solar Energy Systems	FC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME60	Composite Materials	IC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	SSP/MP
2501EC82	Communication Systems	FC	3			3	50	50	100	CE,EEE,ME,CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC83	Electronic Measurements & Instrumentation	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EC84	Introduction to Embedded Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC85	Fundamentals of Image Processing	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
2501EC77	Sensors and Transducers	IC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
2501CS03	Data Structures	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS65	Computer Organization	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS13	Operating Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-

2501IT05	Database Management Systems	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS07	Computer Networks	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT06	Java Programming	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS68	Fundamentals of RedHat Enterprise Linux	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS67	AWS Cloud Foundations	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS66	AWS Cloud Development	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS70	Continuous integration & delivery using DevOps	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT24	Fundamentals of Salesforce Administration	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT34	Advanced Salesforce Administration	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT23	Principles of Pega Systems	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT26	Pega System Architecture & Design	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501MB04	Entrepreneurship Development & Incubation	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501MB05	Business Ethics & Corporate Governance	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501MB06	Entrepreneurship Development & Business Management	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC29	SoC Design	AC	3			3	50	50	100	CE, EEE, ME, CSE, IT, AIML, CSE (DS), PT, Min.E.	MPMC
2501CS23	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:2501CE80	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 Willey.(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- 978-817087960).

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

	L	T	P	C
Course Code:2501EE36	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 Books:

- 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/10810309>

Electrical Safety

Course Code: 2501EE43

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: 978071745130)
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

L T P C

Course Code:2501EE54

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/10810309>
- 3 <https://www.nrel.gov/research/transportation-hybrid-electric.html>

Organizational Behaviour

Course Code: 2501ME73

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:2501ME36

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: 2501ME37

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, Pyrliometer, 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, 209, ISBN : 978070142961.
2. Principles of Solar Engineering, D.Yogi Goswami, Frank Kreith 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, 202, 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: 2501ME60

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 moduli.

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, 210, ISBN9781848828308: .
2. Composite Materials Design and Applications, Daniel Gay, Suong V. Hoa & Stephen W. Tsai, CRC Press, 1st Edition, 202, ISBN : 9781587160844.

Web Links:

1. <https://nptel.ac.in/courses/112104229>
2. <https://www.coursera.org/learn/ceramics-and-composites>.

Communication Systems

Course Code:2501EC82

L	T	P	C
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: 070648115.
2. Communication Systems: Analog and Digital, R P Singh and S D Sapre, McGraw Hill India, Third Edition, ISBN: 125904600.
3. Communication Systems – B. P. Lathi, BS Publication, ISBN: 817800156.

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: 071077820.
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

	L	T	P	C
Course Code: 2501EC83	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: 978070702066.
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

	L	T	P	C
Course Code: 2501EC84	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	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	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/206/ChinaSchool/1_ESIntroduction.pdf
2. <http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>
3. <http://www.vtt.fi/inf/pdf/publications/204/P526.pdf>

Fundamentals of Image Processing

Course Code: 2501EC85

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 techniques. **CO3:** Compare image restoration techniques. **CO4:** Infer the color image processing methods. **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	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-
CO5	3	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.

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

L T P C

Course Code: 2501EC77

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

	L	T	P	C
Course Code: 2501CS03	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:

1. Write a C program to find the total, average of n students using structures
2. Copy one structure variable to another structure of the same type.
3. 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:

1. Implement Merge sort using arrays.
2. Implement Quick sort using arrays
3. 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:2501CS65

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	PO 10	PO 11
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:

- 1.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:

- 1.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: **978-125905275**
2. Computer System Architecture, M. M. Mano, Prentice Hall of India,3rd Edition, **ISBN-13. 978-813170709.**
3. Computer Organization and Architecture Designing for Performance, William 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: 978071329071.**

Web Links:

1. [https://www.classcentral.com/course/swayam-computer-organization- andarchitecture-a-pedagogical-aspect-9824](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:2501CS13	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: 978-93325018803

Reference Books:

1. Modern Operating Systems, Tanenbaum A S, Pearson Education, 3rd Edition. ISBN: 978-013606633
2. Operating Systems A Concept Based Approach, Dhamdhare D M, Tata McGraw-Hill, 3rd Edition. ISBN: 978-125905589
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: 2501IT05	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, relation, 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 DML 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, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER 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(updatable and nonupdatable), 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 and Indexing, Cluster Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing: Tree base 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 by Oracle Academy at the end of the Practice Session.**

Text Books:

- 1 Database System Concepts ,Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw- Hill , 8th Edition., ISBN-13: 978-1260230508.
- 2 Database Management Systems, Raghurama Krishnan, Johannes Gehrke, Mc Graw-Hill, 4th Edition, ISBN: 978-126091195.

Reference Books:

- 1 Database Systems, Ramez Elmasri, Shamkant B. Navathe, 7th Edition, Pearson, ISBN: 978- 0137504277.
- 2 Database Systems, Carlos Coronel, Steven Morris, Peter Rob, 10th Edition, Cengage, ISBN: 978-0357517864.
- 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: 2501IT07

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/P O	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. Agile Software Development, Current Research and Future Directions, Springer-Verlag
- 2 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. Agile Management for Software Engineering: Applying the Theory of Constraints for
- 2 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

	L	T	P	C
Course Code: 2501CS07	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 implements 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

Capstone Project:

Simulate and implement data link layer protocols and network routing strategies using NS2 (Network Simulator 2). It includes configuring network topologies, setting up routing protocols like AODV, DSDV, and OLSR, and analyzing their performance through metrics such as throughput, delay, and packet delivery ratio. Additionally, explore the simulation of data link layer functionalities, including MAC addressing and error detection. You may use NS2's capabilities, that insights into the behaviour of network protocols, aiding in the design and optimization of efficient communication systems.

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>

Java Programming

	L	T	P	C
Course Code: 2501IT06	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

- Sort an array of integers in ascending order.
- Find the maximum and minimum element in an array.
- 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, String Tokenizer, String Buffer and StringBuilder.

Practice:

1. Class Mechanism

- Display the details of a person. Personal details should be given in one method and the qualification details in another method.
- Implement constructor and constructor overloading.
- Implement method overloading.

2. Strings

- Check if a given string is a pangram (contains every letter of the alphabet at least once).
- Find the most frequently occurring character in a string.
- Find all permutations of a given string.
- 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

- Implement multi level Inheritance.
- Implement multiple Inheritance.
- 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

Course Code:	L	T	P	C
2501CS68	0	0	2	2

Practice:

1. Installation and Basic Commands

- Install RHEL: Set up RHEL on your system, configure installation options, and create user accounts.
- Execute Basic Commands: commands like ``ls``, ``cd``, ``pwd``, and ``man``

2. File Management and Text Editing

- File and Directory Management: Explore ``mkdir``, ``cp``, ``mv``, and ``rm``.
- Text Editing: Use ``nano`` or ``vim`` to create and modify text files.

3. Advanced Command Line Operations

- Redirection and Pipes: Understand ``>``, ``>>``, ``|``.
- Wildcards: Learn about ``*``, ``?``.

4. User and Group Management

- User Accounts: Create, modify, and delete users.
- Groups and Permissions: Understand ownership and permissions.

5. Process and Service Management

- Process Management: Explore ``ps``, ``top``, and ``kill``.
- Services**: Start, stop, and manage services (daemons).

6. Network Configuration and Security

- 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: 2501CS67	0	0	3	3

Practice:

- a. Calculate Total Cost of Ownership
- b. Use AWS Pricing calculator to estimate multiple pricing models.
- a. Differentiate between AWS and customer responsibilities using Shared Responsibility Model
- User Management using Identity and Access Management
- a. Securing IAM user accounts.
- IPv4 and IPv6 implementation in cloud
- a. Design Virtual Private Cloud
- Configure NAT gateway.
- a. Implementing Internet Gateway in AWS Cloud
- Working with bastion host.
- a. Create and manage Private & Public subnets.
- Secure VPC using Security Groups
- a. Implement Network Access Control lists to control traffic.
- Build VPC and launch a web server.
- a. Launch EC2 instances in two different regions and connect.
- Create multiple VPCs and peer them using VPC peering.
- a. Create and trigger AWS Lambda functions.
- Use AWS lambda to automate EC2 instance behavior.

- a. Website deployment using AWS Elastic Beanstalk
 - Working with Elastic Block Storage
- a. Creating and working with EC2 snapshots.
 - Configure autoscaling for application deployed in AWS Cloud
- a. Load balance application deployed in AWS Cloud
 - 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

	L	T	P	C
Course Code:2501CS66	0	0	3	3

Practice :

1. AWS CLI installation
2. Working with the AWS SDKs
3. Exploring AWS CloudShell and the AWS Cloud9 Integrated Development Environment
4. Working with Amazon S3
5. Authenticating and Authorizing with IAM
6. Creating IAM Users and IAM Groups
7. Working with DynamoDB
8. Deploying an API
9. Monitoring a REST API
10. a. Developing REST APIs with API Gateway
b. Creating Lambda Functions Using the AWS SDK for Python
11. a. Migrating a Web Application to Docker Containers
b. Running Containers on a Managed Service
12. 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

Course Code:2501CS70

L	T	P	C
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

Course Code:	L	T	P	C
2501IT24 Course	0	0	2	2

Outcomes:

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

- CO1:** Describe custom object creation, formula fields, validation rules, and data relationships in Salesforce to support business logic and reporting.
- CO2:** Recall basic workflow automation tools in Salesforce, including Workflow Rules and Flow Builder.
- CO3:** Explain lead import using Data Loader and demonstrate user account setup and deactivation in Salesforce.
- CO4:** Manage user roles, profiles, and permission sets in Salesforce to control data access and sharing
- CO5:** Configure sharing rules and create reports in Salesforce to manage data visibility and 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	3	2	2	-	3	-	-	-	-	-	2
CO2	3	2	-	-	2	-	-	-	-	-	2
CO3	3	2	-	-	3	-	-	-	-	-	2
CO4	3	2	3	-	3	-	-	-	1	2	2
CO5	3	3	3	2	3	-	-	-	1	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_A250166039/preview-9781782170532_A250166039.pdf
8. https://www.youtube.com/watch?v=mc5cQ1vHcr0&list=PLgW8Fj5TGrqr9oCcfX1MWcoh2o_luUHI9
9. https://www.youtube.com/watch?v=THbIw8hgW0&list=PL1qNeQdVTMhGS6MI6gJsZFgY_DRUUnjYpn

Advanced Salesforce Administration

	L	T	P	C
Course Code: 2501IT34	0	0	3	3

Course Outcomes:

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

- CO1:** Explain the purpose and core features of Salesforce user, profile, and license management.
- CO2:** Configure enterprise-grade security by applying password policies, resetting credentials, and enforcing compliance requirements.
- CO3:** Design an appropriate role hierarchy and sharing model to meet complex data-access scenarios.
- CO4:** Evaluate and optimize record-level access using profiles, permission sets, manual sharing, and escalation rules to balance security with usability.
- CO5:** Build end-to-end service and sales processes—including Web-to-Lead, Web-to-Case, and analytics—in order to deliver actionable insights through reports and dashboards

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	-	-	-	2	-	2
CO2	3	2	1	-	3	-	2	-	-	-	2
CO3	3	3	3	2	3	-	-	2	1	2	2
CO4	2	3	2	2	3	-	2	2	3	2	2
CO5	3	3	3	2	3	-	-	2	3	2	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-gW8Fj5TGrqr9oCcfX1MWcoh2oluUHI9>
2. <https://www.youtube.com/watch?v=THbIw8hg-W0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn>

Principles of Pega Systems

	L	T	P	C
Course Code:2501IT23	0	0	3	3

Course Outcomes:

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

- CO1:** Recall basic concepts of Pega case types, life cycle stages, and case management features.
- CO2:** Identify basic features of case and data management in Pega, including properties, validations, and data pages.
- CO3:** Explain how decision rules, routing, and user interface elements are used to guide case behavior and user interaction in Pega.
- CO4:** Apply Pega tools and rules to build reusable components and test applications effectively
- CO5:** Summarize how reports, security features, and access controls are handled in Pega 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	-	2	-	2	-	-	-	-	-	-
CO3	3	2	2	-	2	-	-	-	-	-	-
CO4	3	2	3	2	3	-	-	-	-	-	2
CO5	3	2	2	-	2	-	-	-	-	-	-

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

	L	T	P	C
Course Code:2501IT26	0	0	3	3

Course Outcomes:

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

- CO1:** Recall basic Pega configuration tasks such as skimming rulesets, rule resolution, and versioning.
- CO2:** Explain case management tasks including urgency overrides, routing, locking, and relevant records
- CO3:** Apply data validation, SOAP connector creation, and integration techniques in Pega applications
- CO4:** Analyze reporting structures using class joins, sub-reports, and local data management.
- CO5:** Design secure and intelligent Pega applications using RBAC, ABAC, and Gen AI 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
CO2	3	2	2	2	-	2	-	-	-	-	2
CO3	3	3	3	3	2	3	-	-	1	2	2
CO4	3	3	3	3	3	3	-	-	1	2	2
CO5	3	3	3	2	2	3	2	1	2	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

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

Course Code: 2501MB04

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/107/101/10711092/>
2. <https://www.tutorialspoint.com>

Business Ethics & Corporate Governance

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

Course Code:2501MB05

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 Vasishth 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 & Business Management

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

Course Code:2501MB06

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: 978818975707
2. Principles of Management by Tripathi P C & Reddy P N, Tata McGraw Hill, ISBN-13: 978071333334.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/106/11106141/>
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/03_lec/

SoC Design

Course Code: 2501EC29

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: 2501CS23

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/>

Multidisciplinary Courses (MDC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS01	Programming for Problem Solving Using C	FC	2		2	4	50	50	100	-
2501CS03	Data Structures	IC	2		2	4	50	50	100	PPSC
2501MB01	Engineering Economics & Management	IC	2			2	50	50	100	-
	Total		06		04	10				

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

Course Code: 2501CS01

L T P C
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.
- CO5:** Demonstrate dynamic memory allocations and 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

Mapping of Course Outcomes with Program Specific Outcomes:

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

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:

1. Explore different platforms
 - 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.
<https://www.codechef.com/learn/course/c/CDEVINTRO/problems/CDEV004B>
 - 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>

- f. 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>
<https://maya.technicalhub.io/owl-program-details/668b9ec2e069313510b0235a>
- 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.
<https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30>
<https://maya.technicalhub.io/owl-program-details/66a0c0dda7d31805366af641>
- e. Distance travelled by an object.
<https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a>
- f. Calculate Simple interest and compound interest.
<https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab>
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.
<https://maya.technicalhub.io/owl-program-details/6686546930bfbd35127c869c>
<https://maya.technicalhub.io/owl-program-details/6688cf91e467bfe336f8352f>
https://www.hackerrank.com/challenges/rectangle-area/problem?utm_source=chatgpt.com
<https://maya.technicalhub.io/owl-program-details/6688ea3ce467bfe336f8ab9d>
- d. Find the maximum of three numbers using conditional operator.
<https://maya.technicalhub.io/owl-program-details/668690d230bfbd35127c9bf5>
- 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.
<https://maya.technicalhub.io/owl-program-details/66868f6730bfbd35127c9ba7>
 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>
<https://maya.technicalhub.io/owl-program-details/66864717f56afec5c0c917e1>
 - c. Given number is a prime or not. (Also Prime numbers between a given range.)
<https://maya.technicalhub.io/owl-program-details/6687b69ddfe02cea4b5404a3>
 - d. Armstrong Number or not.
 - e. Palindrome or not.
<https://maya.technicalhub.io/owl-program-details/6687af17dfe02cea4b5376ae>
 - 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.
<https://www.codechef.com/practice/course/c/LPCAS02/problems/LCAS20>

UNIT – III

Arrays: 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. 1-Dimensional 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.
 - c. Search an element in array (Linear Search).
<https://maya.technicalhub.io/owl-program-details/6687c40ffd042085d9ec15d6>
 - d. Find min and max elements in array.
<https://maya.technicalhub.io/owl-program-details/66879493dfe02cea4b529041>
 - e. Insert an element into array.

- f. Eliminate duplicate elements from array.
<https://maya.technicalhub.io/owl-program-details/66e920a1aca93b27f3364b57>
- g. Sorting of elements in an array using Bubble sort.
2. 2-Demensional Arrays
 - a. Sum of two 2-D arrays.
<https://maya.technicalhub.io/owl-program-details/66864fa9f56afec5c0c924f6>
 - 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.
 - b. Count number of alphabets (lowercase, uppercase, consonants, vowels) and digits
Lowercase to Uppercase, Uppercase to Lowercase, Toggle case, Sentential case
<https://maya.technicalhub.io/owl-program-details/6698e2fbc6bd470f35b73d8>
<https://maya.technicalhub.io/owl-program-details/6698ef03cb6bd470f35b7c3e>
 - c. 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.
<https://maya.technicalhub.io/owl-program-details/6698ed2dcb6bd470f35b7ae7>

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 classes**, **recursion**, 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: Nth factorial using recursion.
4. Objective: Find the super digit of the integer.
5. Implement LCM
6. Objective: Calculate the Nth term of series.
<https://www.hackerrank.com/challenges/recursion-in-c/problem?isFullScreen=true>

UNIT – V

Pointer: Introduction to Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, **functions & 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.

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 13: 9780131103627

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education. ISBN.No: 9352604172
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill. ISBN No. 0071367993
3. Let Us C Yashwanth, Kanetkar, Eighth edition, BPB Publications. ISBN No. 1934015253
4. Programming in C A-Practical Approach, Ajay Mittal. Pearson Education. ISBN No. 9788131729342
5. R G Dromey How to Solve It by Computer (Prentice-Hall International Series in Computer Science. ISBN-13 : 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/>

Additional Practice:

S.No .	Difficulty	Problem Name	Link
1	Easy	Add Two Numbers	https://www.codechef.com/practice/course/cpp/PCPP05/problems/FLOW001
2	Easy	Enormous Input Test	https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/INTEST
3	Easy	ATM	https://www.codechef.com/practice/course/1-star-difficulty-problems/DIFF1200/problems/ATM2
4	Easy	Number Mirror	https://www.codechef.com/practice/course/python/PPY01/problems/START01
5	Easy	Sum of Digits	https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW006
6	Easy	Remainder	https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW002
7	Easy	First and Last Digit	https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/FLOW004
8	Easy	Reverse The Number	https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/FLOW007
9	Easy	Life, the Universe, and Everything	https://staging.codechef.com/practice/course/cpp/PRAC TICECPP2/problems/TEST
10	Easy	Chef and Operators	https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/CHOPRT
11	Easy	Difference and Sum	https://www.codechef.com/problems/DIFFSUM
12	Easy	Second Largest	https://www.codechef.com/practice/course/arrays/ARRAYS/problems/LARGESECOND
13	Easy	Two Sum	https://leetcode.com/problems/two-sum/
14	Easy	Reverse Integer	https://leetcode.com/problems/reverse-integer/
15	Easy	Palindrome Number	https://leetcode.com/problems/palindrome-number/
16	Easy	Roman to Integer	https://leetcode.com/problems/roman-to-integer/
17	Easy	Remove Duplicates from Sorted Array	https://leetcode.com/problems/remove-duplicates-from-sorted-array/
18	Easy	Remove Element	https://leetcode.com/problems/remove-element/
19	Easy	Find the Index of the First Occurrence in a String	https://leetcode.com/problems/find-the-index-of-the-first-occurrence-in-a-string/
20	Easy	Length of Last Word	https://leetcode.com/problems/length-of-last-word/
21	Easy	Plus One	https://leetcode.com/problems/plus-one/
22	Easy	Merge Sorted Array	https://leetcode.com/problems/merge-sorted-array/
23	Easy	Majority Element	https://leetcode.com/problems/majority-element/
24	Easy	Single Number	https://leetcode.com/problems/single-number/
25	Easy	Move Zeroes	https://leetcode.com/problems/move-zeroes/

26	Easy	Missing Number	https://leetcode.com/problems/missing-number/
27	Easy	Contains Duplicate	https://leetcode.com/problems/contains-duplicate/
28	Easy	Valid Anagram	https://leetcode.com/problems/valid-anagram/
29	Easy	Valid Parentheses	https://leetcode.com/problems/valid-parentheses/
30	Easy	Fibonacci Number	https://leetcode.com/problems/fibonacci-number/
31	Easy	Climbing Stairs	https://leetcode.com/problems/climbing-stairs/
32	Easy	Binary Search	https://leetcode.com/problems/binary-search/
33	Easy	Number of 1 Bits	https://leetcode.com/problems/number-of-1-bits/
34	Easy	Hamming Weight	https://leetcode.com/problems/number-of-1-bits/description/
35	Easy	Power of Two	https://leetcode.com/problems/power-of-two/
36	Easy	Power of Three	https://leetcode.com/problems/power-of-three/
37	Easy	Same Tree	https://leetcode.com/problems/same-tree/
38	Easy	Maximum Subarray	https://leetcode.com/problems/maximum-subarray/
39	Medium	Chef and Notebooks	https://www.codechef.com/problems/CNOTE
40	Medium	Chef and Wildcard Matching	https://www.codechef.com/search?q=TWOSTR
41	Medium	Minimum Moves	https://www.codechef.com/search?q=SALARY
42	Medium	Lucky Four	https://www.codechef.com/search?q=LUCKFOUR
43	Medium	Maximum Difference	https://www.codechef.com/search?q=MAXDIFF
44	Medium	Uncle Johny	https://www.codechef.com/search?q=JOHNY
45	Medium	Chef and Strings	https://www.codechef.com/search?q=CHFSTLT
46	Medium	Two vs Rib	https://www.codechef.com/search?q=TWOVRIB
47	Medium	Chef and Array	https://www.codechef.com/search?q=CHFARRP
48	Medium	Add Two Numbers	https://leetcode.com/problems/add-two-numbers/
49	Medium	Longest Substring Without Repeating Characters	https://leetcode.com/problems/longest-substring-without-repeating-characters/
50	Medium	Longest Palindromic Substring	https://leetcode.com/problems/longest-palindromic-substring/
51	Medium	3Sum	https://leetcode.com/problems/3sum/
52	Medium	Container With Most Water	https://leetcode.com/problems/container-with-most-water/

53	Medium	Integer to Roman	https://leetcode.com/problems/integer-to-roman/
54	Medium	String to Integer (atoi)	https://leetcode.com/problems/string-to-integer-atoi/
55	Medium	Divide Two Integers	https://leetcode.com/problems/divide-two-integers/
56	Medium	Rotate Image	https://leetcode.com/problems/rotate-image/
57	Medium	Set Matrix Zeroes	https://leetcode.com/problems/set-matrix-zeroes/
58	Medium	Spiral Matrix	https://leetcode.com/problems/spiral-matrix/
59	Medium	Jump Game	https://leetcode.com/problems/jump-game/
60	Medium	Permutations	https://leetcode.com/problems/permutations/
61	Medium	Combination Sum	https://leetcode.com/problems/combination-sum/
62	Medium	Search in Rotated Sorted Array	https://leetcode.com/problems/search-in-rotated-sorted-array/
63	Medium	Group Anagrams	https://leetcode.com/problems/group-anagrams/
64	Medium	Sort Colors	https://leetcode.com/problems/sort-colors/
65	Medium	Subsets	https://leetcode.com/problems/subsets/
66	Medium	Reverse Linked List II	https://leetcode.com/problems/reverse-linked-list-ii/
67	Medium	Add Two Numbers II	https://leetcode.com/problems/add-two-numbers-ii/
68	Medium	Reorder List	https://leetcode.com/problems/reorder-list/
69	Medium	Linked List Cycle II	https://leetcode.com/problems/linked-list-cycle-ii/
70	Medium	K-th Largest Element in an Array	https://leetcode.com/problems/kth-largest-element-in-an-array/
71	Medium	Product of Array Except Self	https://leetcode.com/problems/product-of-array-except-self/
72	Medium	Word Search	https://leetcode.com/problems/word-search/
73	Medium	Unique Paths	https://leetcode.com/problems/unique-paths/
74	Medium	Minimum Path Sum	https://leetcode.com/problems/minimum-path-sum/
75	Medium	Temperature Converter - II	https://www.codechef.com/practice/course/c/LPCA_S03/problems/LCAS30B
76	Medium	Reverse	https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true

77	Medium	Sentence in a new line	https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true
78	Hard	Median of Two Sorted Arrays	https://leetcode.com/problems/median-of-two-sorted-arrays/
79	Hard	Regular Expression Matching	https://leetcode.com/problems/regular-expression-matching/
80	Hard	Wildcard Matching	https://leetcode.com/problems/wildcard-matching/
81	Hard	Trapping Rain Water	https://leetcode.com/problems/trapping-rain-water/
82	Hard	First Missing Positive	https://leetcode.com/problems/first-missing-positive/
83	Hard	Longest Valid Parentheses	https://leetcode.com/problems/longest-valid-parentheses/
84	Hard	Merge k Sorted Lists	https://leetcode.com/problems/merge-k-sorted-lists/
85	Hard	Reverse Nodes in k-Group	https://leetcode.com/problems/reverse-nodes-in-k-group/description/
86	Hard	Sudoku Solver	https://leetcode.com/problems/sudoku-solver/
87	Hard	N-Queens	https://leetcode.com/problems/n-queens/description/
88	Hard	Edit Distance	https://leetcode.com/problems/edit-distance/
89	Hard	Word Ladder II	https://leetcode.com/problems/word-ladder-ii/
90	Hard	Maximal Rectangle	https://leetcode.com/problems/maximal-rectangle/
91	Hard	Binary Tree Maximum Path Sum	https://leetcode.com/problems/binary-tree-maximum-path-sum/
92	Hard	Serialize and Deserialize Binary Tree	https://leetcode.com/problems/serialize-and-deserialize-binary-tree/
93	Hard	Variadic functions in C	https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true
94	Hard	Small Triangles, Large Triangles	https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true
95	Hard	Permutations of Strings	https://www.hackerrank.com/challenges/permutations-of-strings/problem?isFullScreen=true

Maya Programs

S.No.	Problem Name	Maya Program Link
1	Can Cross the Bridge	https://maya.technicalhub.io/owl-program-details/6686308df56afec5c0c8e2dd
2	Hypotenuse	https://maya.technicalhub.io/owl-program-details/6686404ef56afec5c0c90135
3	Heron's Formula	https://maya.technicalhub.io/owl-program-details/66864474f56afec5c0c911f5
4	Loss Percentage	https://maya.technicalhub.io/owl-program-details/66864868f56afec5c0c91a4a
5	King Tours	https://maya.technicalhub.io/owl-program-details/66864c96f56afec5c0c921f1

6	Profit Percentage	https://maya.technicalhub.io/owl-program-details/66865237f56afec5c0c92694
7	Area and Perimeter of Square	https://maya.technicalhub.io/owl-program-details/6686546930bfd35127c869c
8	Volume of Sphere	https://maya.technicalhub.io/owl-program-details/6686565530bfd35127c8818
9	Required Points	https://maya.technicalhub.io/owl-program-details/66865b1130bfd35127c8a04
10	Instant Noodles	https://maya.technicalhub.io/owl-program-details/66865ddb30bfd35127c8c0a
11	Find Second Number	https://maya.technicalhub.io/owl-program-details/668660a530bfd35127c8cde
12	Kmph to Mps	https://maya.technicalhub.io/owl-program-details/668663ce30bfd35127c8dfb
13	Inches to Centimeters	https://maya.technicalhub.io/owl-program-details/6686665e30bfd35127c8f3a
14	Capacity	https://maya.technicalhub.io/owl-program-details/668678aa30bfd35127c95b9
15	Average of Two Numbers	https://maya.technicalhub.io/owl-program-details/6687b002dfe02cea4b5389d6
16	Compound Interest	https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab
17	Average Weight	https://maya.technicalhub.io/owl-program-details/6687b93edfe02cea4b54367a
18	Arithmetic Operations	https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1
19	Distance Between Two Points	https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a
20	Days into Years, Weeks	https://maya.technicalhub.io/owl-program-details/6687cad1fd042085d9ec95a8
21	Convert Seconds to Hours, Minutes and Seconds	https://maya.technicalhub.io/owl-program-details/6688c926e467bfe336f8007b
22	Hours and Minutes	https://maya.technicalhub.io/owl-program-details/6688e4f0e467bfe336f89673
23	Romeo and Juliet	https://maya.technicalhub.io/owl-program-details/6688e068e467bfe336f87a8b
24	Gross Salary of an Employee	https://maya.technicalhub.io/owl-program-details/6688dd95e467bfe336f87682
25	Surface Area and Volume of a Cube	https://maya.technicalhub.io/owl-program-details/6688d909e467bfe336f872ca
26	Area of Trapezium	https://maya.technicalhub.io/owl-program-details/6688d637e467bfe336f86c5e
27	Swap Two Numbers	https://maya.technicalhub.io/owl-program-details/6688d2d0e467bfe336f84f55
28	Last Two Digits of a Given Year	https://maya.technicalhub.io/owl-program-details/6688ccfae467bfe336f81f90
29	Arithmetic Operations	https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1
30	Uppercase Letters in a String	https://maya.technicalhub.io/owl-program-details/669a2453c03fc56b320b215c
31	Factors Finding	https://maya.technicalhub.io/owl-program-details/66866c4a30bfd35127c90b4

32	String Copy	https://maya.technicalhub.io/owl-program-details/669a03ded62716a9c6d4fa9a
33	Recursive Digit Sum	https://www.hackerrank.com/challenges/recursive-digit-sum/problem

	Basic Programs	Aditya's Internal Coding Platform (Maya)	Code chef	Hacker rank	Leet code	Total
Unit-1	4	8	2	5	0	19
Unit-2	4	4	1	4	0	13
Unit-3	8	7	0	2	0	17
Unit-4	3	0	0	3	0	6
Unit-5	7	0	4	4	0	15
Additional Practice	0	33	22	5	68	128
Total	26	52	29	23	68	198

Data Structures
(Common to EEE, ECE, CSE, IT, AIML & CSE (DS))

Course Code: 2501CS03

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 to handle heterogeneous data.
- CO2:** Illustrate Time and Space complexities for different 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		

Mapping of Course Outcomes with Program Specific Outcomes:

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

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 Structures: Introduction to Data Structures, Types of Data Structures.

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:

1. Implement Merge sort using arrays.
<https://www.hackerrank.com/contests/hw1/challenges/merge-sort>
2. Implement Quick sort using arrays
<https://www.hackerrank.com/challenges/quicksort1/problem>
3. Implement Radix Sort using arrays
https://www.hackerrank.com/contests/hw1/challenges/radix-sort?utm_source

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.
https://leetcode.com/problems/design-linked-list/description/?utm_source
2. Perform different operations in double linked list
https://leetcode.com/problems/design-linked-list/?utm_source
3. Circular Linked List
https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm_source

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
<https://www.hackerrank.com/challenges/balanced-brackets/problem>
https://leetcode.com/problems/design-linked-list/description/?utm_source
2. Implement a program to evaluate a postfix expression.
<https://leetcode.com/problems/evaluate-reverse-polish-notation/description/>
3. Queue and its operations using arrays and Linked List
<https://leetcode.com/problems/implement-queue-using-stacks/description/>
https://leetcode.com/problems/design-linked-list/description/?utm_source
4. Implement Circular Queue using Arrays
<https://leetcode.com/problems/design-circular-queue/description/>

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).
<https://leetcode.com/problems/insert-into-a-binary-search-tree/description/>
<https://leetcode.com/problems/delete-node-in-a-bst/description/>
2. Implement Binary search Tree (BST) Traversals.
<https://www.hackerrank.com/challenges/tree-inorder-traversal/problem>
<https://www.hackerrank.com/challenges/tree-preorder-traversal/problem>
<https://www.hackerrank.com/challenges/tree-postorder-traversal/problem>
3. Graph Traversal using Breadth First Search (BFS)
<https://www.hackerrank.com/challenges/bfsshortreach/problem>
4. Graph Traversal using Depth First Search (DFS)
<https://leetcode.com/problems/number-of-islands/description/>

Text Books:

1. Data Structures using C, Rema Tharaja, Oxford University Press, 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: 978-0716782506
3. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407
4. 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>

Additional Practice:

SNO	Difficulty	Problem Name	URL
1	Easy	Structs and enums	https://www.hackerrank.com/challenges/too-high-boxes/problem
2	Easy	Structs and enums	https://www.codechef.com/problems/HS08TEST?tab=statement
3	Medium	Structs and enums	https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem
4	Easy	Arrays and Hashtables	https://leetcode.com/problems/two-sum/description/
5	Easy	Arrays and Pointers	https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source
6	Medium	Arrays and Pointers	https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source
7	Easy	Linked List	https://leetcode.com/problems/merge-two-sorted-lists/description/
8	Medium	Arrays and Matrix	https://leetcode.com/problems/diagonal-traverse/description/
9	Easy	Linked List	https://www.hackerrank.com/challenges/compare-two-linked-lists/problem
10	Medium	Stack applications	https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm
11	Medium	Binary Tree	https://leetcode.com/problems/binary-tree-right-side-view/description/
12	Medium	Stack applications	https://leetcode.com/problems/remove-k-digits/description/
13	Medium	Graph Theory	https://www.hackerrank.com/challenges/journey-to-the-moon/problem
14	Medium	Graph Traversals	https://leetcode.com/problems/number-of-provinces/description/
15	Medium	Graph Theory	https://www.hackerrank.com/challenges/torque-and-development/problem

	Basic Programs	Aditya's Internal coding Platform(Maya)	Code chef	Hacker rank	Leet code	Geek for Geeks
Unit-1	3	0	0	0	0	0
Unit-2	0	0	0	3	0	0
Unit-3	0	0	1	0	2	0
Unit-4	0	0	0	1	5	0
Unit-5	0	0	0	4	3	0
Additional Practice	0	0	1	5	8	1
Total	3	0	2	13	18	1

Engineering Economics & Management
(Common to CE, EEE, ME, CSE, IT, AIML & CSE(DS))

Course Code: 2501MB01

L T P C
2 0 0 2

Course Outcomes:

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

- CO1:** Explain the Business Economic concepts, law of demand and forecasting methods.
- CO2:** Identify production and cost behaviour for managerial decision making with Break-Even Point (BEP).
- CO3:** Make use of financial accounting and capital budgeting techniques for decision making.
- CO4:** Summarize management and motivational theories to renovate the practice of Management.
- CO5:** Illustrate the functional management and project management using PERT and CPM.

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	1									2	
CO3										3	
CO4	1							1	1	2	
CO5										3	

UNIT-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics- Concept of Demand, Types of Demand, Determinants of Demand- Law of Demand and its limitations- Elasticity of Demand, Types- Demand forecasting and its Methods.

UNIT-II

Production and Cost Analyses:

Concept of Production function Law of Variable Proportions-Isoquants and Isocosts - Producer Equilibrium-, cost concepts: opportunity costs, explicit and implicit costs- Fixed costs, Variable Costs – Cost –Volume-Profit Analysis-Determination of Breakeven point (simple problems).

UNIT-III

Introduction to Markets and Financial Accounting: Market Structures-Classification of markets, Introduction to Financial Accounting , Concepts and conventions, Accounting cycle, Journal entries and Ledger (Simple Problems), Methods of capital budgeting (Simple Problems).

UNIT-IV

Operations Management :

Concept nature and importance of Management, Generic Functions of Management, Theories of Motivation, Plant location and layout, Principles of organization, SWOT analysis.

Material Management: Need for Inventory control, EOQ, ABC analysis

UNIT – V

Functional Management And Project Management

Concept of HRM , HRD and PMIR, Functions of HR Manager , Job Evaluation and Merit Rating , Marketing Management, Functions of Marketing , Channels of distributions - Development of Network , Difference between PERT and CPM, Finding Critical Path (Simple Problems)

Text Books:

- 1 Managerial Economics and Financial Analysis, A. R. Aryasri , McGraw Hill Education, ISBN: 978-07078031
- 2 Managerial Economics and Financial Analysis', N. Appa Rao, P. Vijay Kumar, Cengage Publications, New Delhi, ISBN: 978-8131515952
- 3 Management Science by Aryasri; Publisher: Tata McGraw Hill, 209, ISBN: 978-07090279
- 4 Management by James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R. Gilbert 6th Ed; Publisher: Pearson Education/Prentice Hall, ISBN: 978-0131087477

Reference Books:

- 1 Principles of Marketing: A South Asian Perspective by Kotler Philip, Gary Armstrong, Prafulla Y. Agnihotri, and Eshanul Haque, 13th Edition, Publisher: Pearson Education/Prentice Hall of India, ISBN: 9788131731017
- 2 A Handbook of Human Resource Management Practice by Michael Armstrong, 210; Publisher: Kogan Page Publishers, ISBN: 978-1789661033

Web Links:

- 1 www.managementstudyguide.com
- 2 www.citehr.com
- 3 www.nptel.ac.in/courses/122106032
- 4 www.btechguru.com/courses--nptel--basic-course

Ability Enhancement Courses (AEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EN01	Essential Cognitive skills for Engineers	FC			1	1	100	-	100	-
2501EN02	Advanced Cognitive Skills for Engineers (or) Proficiency in Sanskrit / Hindi / Foreign language (Japanese/German/Spanish/ French)	FC			1	1	100	-	100	-
2501UC01										
2501UC02										
2501UC05										
2501UC04										
2501UC06										
2501UC03										
2501UC07	Design Thinking using AI	FC			1	1	100	-	100	
2501UC08	Universal Human Values	FC	2			2	50	50	100	
2501UC09	Technical Paper Publication	AC			2	2	100	-	100	-
2501EE57	Student Activity Based Learning	AC				2	100	-	100	-
	Total		02		05	09				

Essential Cognitive Skills For Engineers (Common to all branches)

Course Code: 2501EN01

L T P C
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: <i>u</i>

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:

- Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones.

Suggested Software:

- Cambridge Empower
- Soft X (K-Van Solutions)

Reference Books:

1. M Ashraf Rizvi: Effective Technical Communication
2. Raymond Murphy: English Grammar in Use, Cambridge University Press. Fifth Edition
3. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, 2013

Web links:

- <https://www.cambridgeone.org/login>
- <https://www.britishcouncil.in/english/online>
- www.englishmedialab.com

ADVANCED COGNITIVE SKILLS FOR ENGINEERS (Common to all branches)

Course Code: 2501EN02

L T P C
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 TV?</i>

Writing	Email: Complaining about an important issue.
Grammar	Email of complaint, Using formal language
Vocabulary	<i>Too/enough; so/such</i> , Causative <i>have/get</i>
Pronunciation	Describing life in cities, Film and TV; Houses
	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: l, 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 : ui, 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

Text Book:

- Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones.

Suggested Software:

- Cambridge Empower
- Soft X (K-Van Solutions)

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press.2018.
2. Michael Swan- Practical English Usage
3. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India,2016

Web links:

- <https://www.cambridgeone.org/login>
- <https://www.coursera.org/>
- <https://www.skillshare.com/>
- <https://www.mindtools.com/cawh8bu/communication-tools>

Design Thinking using AI

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

	L	T	P	C
Course Code:2501UC07	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

Practice using any AI tool:

Students are advised to use any AI tool like Otter AI etc for Transcribe interviews automatically and summarize user insights.

UNIT – III

Design Thinking in IT: Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping

Practice using any AI tool:

Students are advised to use any AI tool like ChatGPT, Claude, Perplexity etc to define, synthesize, ideate and prototype.

UNIT – IV

DT For strategic innovations: Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design.

Practice using any AI tool:

Students are advised to use any AI tool like looka, logomkr, canva and figma etc for logo, prototyping and sketching.

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: 2501UC08	1	1	0	2

Pre Requisites: Universal Human Values (UHV-I) (desirable).

Course Objectives:

This course input is intended

1. To help the students appreciate the complementarity between 'VALUES' and 'SKILLS' and understand how ethical foundations enhance technical competence to achieve sustainable happiness, prosperity, and responsible professional growth.
 2. To develop a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a right understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values (UHV) and movement towards value-based living in a natural way.
 3. To highlight real-world implications of Holistic understanding of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
 4. To encourage the students to realise their full potential and act accordingly.
 5. To assist the students to live with a feeling of relationship, harmony and co-existence.
- Thus, this course is intended to provide a much-needed input in value education to the young enquiring minds.

UNIT I INTRODUCTION TO VALUE EDUCATION

Lecture 1: Holistic Development and the Role of Education (Right Understanding, Relationship and Physical Facility)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 - Sharing about Oneself
Lecture 3: Self-Exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 - Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 - Exploring Natural Acceptance.

UNIT II HARMONY IN THE HUMAN BEING

Lecture 7: Understanding Human being as the Co-existence of the self and the body
Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 - Exploring the difference of Needs of self and body
Lecture 9: The body as an Instrument of the self
Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 - Exploring Sources of Imagination in the self
Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 - Exploring Harmony of self with the body.

UNIT III HARMONY IN THE FAMILY AND SOCIETY

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7 - Exploring the Feeling of Trust

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 - Exploring the Feeling of Respect

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS9 - Exploring Systems to fulfil Human Goal

UNIT IV HARMONY IN THE NATURE/EXISTENCE

Lecture 19: Understanding Harmony in Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 - Exploring the Four Orders of Nature

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 - Exploring Co-existence in Existence.

UNIT V IMPLICATIONS OF THE HOLISTIC UNDERSTANDING A LOOK AT PROFESSIONAL ETHICS

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 - Exploring Ethical Human Conduct

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 - Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case

Studies Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 - Exploring Steps of Transition towards Universal Human Order

Course Outcomes:

Upon successful completion of the course, students will be able to

CO1: Demonstrate an understanding of basic human aspiration and the concept of Natural Acceptance and apply them in personal and professional decision-making.

CO2: Develop self-awareness and practice self-regulation.

CO3: Recognize human-human relationship (Justice) and identify human goals in society.

CO4: Appreciate the harmony in nature and existence.

CO5: Develop as socially and ecologically responsible engineers in handling problems with sustainable solutions (user-friendly and eco-friendly).

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 3rd Revised Edition, UHV Publications, Sarva Shubha Nyas, Kanpur, 2023. ISBN: 978- 81-957703-7-3 (Printed Copy) ISBN: 978-81-957703-6-6 (e-book)
2. R R Gaur, R Asthana, G P Bagaria, *Teachers' Manual for a Foundation Course in Human Values and Professional Ethics*, 3rd Revised Edition, UHV Publications, Sarva Shubha Nyas, Kanpur, 2023.

Reference Books:

1. *Jeevan Vidya: Ek Parichaya*, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book), Annie Leonard, Free Press, 2010.
4. *The Story of My Experiments with Truth*, Mohandas Karamchand Gandhi, Fingerprint! Publishing
5. *Small is Beautiful* - E. F Schumacher, Random House, 2011.
6. *Slow is Beautiful* - Cecile Andrews, New Society Publishers, 2006
7. *Economy of Permanence* - J C Kumarappa
8. *Vivekananda* - Romain Rolland

Online Resources

1. <https://fdp-si.aicte-india.org/index.php>
2. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview
3. <https://uhv.org.in/>
4. <https://www.youtube.com/@UniversalHumanValues/playlists>

Student Activity based Learning

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

CourseCode:2501EE057

L T P C
0 0 0 2

S.No	Category	Description	Merit/ Participation	Level & Points per event			Minimum Points to earn
				Interna tional	National	University	
1	Co-Curricular Activities	Tech Quiz, Coding\Decoding\ poster/ events etc., in technical symposium/ Coding Competition/ SIH	Participation	20	10	5	70
			Merit	40	20	10	
		Projects Developed	-	-	20	10	
		Attending Workshop	Participation	-	10	5	
		Industrial visits	Participation	-	-	5	
2	Extra- Curricular Activities	Cultural Activities Music/ Dance/ Essay Writing/ Painting/ Drawing / Literary Arts etc.	Participation	20	10	5	10
			Merit	40	20	10	
		Sports/ Games	Participation	20	10	5	
			Merit	40	20	10	
3	Outreach Activities	NSS/ Leo Club/ NCC/ eco club / Republic Day/ Viksit Bharat etc,,	Participation	-	10	5	5
4	Entrepreneurs hip and Innovation	Ideathons/ Hackathons	Participation	20	10	5	5
			Merit	40	20	10	
5	Leadership & Management	Event Volunteer	-	-	10	5	10
		Member of the Organizing Team		-	20	10	
		Coordinator for an Event		-	30	20	
Total							100

Award of Grade: (Evaluation will be done in VIII Semester)

Range of Points	Grade	Grade Point
>225	O	10
201-225	A+	9
176-200	A	8
151-175	B+	7
126-150	B	6
100-125	C	5
<100	F	0

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501IT01	Business Intelligence Lab	FC			2	2	50	50	100	-
2501EE17	Smart Technology & Applications Lab	IC			2	2	50	50	100	-
2501CS05	Machine Learning with Python	IC			2	2	50	50	100	-
2501EE18	Intelligent Algorithms for Power Systems	AC			2	2	50	50	100	-
	Total				08	08				

Business Intelligence Lab

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

Course Code: 2501IT01

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

IOT Applications of Electrical Engineering

Course Code:2501EE17

L	T	P	C
0	0	2	2

Course Outcomes:

At the end of the Course, student s will be able to:

- CO1** Explain the sensors & actuators for IoT applications.
- CO2** Apply various sensors to IoT applications.
- CO3** Utilize the cloud platform & APIs for IoT application
- CO4** Experiment with embedded boards for creating IoT prototypes.
- CO5** Develop 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	1	3	2	1	2				1	1	
CO2	1	2	3	1	2				1	1	
CO3	1	3	2	1	2				1	1	
CO4	1	2	3	1	2				1	1	
CO5	1	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

Practice:

1. Interfacing of IR sensor with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
2. To interface Organic Light Emitting Diode (OLED) with Arduino/Raspberry Pi
3. To interface Bluetooth with Arduino/Raspberry Pi & write a program to send sensor data to smartphone using Bluetooth.
4. To interface Bluetooth with Arduino/Raspberry Pi & write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
5. Interfacing of 7 Segment Display with Arduino/Raspberry Pi
6. Interfacing of Joystick with Arduino/Raspberry Pi
7. Interfacing of Analog Input & Digital Output with Arduino/Raspberry Pi

8. Night Light Controlled & Monitoring System
9. A Heart Rate Monitoring System
10. LDR based appliance control

Additional Practice:

11. Fire Alarm Using Arduino
12. Alexa based Home Automation System

Text Books:

- 1 IoT Fundamentals, Networking Technologies, Protocols & Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetette, rob Barton, Jerome Henry, CISCO, Pearson, 2018 (ISBN: 9781587144561).
- 2 Designing the Internet of Things, Adrian McEwen & Hakim Cassimally, Wiley (ISBN: 9781118430620).

Reference Books:

- 1 An Introduction to Internet of Things, Connecting devices, Edge Gateway & Cloud with Applications, Rahul Dubey, Cengage, 2019 (ISBN: 978935350931).
- 2 Designing the Internet of Things, by Adrian McEwen, Wiley Publishers (ISBN: 9781118430620).

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>

Machine Learning With Python

Course Code:2501CS05

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1** Underst& the basic concepts of Python language.
- CO2** Generate, analyze, & interpret data using Python
- CO3** Analyze several problems & apply ML techniques to solve it
- CO4** Design prediction & classification models
- CO5** Underst& the basic concepts of deep neural network model & design the same.

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	3	1						1	1		
CO2	2	3	1						1	1		
CO3	2	3	1						1	1		
CO4	2	3	1						1	1		
CO5	2	3	1						1	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. Basic Programs: Introduction to Python- Importing datasets- Reading data from different file formats Data Pre-processing & visualization
2. P&as: Missing Data P&as Overview, Categorical Data, Several other data operations through P&as & Time Series data analysis.
3. Numpy:
 - 3.1) Creating N-dims arrays Some Mathematical functions, Indexing & slicing.
 - 3.2) Numeric operations using NumPy
4. Matplotlib & Seaborn: Histogram, Line plot, Scatter plot, bar plot, BoxPlot, Heat Map Xlabel, Ylabel, Xticks, Yticks, title Overview.

5. Regression: Implementation of various types of regression using any dataset.
6. Decision Tree: Implementation of the decision tree based ID3 algorithm using an appropriate data set & verification of inductive bias of decision tree learning algorithm
7. Support Vector Machine: Implementation of SVM for h&written character recognition using MNIST dataset.
8. KNN: Implementation of k-Nearest Neighbor Classification
9. Naive Bayes classification :Implementation of Naive Bayes classification
10. Backpropagation algorithm: Implementation of Backpropagation algorithm for deep neural networks. Study of impact on performance when activation functions are changed. Consider three common activations functions. - Sigmoid, Relu, Tanh

Additional Practice:

11. Implement logistic regression.
12. Implementation of Recommendation systems
13. Implement Applications: Natural Language Processing Projects: Automatic Review Analyzer

Reference Books:

- 1 Pattern Recognition & Machine Learning by C. M. Bishop. First Edition. Springer (ISBN: 978-149393843)
- 2 Machine Learning: The Art & Science of Algorithms that Make Sense of Data, P. Flach. First Edition, Cambridge University Press.(ISBN: 978-1107422223)

Web Links:

- 1 <https://ml-course.github.io/master/labs/Lab%201%20-%20Tutorial>
- 2 <https://www.nielit.gov.in/calicut/calicut/content/machine-learning-using-python-smart-lab-free-course>
- 3 Machine Learning with MATLAB - MATLAB & Simulink (mathworks.com)

Intelligent Algorithms for Power System Lab

Course Code:2501EE18

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1** Acquire knowledge about basic of MATLAB & SIMULINK software
- CO2** Apply evolutionary techniques in real time problems
- CO3** Acquire knowledge & apply neural networks in real time problems
- CO4** Apply fuzzy systems in real time problems
- CO5** Apply genetic algorithm in real time problems

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					1	1	
CO2	2	3	2	2					1	1	
CO3	2	3	1	1					1	1	
CO4	2	3	2	2					1	1	
CO5	2	3							1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

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

Practice:

1. Introduction to Fundamental of Fuzzy Logic & Basic Operations
2. Fuzzy Inference System (FIS)
3. Fuzzy Weighted Average & Application
4. Fuzzy Control & Application
5. Introduction to Neural Networks & Perceptron Example
6. Multilayer Perceptron & Application
7. Probabilistic Neural Networks & Application
8. Application of genetic algorithm to optimize controller parameters
9. Application of evolutionary algorithms to optimize controller parameters
10. Application of neural networks with optimization techniques to optimize controller parameters

Additional Practice:

11. Application of fuzzy sets with optimization techniques to optimize controller parameters
12. LFC of a single area system using genetic algorithm
13. LFC of a two-area system using genetic algorithm
14. Application of evolutionary algorithms for single-area LFC system using Integral squared error

Reference Books:

- 1 “Principles of Soft Computing”, S.N.Sivanandam&S.N.DeepaWiley (ISBN: 9788126527410).
- 2 “Genetic Algorithm in Search Optimization & Machine Learning”, David E. Goldberg, Pearson Education (ISBN: 978021157673).
- 3 “Fuzzy Set Theory: Foundations & Applications”, George J. Klir, Ute St. Clair, Bo Yuan, Prentice Hall (ISBN: 9780133410587).

Web Links:

- 1 <http://vlabs.iitkgp.ac.in/scte/>
- 2 <http://vlabs.iitkgp.ac.in/scte/exp5/index.html>

Value Added Courses (VAC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS04	Internet of Things	FC			1	1	100	-	100	-
2501UC11	Employability skills -1	FC			3	0	100	-	100	-
2501UC13	Employability skills -2	FC			3	0	100	-	100	ES-1
2501CS02	Data Analysis Using Python	IC			2	2	50	50	100	PPSC
2501UC14	Employability skills -3	IC			3	0	100	-	100	ES-2
2501UC15	Employability skills -4	IC			3	0	100	-	100	ES-3
2501UC16	Employability skills -5	AC			3	1	100	-	100	ES-4
2501AC06	Advanced Data Structures & Algorithm	AC	2		1	0	100	-	100	DS
	Total		2		19	04				

Data Analysis using Python

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

	L	T	P	C
Course Code:2501CS02	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 DataFrame 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 DataFrame.
- iii) Write a Pandas program to insert a new column in existing DataFrame.
- iv) Write a Pandas program to get list from DataFrame column headers.
- v) Write a Pandas program to get list from DataFrame 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 create a simple calculator GUI application using functions for arithmetic operations.
- 3) Write a Python program to build a todo list GUI application with functions for adding, deleting, and updating tasks.
- 3. Save a multi-page PDF with different visualizations.

Reference Books:

- 1. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, SueBlumenberg. ISBN:978-153051120
- 2. Code with Python: Suresh Sundaradasu, S. Rama Sree ISBN: 978-9355017574
- 3. Python Programming, Dr. Maganti Venkatesh, Monelli Ayyavaraiah, Niveditha Ravindra Pandey, Neethumol Sabu, 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/>

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

Course Code: 2501CS04

L T P C
0 0 1 1

Course Outcomes:

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

- CO1:** Identify and select appropriate sensors, actuators, and boards (Arduino/Pi) for specific tasks.
- CO2:** Execute digital and analog interfacing of peripherals with embedded platforms.
- CO3:** Develop control algorithms and decision-making logic for real-time automation.
- CO4:** Configure cloud platforms and APIs for data transmission and visualization.
- CO5:** Design and build functional end-to-end IoT prototypes 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	2	1			1						
CO2	2	2	1		2						
CO3	1	2	2	1							
CO4	1	1		1	2						1
CO5	1	2	2	2	2	1	1	1	2	2	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		
CO2		
CO3		
CO4		
CO5		

Practice:

- Study of Arduino UNO and Raspberry Pi boards including architecture, pin configuration, power supply, communication interfaces and development environments.
- Study of commonly used sensors and actuators such as temperature sensor, moisture sensor, LDR, ultrasonic sensor, IR sensor, PIR sensor, LED and motor. Identify their working principles and applications.
- Design and implement basic digital input–output operations using Arduino by controlling LED/buzzer.
- Interface an analog sensor (LDR) with Arduino and display sensor values on Serial Monitor.
- Interface a digital sensor (Ultrasonic sensor) with Arduino and display measured values on Serial Monitor.
- Develop conditional logic using Arduino to control LED or buzzer based on sensor threshold values.
- Interface a servo motor with Arduino and control its angular position based on sensor input to demonstrate automatic gate or smart irrigation model.

8. Design and implement a multi-sensor monitoring system using Arduino to read analog and digital sensors simultaneously and display results on Serial Monitor.
9. Create a cloud platform account, explore available IoT services and register a device (Thing) on the platform.
10. Demonstration of IoT based system to upload sensor data to cloud platform and visualize the received data in graphical form.

Additional Practice (Any 2 from the following)

1. **Smart Lighting System:** Design a lighting system that automatically turns ON/OFF or dims lights based on human movement or surrounding light conditions to demonstrate energy saving.
2. **Intelligent Traffic Control System:** Develop an automated traffic signal system for busy roads with priority control for emergency vehicles (such as ambulances).
3. **Smart Parking System:** Create a sensor-based parking system to detect available slots and provide parking guidance or remote monitoring.
4. **Air Pollution Monitoring System:** Build an IoT-based setup using gas or environmental sensors to measure air quality and indicate whether pollution levels are safe or dangerous.
5. **Bluetooth-Based Actuator Control:** Control motors or other actuators connected to a development board using Bluetooth communication.

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 Internet of Things, by Vengalapudi Appala Konda and Prof. Sangareddy B. Krutakoti, Scientific International Publishing House, First Edition, 2024. ISBN: 978-93-6132-958-6.

Web Links:

- 1 <https://iotvirtuallab.github.io/vlab/Experiments/index.html>
- 2 https://onlinecourses.nptel.ac.in/noc21_cs17/preview
- 3 <https://www.electronicsforu.com/electronics-projects/internet-of-things-iot>
- 4 <https://www.coursera.org/specializations/iot>
- 5 <https://projecthub.arduino.cc/>
- 6 <https://www.edureka.co/iot-certification-training>

Employability Skills- I
(CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT,Min.E&Agri.E)

Course Code:2501UC11

L	T	P	C
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-139789389957426.**
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

Employability Skills- II

(CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT,Min.E&Agri.E)

	L	T	P	C
Course Code:2501UC13	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 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

Employability Skills- III

(CE,EEE,ME,ECE,CSE,IT,AI ML,CSE(DS),PT,Min.E&Agri.E)

Course Code:2501UC14

L	T	P	C
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**-139789389957426.
- 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

Employability Skills- IV

(CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT,Min.E&Agri.E)

Course Code:2501UC15

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 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

Employability Skills- V

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

Course Code:2501UC16

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**-139789389957426.
- 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

Advanced Data Structures & Algorithm

	L	T	P	C
Course Code:2501AC06	2	0	1	0

Course Outcomes:

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

CO1: Analyze the algorithms efficiency and hashing techniques for searching.

CO2: Illustrate the concepts of search trees and operations of Priority Queues.

CO3: Analyze the algorithms of Divide & Conquer and Greedy paradigms.

CO4: Analyze the algorithms of Dynamic Programming paradigm.

CO5: Design the algorithms of Backtracking and Brach & Bound paradigms.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Algorithm Analysis, Space and Time Complexity analysis, Asymptotic Notations.

Hashing: Introduction to Static Hashing, Hash Tables, Hash Functions, Different Hash Functions, Collision Resolution Techniques, Dynamic Hashing.

Practice:

1. Write a program to implement collision resolution techniques of Hash data structure.

UNIT – II

AVL Trees – Creation, Insertion, Deletion operations and Applications.

B-Trees – Creation, Insertion, Deletion operations and Applications

Priority Queues (Heaps): Introduction, Binary Heaps-Model and Simple Implementation, Basic Heap Operations, Other Heap Operations, Applications of Priority Queues

Practice:

1. Write a program to implement AVL tree operations
2. Write a program to implement Max heap and min heap operations

UNIT – III

Divide and Conquer: The General Method, Binary Search, Merge Sort, Quick Sort.

Greedy Method: The General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths.

Practice:

1. Write a program to sort the given list of elements using Merge sort technique using divide and conquer approach.
2. Write a program to implement Single Source Shortest Paths using greedy approach.

UNIT – IV

Dynamic Programming: The General Method, Single Source Shortest Paths– General Weights (Bellman Ford Algorithm), All-pairs shortest paths, Optimal Binary Search Trees, 0/1 Knapsack, Travelling Salesperson problem

Practice:

1. Write a program to implement 0/1 Knapsack problem using Dynamic Programming approach.
2. Write a program to implement all pairs shortest path problem using Dynamic Programming approach.

UNIT – V

Backtracking: The General Method, N-Queens Problem, Sum of Subsets problem, Graph Coloring, Hamiltonian cycles.

Branch and Bound: The General Method, 0/1 Knapsack Problem, Travelling Salesperson problem.

Practice:

1. Write a program to implement N-Queens problem using backtracking algorithm.
2. Write a program to implement Travelling Salesperson problem using branch and bound approach.

Text Books:

1. Fundamentals of Data Structures in C++, Horowitz, Ellis; Sahni, Sartaj; Mehta, Dinesh, 2nd Edition Universities Press.
2. Computer Algorithms in C++, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, 2nd Edition University Press.

Reference Books:

1. Data Structures and program design in C, Robert Kruse, 2nd Edition Pearson Education Asia.
2. An introduction to Data Structures with applications, Trembley & Sorenson, McGraw Hill
3. The Art of Computer Programming, Vol.1: Fundamental Algorithms, Donald E Knuth, Addison - Wesley.
4. Data Structures using C & C++: Langsam, Augenstein & Tanenbaum, Pearson

Web Links:

1. <https://archive.nptel.ac.in/courses/106/102/106102064/>
2. <https://archive.nptel.ac.in/courses/106/106/106106131/>
3. <http://peterindia.net/Algorithms.html>

Mandatory Courses (MC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501AC01	Environmental Science	FC	2			0	100	-	100	-
2501AC02	Constitution of India	FC	2			0	100	-	100	-
2501AC03	Research Methodology	FC	2			0	100	-	100	-
2501AC04	Intellectual Property Rights & Patents	FC	2			0	100	-	100	-
2501AC05	Indian Knowledge Systems	FC	2			0	100	-	100	-
	Total		10			0				

Environmental Science

(CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT,Min.E)

Course Code: 2501AC01

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: 978-817087380.

Web Links:

1. <https://archive.nptel.ac.in/courses/127/105/127105018/>
2. https://onlinecourses.swayam2.ac.in/cec24_ge05/preview

(CE,EEE,ME,ECE,CSE,IT,AIIML,CSE(DS),PT,Min.E)

Course Code: 2501AC02

L	T	P	C
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/11104065/

Research Methodology
(CE,EEE,ME,ECE,CSE,IT,AI ML,CSE(DS),PT,Min.E)

Course Code: 2501AC03

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: 97881225015223.
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/121/106/12110607/>

Intellectual Property Rights & Patents
(CE,EEE,ME,ECE,CSE,IT,AI ML,CSE(DS),PT,Min.E)

Course Code: 2501AC04

L	T	P	C
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: 978817802774.
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: 978-07077171.
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: 2501AC05

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 in Electrical and Electronics Engineering
(offered to other branches students)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE55	Operation &Control of Electric Machines	FC	2			2	50	50	100	BEEE
2501EE56	Fundamentals of Power Electronics	FC	2			2	50	50	100	BEEE
2501EE13	Electrical Measurements & Instrumentation	FC	2	1	1	4	50	50	100	ENA-1/BEEE
2501EE53	Electric Power Generation, Transmission & Distribution Systems	IC	3			3	50	50	100	ENA-1/BEEE
2501EE34	Alternative Energy Sources (or) Utilization of Electrical Energy	IC	3			3	50	50	100	EPGD S / BEEE/ ISM
2501EE27										
2501EE37	Hybrid Electric Vehicles (or)	AC	3			3	50	50	100	FPE/ OCEM
2501EE35	Special Electric machines									
2501EE43	Electrical Safety (or)	AC	3			3	50	50	100	EPGD S/PSA
2501EE30	Methods & Algorithms for Intelligent Control									
	Total		18	1	1	20				

Electric Power Generation, Transmission & Distribution Systems

Course Code: 2501EE53

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: 978817700207).
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: 978070151413).

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>

Operation & Control of Electric Machines

Course Code:2501EE55

L	T	P	C
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: 978070699670).
- 2 Electrical Machinery by Abijith Chakrabarthi & Sudhipta Debnath, McGraw Hill, 1st edition (ISBN: 978125906456).

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

Course Code:2501EE56

L	T	P	C
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: 978074633694).

Web Links:

- 1 <https://nptel.ac.in/courses/108/101/10811038/>
- 2 <https://nptel.ac.in/courses/108/102/108102145/>
- 3 <https://nptel.ac.in/courses/108/102/108102145/>

Electrical Measurements & Instrumentation

Course Code:2501EE13

L	T	P	C
2	1	1	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 lissajious 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 - 5th Edition - Wheeler Publishing (ISBN: 9780273402022).
- 2 Modern Electronic Instrumentation & Measurement Techniques by A.D. Helfrick & W.D. Cooper - 5th Edition, PHI (ISBN: 9788120307520).

Reference Books:

- 1 Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications (ISBN: 978609578337).
- 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:2501EE34

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:2501EE27

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: 978938027845).
- 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

Special Electrical Machines

Course Code:2501EE35

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:	2501EE43	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: 978071745130)
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

Course Code: 2501EE30

L	T	P	C
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: 978023527616).
- 2 “Genetic Algorithm in Search Optimization & Machine Learning”, David E. Goldberg, Pearson Education (ISBN: 978021157673).

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, Kluware academic publisher (ISBN: 97807923462501).

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 Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	251EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	251EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	251EC099	Basic Programming Lab (or)	1	0	2	3	V
	251EC100	Basic Laboratory Course for Quantum Technologies					
4	251EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII
Any One course from the below							
5	251EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	251EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	251EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	251EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	251EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	251EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	251EC108	Quantum Optics	3	0	0	3	VII
12	251EC109	Quantum Cybersecurity	3	0	0	3	VII
13	251EC110	Quantum Machine Learning	3	0	0	3	VII
Total			18	0	0	18	

Survey of Quantum Technologies and Applications

Course Code: 251EC097

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: 251EC098

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: 251EC099

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: 251EC100

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: 251EC102

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: 251EC103

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: 251EC104

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: 251EC105

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: 251EC106

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: 251EC107

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: 251EC108

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)