

ADITYA UNIVERSITY

B. TECH. FOUR YEAR DEGREE

PROGRAM CURRICULUM

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

PETROLEUM TECHNOLOGY



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

Aditya Nagar, ADB Road, Surampalem - 533 437

Department of Petroleum Technology

Department Vision

To be a globally recognized centre of excellence in petroleum engineering education, fostering research, innovation, and sustainable solutions.

Department Mission

M1: Provide transformative learning through practice, and industry collaboration.

M2: Advance in impactful research through innovation and technology.

M3: Apply sustainable practices to address global resource and environmental challenges.

Program Educational Objectives (PEOs)

Graduates of the Program will

PEO 1: Pursue lifelong learning and growth in petroleum and related fields.

PEO 2: Develop solutions for petroleum industry challenges in exploration, production, and management.

PEO 3: Demonstrate research ability, teamwork, and leadership.

Program Specific Outcomes (PSOs)

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

PSO 1: Solve exploration and production problems using modern tools.

PSO 2: Design and optimize petroleum processing systems and equipment.

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 Petroleum Technology
B. Tech (PT) Program Curriculum-2025
(Applicable for the batches admitted from A.Y 2025-26)

UG Programs Offered

- B. Tech in (Petroleum Technology)
- B. Tech in (Petroleum Technology) with
 - Minor degree in Civil Engineering
 - Minor degree in Electrical and Electronics 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 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 (Petroleum Technology)

- Minor Stream in Pipeline and Petroleum Transport Engineering
- Minor Stream in Fire and Safety in Petroleum Industries

VISION & MISSION OF THE UNIVERSITY

VISION:

To be a globally recognized University through excellence in Education, Innovation, and Sustainable growth

MISSION:

M1: Deliver collaborative education to prepare students for global challenges through transformative learning

M2: Vibrant research ecosystem, innovation, and sustainable growth.

M3: Sustainable and inclusive community, global challenges.

VISION & MISSION OF THE DEPARTMENT

VISION:

To gain global recognition in petroleum education in research excellence, innovation, and sustainable solutions.

MISSION:

M1: Offer transformative learning for lifelong growth in petroleum engineering.

M2: Drive impactful research in innovation, and technology.

M3: Empower students to tackle global challenges in resource and environmental sustainability.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Program will

PEO 1: Pursue continuous professional growth through self-learning and further education in Petroleum and related fields.

PEO 2: Use engineering skills, critical thinking, and problem-solving to address societal, technical, and business challenges.

PEO 3: Demonstrate research skills, team spirit or leadership qualities.

PROGRAM OUTCOMES (POs)

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

- PO 1 **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- PO 2 **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- PO 3 **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- PO 4 **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- PO 5 **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- PO 6 **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- PO 7 **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- PO 8 **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- PO 9 **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective

reports and design documentation, make effective presentations considering cultural, language, and learning differences.

- PO 10 **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- PO 11 **Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs)

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

PSO 1: Solve petroleum technology problems using analytical methods, modern tools, and techniques.

PSO 2: Design, operate, maintain, and troubleshoot petroleum process equipment.

Credit Division Category-wise

S. No.	Broad Category of Course	UGC	Credits
1	Major (Core) MCC	80	81
2	Minor Stream Courses (MSC) (or) University Open Elective Courses (UEC)	32	32
3	Multidisciplinary Courses (MDC)	09	09
4	Ability Enhancement Courses (AEC)	08	09
5	Skill Enhancement Courses (SEC)	09	09
6	Value Added Courses (VAC)	6-8	04
7	Summer Internship (SI)	2-4	04
8	Full Semester Internship (PROJ)	12	12
9	Mandatory Course (MC)	00	00
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
2501CH01	Engineering Chemistry	FC	2		1	3	50	50	100	-
2501MA01	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
2501PH01	Solid State Physics	FC	2		1	3	50	50	100	-
2501PT06	Geology & Sedimentology for Petroleum Engineers	FC	1	1	2	4	50	50	100	-
2501PT10	Petroleum Geology & Exploration Techniques	FC	1	1	2	4	50	50	100	-
2501MA02	Differential Equations & Vector Calculus	FC	2		1	3	50	50	100	LA&C
2501MA05	Numerical Methods & Integral Transforms	IC	2	1		3	50	50	100	-
2501MA06	Complex Variables & Statistical Methods	IC	2	1		3	50	50	100	-
2501IT01	Business Intelligence Lab	FC			2	2	50	50	100	-
2501CS01	Programming for Problem Solving Using C	FC	2		2	4	50	50	100	BIL
2501ME01	Engineering Graphics	FC	1		2	3	50	50	100	-
2501ME03	Engineering Workshop	FC			1	1	100	-	100	-
2501PT01	Drilling Engineering	IC	2		2	4	50	50	100	GSPE & PGET
2501PT04	Fluid Mechanics for Petroleum Engineers	IC	1	1	2	4	50	50	100	-
2501PT09	Petroleum Formation Evaluation	IC	1	1		2	50	50	100	PGET
2501PT08	Instrumentation & Process Control	IC	2		2	4	50	50	100	-
2501PT05	Fundamentals of Liquefied Natural Gas	IC	3			3	50	50	100	FMPE
2501PT02	Elements of Reservoir Engineering	IC	2		2	4	50	50	100	GSPE
2501PT11	Petroleum Production Engineering	IC	1	1		2	50	50	100	ERE
2501PT12	Petroleum Refinery Engineering	IC	3			3	50	50	100	PPE
2501PT07	Heat Transfer in Petroleum Operations	IC	1	1	2	4	50	50	100	FMPE

2501PT14	Safety & Environmental Engineering Practices in Petroleum Industry	IC	2			2	50	50	100	-
2501PT17	Well Workover & Stimulation	AC	1	1		2	50	50	100	ERE
2501PT13	Reservoir Modelling & Simulation	AC	1	1	2	4	50	50	100	ERE
2501PT15	Surface Production Operations	IC	2			2	50	50	100	-
2501PT16	Unconventional Hydrocarbon Resources	AC	1	1		2	50	50	100	ERE
2501PT03	Enhanced Oil Recovery	AC	2	1		3	50	50	100	PPE
Total			42	13	26	81				

Multidisciplinary Courses (MDC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE01	Basic Electrical & Electronics Engineering	FC	2		2	4	50	50	100	-
2501MB02	Engineering Economics	IC	3			3	50	50	100	-
2501MB03	Management Science	AC	2			2	50	50	100	-
	Total		7		2	9				

Ability Enhancement Courses (AEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EN01	Essential Cognitive Skills for Engineers	FC			1	1	100	-	100	-
2501EN02/ 2501UC05/ 2501UC04/ 2501UC03/ 2501UC06	Advanced Cognitive Skills for Engineers (or) Proficiency in Foreign Language ((Japanese/ German/ French/ Spanish)	FC			1	1	100	-	100	-
2501UC07	Design Thinking using AI	FC			1	1	100	-	100	-
2501UC08	Universal Human Values	FC	2			2	100	-	100	-
2501UC09	Technical Paper Publication	AC			2	2	100	-	100	-
2501PT52	Student Activity Based Learning	AC			2	2	100	-	100	-
Total			2		7	9				

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT19	MATLAB For Petroleum Engineers Lab	IC			2	2	50	50	100	-
2501PT51	Well Control and Pressure Control Lab	IC			1	1	100	-	100	-
2501PT20	Petroleum Equipment Design and Simulation Lab	IC			2	2	50	50	100	SPO
2501PT18	Drilling Simulation Lab	AC			2	2	50	50	100	-
2501PT21	Unit Operations Using SCI Lab	AC			2	2	50	50	100	FMPE & HTPO
Total					9	9				

Value Added Courses (VAC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS02	Data Analysis Using Python	IC			2	2	50	50	100	PPSC
2501CS04	Internet of Things	FC			1	1	50	50	100	-
2501UC11	Employability Skills-I	FC			3	0	100	-	100	-
2501UC13	Employability Skills-II	FC			3	0	100	-	100	ES-I
2501UC14	Employability Skills-III	IC			3	0	100	-	100	ES-II
2501UC15	Employability Skills-IV	IC			3	0	100	-	100	ES-III
2501UC16	Employability Skills-V	AC			3	1	100	-	100	ES-IV
Total					18	4				

Summer Internships (SI)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT22	Summer Internship-I	IC			2	2	100	-	100	-
2501PT23	Summer Internship-II	AC			2	2	100	-	100	-
Total					4	4				

Full Semester Internship (PROJ)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT24	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 (MSC)

Pipeline and Petroleum Transport Engineering:

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT27	Introduction To Petroleum Engineering	FC	3			3	50	50	100	-
2501PT35	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
2501PT34	Transportation of Petroleum Products	FC	3			3	50	50	100	-
2501PT31	Pipeline Engineering	FC	3			3	50	50	100	-
2501PT29	Operational & Maintenance of Pipelines	IC	3			3	50	50	100	PE
2501PT26	Flow Assurance	IC	2			2	50	50	100	IPE
2501PT28	Midstream Project Economic Analysis	IC	3			3	50	50	100	TPP
2501PT33	Storage & Transportation of Crude oil & Natural Gas	IC	3			3	50	50	100	TPP & UOPI
2501PT25	Data Analytics & AI For Process Industry	IC	3			3	50	50	100	UOPI
2501PT30	Petroleum Economics Policies & Regulations	AC	3			3	50	50	100	MPEA
2501PT32	Pipeline Project Management	AC	3			3	50	50	100	OMP
Total			32			32				

Fire and Safety in Petroleum Industries:

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT39	Fundamentals of Petroleum Engineering	FC	2			2	50	50	100	-
2501PT38	Fire Risk & Control	FC	3			3	50	50	100	-
2501PT41	Occupational Health & Safety	FC	3			3	50	50	100	-
2501PT45	Statutory Rules & Regulation	FC	3			3	50	50	100	-
2501PT36	Advances In Sustainable Development	IC	3			3	50	50	100	OHS
2501PT40	Hazard Identification & Risk Assessment	IC	3			3	50	50	100	OHS
2501PT46	Structural Fire Protection System	IC	3			3	50	50	100	FRC
2501PT42	Process Safety & Security	IC	3			3	50	50	100	OHS
2501PT44	Safety In Engineering Industry	AC	3			3	50	50	100	HIRA
2501PT43	Safety In Drilling	AC	3			3	50	50	100	HIRA
2501PT37	Disaster Risk Management	AC	3			3	50	50	100	-
Total			32			32				

UNIVERSITY OPEN ELECTIVE COURSE S (UEC)

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
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, 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
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,	FPE

										AIML, CSE(DS) PT, Min. E	
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, Min E	FPE
2501ME58	Industry 5.0 for Engineers	AC	3			3	50	50	100	CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min E	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	SEE	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,	ISCM

										AIML, CSE(DS) PT, Min. E	
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	-
2501CE62	Waste Water Management	IC	3			3	50	50	100	EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min. E	-
2501CE59	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	-
2501CE58	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					

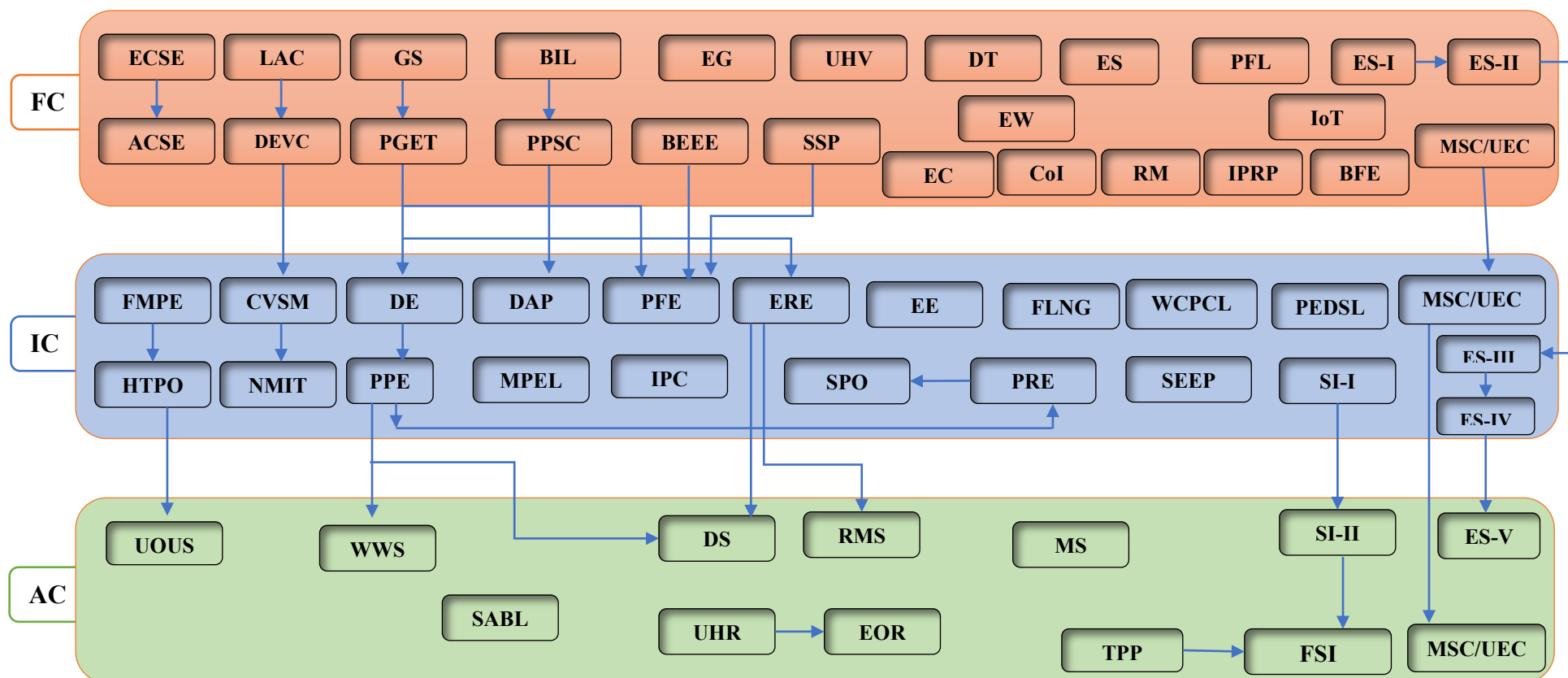
Security											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
2501CS32	Cybersecurity Essentials	FC	2		1	3	50	50	100	CE, EEE, ME, ECE, PT, Min. E	-
2501IT35	Security in Software Development	FC	3			3	50	50	100	CE, EEE, ME, ECE, PT, Min. E	-
2501CS28	Ethical Hacking	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
2501CE65	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, CSE, IT, AIML, CSE(DS) PT, Min. E	-
2501EC83	Electronic Measurements & Instrumentation	FC	3			3	50	50	100	CE, EEE, CSE, IT, AIML, CSE(DS) PT, Min. E	BEEE
2501EC84	Introduction to Embedded Systems	FC	3			3	50	50	100	CE, EEE, CSE, IT, AIML, CSE(DS) PT, Min. E	-

2501EC85	Fundamentals of Image Processing	FC	3			3	50	50	100	CE, EEE, CSE, IT, AIML, CSE(DS) PT, Min. E	
2501EC77	Sensors and Transducers	IC	3			3	50	50	100	CE, EEE, 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 (PT) PROGRAM CURRICULUM PRE-REQUISITE FLOW CHART



FC: Foundation Courses

LAC: Linear Algebra & Calculus
DEVC: Differential Equations & Vector Calculus
GS: Geology & Sedimentology for Petroleum Engineers
PGET: Petroleum Geology & Exploration Techniques
EC: Engineering Chemistry
SSP: Solid State Physics
PPSC.: Programming for Problem Solving Using C
BIL: Business Intelligence Lab
BEEE: Basic Electrical & Electronics Engineering
ECSE: Essential Cognitive Skills for Engineers
ACSE: Advanced Cognitive Skills for Engineers
PFL: Proficiency in Foreign language
DT: Design Thinking using AI
UHV: Universal Human Values
EG: Engineering Graphics
EW: Engineering Workshop
IoT: Internet of Things
ES: Environmental Science
CoI: Constitution of India
RM: Research Methodology
IPRP: Intellectual Property Rights & Patents
BFE: Biology for Engineers
ES-I: Employability Skills-I
ES-II: Employability Skills-II
MSC/UEC: Minor Stream Course / University Elective Courses

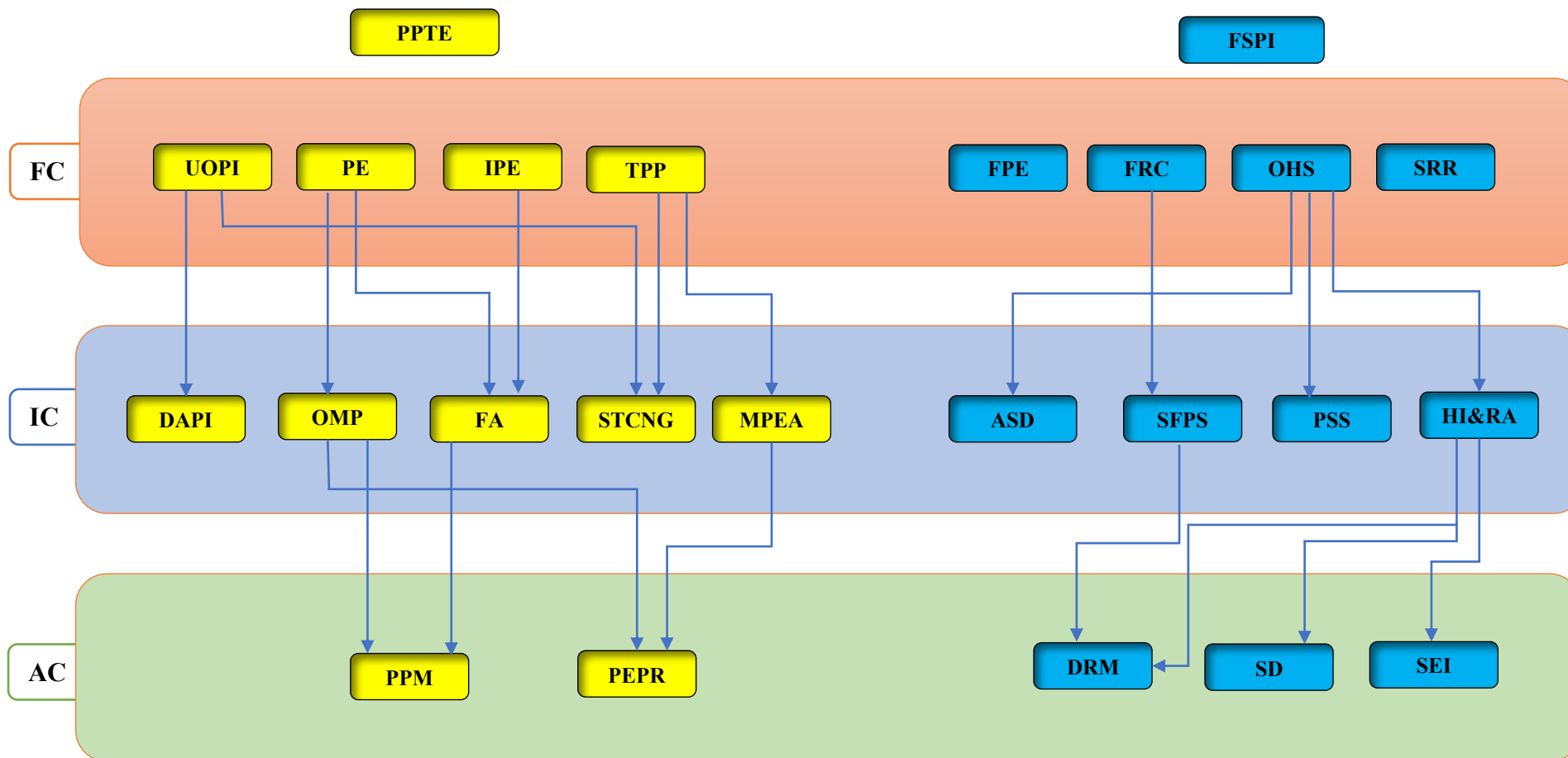
IC: Intermediate-level Courses

NMIT: Numerical Methods & Integral Transforms
EE: Engineering Economics
DE: Drilling Engineering
FMPE: Fluid Mechanics for Petroleum Engineers
HTPO: Heat Transfer in Petroleum Operations
DAP: Data Analysis Using Python
CVSM: Complex Variables & Statistical Methods
PFE: Petroleum Formation Evaluation
IPC: Instrumentation & Process Control
FLNG: Fundamentals of Liquefied Natural gas
ERE: Elements of Reservoir Engineering
WCPC: Well Control & Pressure Control Lab
MPEL: MATLAB for Petroleum Engineers Lab
PEDSL: Petroleum Equipment Design & Simulation Lab
SI-I: Summer Internship-I
PPE: Petroleum Production Engineering
PRE: Petroleum Refinery Engineering
SEEP: Safety & Environmental Engineering Practices in Petroleum Industry
SPO: Surface Production Operations
ES-III: Employability Skills-III
ES-IV: Employability Skills-IV

AC: Advanced Courses

DSL: Drilling Simulation Lab
MS: Management Science
WWS: Well Workover & Stimulation
RMS: Reservoir Modelling & Simulation
UOUS: Unit Operations Using SCI Lab
UHR: Unconventional Hydrocarbon Resources
EOR: Enhanced Oil Recovery
SI-II: Summer Internship-II
TPP: Technical Paper Publication
FSI: Full Semester Internship
ES-V: Employability Skills-V
SABL: Student Activity Based Learning

B. TECH (PT) MINOR STREAM COURSES PRE-REQUISITE FLOW CHART



Minor Stream	Foundation Courses		Intermediate Level Courses		Advanced Courses	
PPTE: Pipeline and Petroleum Transport Engineering	UOPI	Unit Operations in Petroleum Industry	DAPI	Data Analytics & AI for Process Industry	PPM	Pipeline Project Management
	PE	Pipeline Engineering	OMP	Operational & Maintenance of Pipelines	PEPR	Petroleum Economics Policies & Regulations
	IPE	Introduction to Petroleum Engineering	FA	Flow Assurance		
	TPP	Transportation of Petroleum Products	STCNG	Storage & Transportation of Crude oil & Natural Gas		
			MPEA	Midstream Project Economic Analysis		
FSPI: Fire and Safety in Petroleum Industries	FPE	Fundamentals of Petroleum Engineering	ASD	Advances In Sustainable Development	DRM	Disaster Risk Management
	FRC	Fire Risk & Control	SFPS	Structural Fire Protection System	SD	Safety In Drilling
	OHS	Occupational Health & Safety	PSS	Process Safety & security	SEI	Safety In Engineering Industry
	SRR	Statutory Rules & Regulation	HI&RA	Hazard Identification & Risk Assessment		

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
2501PH01	Solid State Physics	MCC	FC	2		1	3	4
2501PT06	Geology & Sedimentology for Petroleum Engineers	MCC	FC	1	1	2	4	6
2501ME01	Engineering Graphics	MCC	FC	1		2	3	5
2501IT01	Business Intelligence Lab	MCC	FC			2	2	4
2501ME03	Engineering Workshop	MCC	FC			1	1	2
2501EN01	Essential Cognitive Skills for Engineers	AEC	FC			1	1	2
2501UC07	Design Thinking using AI	AEC	FC			1	1	2
Total				6	2	10	18	28

II SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501MA02	Differential Equations & Vector Calculus	MCC	FC	2	1		3	3
2501CH01	Engineering Chemistry	MCC	FC	2		1	3	4
2501CS01	Programming For Problem Solving Using C	MCC	FC	2		2	4	6
2501PT10	Petroleum Geology & Exploration Techniques	MCC	IC	1	1	2	4	6
2501EE01	Basic Electrical & Electronics Engineering	MDC	FC	2		2	4	6
2501MB03	Management Science	MDC	AC	2			2	2
2501EN02	Advanced Cognitive Skills for Engineers	AEC	FC			1	1	2
2501UC08	Universal Human Values	AEC	FC	2			2	2
2501UC11	Employability Skills -I	VAC	FC			3	0	3
2501AC01	Environmental Science	MC	FC				0	2
Total				13	2	11	23	36

III 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
2501PT04	Fluid Mechanics for Petroleum Engineers	MCC	IC	1	1	2	4	6
2501PT08	Instrumentation & Process Control	MCC	IC	2		2	4	6
-	Minor Stream Course - 1 / University Open Elective Course - 1	MSC / UEC	FC/ IC	2			2	2
-	Minor Stream Course - 2 / University Open Elective Course -2	MSC / UEC	FC/ IC	3			3	3
2501MB02	Engineering Economics	MDC	IC	3			3	3
2501UC13	Employability Skills -II	VAC	FC			3	0	3
2501AC02	Constitution of India	MC	FC					2
Total				13	2	7	19	28

IV 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
2501PT07	Heat Transfer in Petroleum Operations	MCC	IC	1	1	2	4	6
2501PT05	Fundamentals of Liquefied Natural gas	MCC	IC	3			3	3
2501PT02	Elements of Reservoir Engineering	MCC	IC	2		2	4	6
-	Minor Stream Course - 3 / University Open Elective Course - 3	MSC / UEC	IC/ AC	3			3	3
2501PT51	Well Control and Pressure Control Lab	SEC	IC			1	1	2
2501PT19	MATLAB For Petroleum Engineers Lab	SEC	IC			2	2	4
2501CS02	Data Analysis Using Python	VAC	FC			1	1	2
2501UC14	Employability Skills -III	VAC	IC			3	0	3
2501AC03	Research Methodology	MC	FC				0	2
Total				11	2	11	21	34

V SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501PT09	Petroleum Formation Evaluation	MCC	IC	1	1		2	2
2501PT01	Drilling Engineering	MCC	IC	2		2	4	6
2501PT11	Petroleum Production Engineering	MCC	IC	1	1		2	2
2501PT15	Surface Production Operations	MCC	IC	2			2	2
-	Minor Stream Course – 4 / University Open Elective Course -4	MSC / UEC	IC/ AC	3			3	3
-	Minor Stream Course - 5 / University Open Elective Course - 5	MSC / UEC	IC/ AC	3			3	3
-	Minor Stream Course – 6 / University Open Elective Course -6	MSC / UEC	IC/ AC	3			3	3
2501PT18	Drilling Simulation Lab	SEC	AC			2	2	4
2501CS04	Internet of Things	VAC	FC			1	1	2
2501UC15	Employability Skills -IV	VAC	IC			3	0	3
2501PT22	Summer Internship-I	SI	IC			2	2	4
2501AC04	Intellectual Property Rights & Patents	MC	FC				0	2
Total				15	2	10	24	36

VI SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501PT14	Safety & Environmental Engineering Practices in Petroleum Industry	MCC	IC	2			2	2
2501PT17	Well Workover & Stimulation	MCC	AC	1	1		2	2
2501PT13	Reservoir Modelling & Simulation	MCC	AC	1	1	2	4	6
2501PT12	Petroleum Refinery Engineering	MCC	IC	3			3	3
-	Minor Stream Course - 7 / University Open Elective Course – 7	MSC / UEC	IC/ AC	3			3	3
-	Minor Stream Course – 8 / University Open Elective Course -8	MSC / UEC	IC/ AC	3			3	3
2501PT20	Petroleum Equipment Design & Simulation Lab	SEC	IC			2	2	4
2501AC05	Indian Knowledge Systems	MC	FC				0	2
Total				13	2	4	19	25

VII SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2501PT16	Unconventional Hydrocarbon Resources	MCC	AC	1	1		2	2
2501PT03	Enhanced Oil Recovery	MCC	AC	2	1		3	3
-	Minor Stream Course - 9 / University Open Elective Course – 9	MSC / UEC	IC/ AC	3			3	3
-	Minor Stream Course – 10 / University Open Elective Course -10	MSC / UEC	IC/ AC	3			3	3
-	Minor Stream Course – 11/ University Open Elective Course -11	MSC / UEC	IC/ AC	3			3	3
2501PT21	Unit Operations Using SCI Lab	SEC	AC			2	2	4
2501PT23	Summer Internship-II	SI	AC			2	2	4
	Total			12	2	4	18	22

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
2501UC16	Employability Skills -V	VAC	AC			3	1	3
2501PT52	Student Activity Based Learning	AEC	AC			2	2	4
2501PT24	Full Semester Internship	PROJ	AC			12	12	24
	Total					19	17	35

Total Credit: 160

Minor Degree in Petroleum Technology (offered to other branches students)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT27	Introduction to Petroleum Engineering	FC	3			3	50	50	100	-
2501PT35	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
2501PT47	Fundamentals of Geology & Reservoir Engineering	IC	3			3	50	50	100	-
2501PT48	Fundamentals of Drilling & Production Engineering (or)	IC	2			2	50	50	100	-
2501PT16	Unconventional Hydrocarbon Resources		1	1		2				
2501PT05	Fundamentals of Liquefied Natural Gas (or)	IC	3			3	50	50	100	-
2501PT49	Natural Gas Hydrates	AC	3			3				
2501PT50	Artificial Lift Techniques (or)	AC	3			3	50	50	100	-
2501PT03	Enhanced Oil Recovery		2	1		3				
2501PT12	Petroleum Refinery Engineering	AC	3			3	50	50	100	-
Total			18	2		20				

Minor Degree in Civil Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CE25	Repair & Rehabilitation of Structures	FC	3			3	50	50	100	-
2501CE43	Building Planning & Computer-Aided Drawing	FC			2	2	50	50	100	-
2501CE27	Green Buildings	FC	3			3	50	50	100	-
2501CE40	Fundamentals of Soil Behaviour	FC	2	1		3	50	50	100	-
2501CE54	Railway Engineering (or)	FC	3			3	50	50	100	-
2501CE47	Docks & Harbour Engineering									
2501CE36	Environmental Impact & Risk Management (or)	IC	3			3	50	50	100	-
2501CE37	Environmental Management									
2501CE56	Urban Transportation Planning (or)	IC	3			3	50	50	100	-
2501CE49	Intelligent Transportation Systems									
Total			17	1	2	20				

Minor Degree in Electrical and Electronics Engineering

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 and 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/ OCM
2501EE35	Special Electric machines									
2501EE43	Electrical Safety (or)	AC	3			3	50	50	100	EPGDS/PSA
2501EE30	Methods & Algorithms for Intelligent Control									
	Total		18	1	1	20				

Minor Degree in Mechanical Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501ME74	Basic Mechanical Engineering	FC	2			2	50	50	100	-
2501ME04	Engineering Thermodynamics	IC	2	1		3	50	50	100	SSP/ MP
2501ME77	Introduction to Automobile Engineering (or)	IC	3			3	50	50	100	SSP/ MP
2501ME78	Mechanics of Solids									
2501ME12	Heat Power Engineering (or)	IC	2	1		3	50	50	100	ETD
2501ME40	Refrigeration & Air Conditioning									
2501ME75	Production Technology	IC	3			3	50	50	100	EW
2501ME76	Metallurgy & Material Science	IC	3			3	50	50	100	SSP/ MP
2501ME79	Theory of Machines (or)	AC	3			3	50	50	100	SSP/ MP
2501ME80	Advanced Engineering Metrology									

Total	18	2		20				

Minor Degree in Electronics and Communication Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241EC87	Fundamentals of Communications	FC	2		1	3	50	50	100	-
241EC88	Fundamentals of Signal Processing	FC	2		1	3	50	50	100	-
241EC89	Analog & Digital Circuits	IC	2			2	50	50	100	BEEE
241EC42	Wireless LAN's & PAN's	IC	3			3	50	50	100	-
241EC90	Linear & Digital IC Applications (or) Sensors and Actuators	IC	3			3	50	50	100	ADC
241EC91										
241EC92	Embedded Microcontrollers (or) Digital System Design	IC	2		1	3	50	50	100	ADC, PPSC
241EC93										
241EC67	Introduction to Internet of Things (or) Modern Wireless Communications	AC	2		1	3	50	50	100	EM, WLANS&PANS
241EC74			3			3	50	50	100	FC
Total			16		4	20				

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS13	Operating Systems	IC	2		1	3	50	50	100	-
2501CS07	Computer Networks	IC	2		1	3	50	50	100	-
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
2501AI03	Data Mining	IC	1		2	3	50	50	100	-

Minor Degree in Computer Science and Engineering

Minor Degree in Data Science

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requis ite
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
2501CS34	Fundamentals of Data Science	IC	2		1	3	50	50	100	PPSC
2501CS12	NoSQL Databases	IC	2			2	50	50	100	-
2501AI03	Data Mining	IC	1		2	3	50	50	100	-
2501CS37	Health Care Data Analytics (or)	IC	2		1	3	50	50	100	PPSC
2501CS36	Business Intelligence & Analytics									
2501AI04	Big Data Analytics (or)	AC	2		1	3	50	50	100	DM
2501AI19	Data Visualization									DAP
2501CS41	Social Network Analysis (or)	AC	2		1	3	50	50	100	
2501CS40	Social Networks & Semantic Web									
Total			13		7	20				

Minor Degree in Artificial Intelligence and Machine Learning

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS08	Object Oriented Programming through C++ (or) Java Programming	IC	2		2	4	50	50	100	PPSC
2501IT06										
2501CS16	Introduction to MERN Stack Development (or) Information Security Analysis & Audit	IC			2	2	50	50	100	JP
2501CS30			2			2	50	50	100	-
2501CS18	Advanced MERN Stack Development (or) Flutter Fundamentals	AC			2	2	50	50	100	IMSD
2501IT12					2	2	50	50	100	-
Total			11		9	20				

2501AI02	Artificial Intelligence	IC	2		1	3	50	50	100	DAP
2501AI05	Machine Learning	IC	2		2	4	50	50	100	DAP
2501AI15	AI Chatbots	IC	2			2	50	50	100	DAP
2501AI14	Soft Computing (or) Fundamentals of Data Science	IC	1	0	2	3	50	50	100	AI
2501CS34		IC	2	0	1	3	50	50	100	PPSC
2501AI10	Natural Language Processing (or) Data Visualization	AC	2		1	3	50	50	100	DAP
2501AI19										
2501AI16	Prompt Engineering & GenAI (or) Social Network Analysis	AC	2		1	3	50	50	100	ML
2501CS41										
2501AI17	Federated Machine Learning	AC	2			2	50	50	100	ML
Total			14		6	20				

Minor Degree in Mining Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MN03	Development of Mineral Deposits	FC	3			3	50	50	100	-
2501MN41	Green Mining	FC	3			3	50	50	100	-
2501MN06	Surface Mining	IC	3			3	50	50	100	DMD
2501MN24	Drilling & Blasting	IC	3			3	50	50	100	DMD
2501MN07	Underground Coal Mining Technology (or) Underground Metal Mining Technology	IC	3			3	50	50	100	DMD
2501MN08										
2501MN14	Mine Legislation & General Safety (or) Environmental Pollution & Control	AC	3			3	50	50	100	UCMT / UMMT
2501MN28										
2501MN45	Industrial Safety Practices (or) Ground Control	AC	2			2	50	50	100	-
2501MN46										
Total			20			20				

Minor Degree in Agricultural Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite

2501AE82	Fundamentals of Renewable Energy Sources	FC	3	0	0	3	50	50	100	-
2501AE83	Post-harvest Engineering of Cereal Crops	FC	3	0	0	3	50	50	100	-
2501AE84	Ground Water Hydrology	FC	3	0	0	3	50	50	100	-
2501AE85	Micro Irrigation Systems	IC	2	0	0	2	50	50	100	-
2501AE86	Surface Water Hydrology (or)	IC	3	0	0	3	50	50	100	GWH
2501AE87	Land & Water Management Engineering									

2501AE88	Agricultural Process Engineering & Food Quality (or) Post-harvest Engineering for Horticultural Produce	AC	3	0	0	3	50	50	100	PHECC
2501AE89										
2501AE90	Agricultural Machinery & Equipment (or) Design of Bio-energy systems	AC	3	0	0	3	50	50	100	FRES
2501AE91										
Total			20			20				

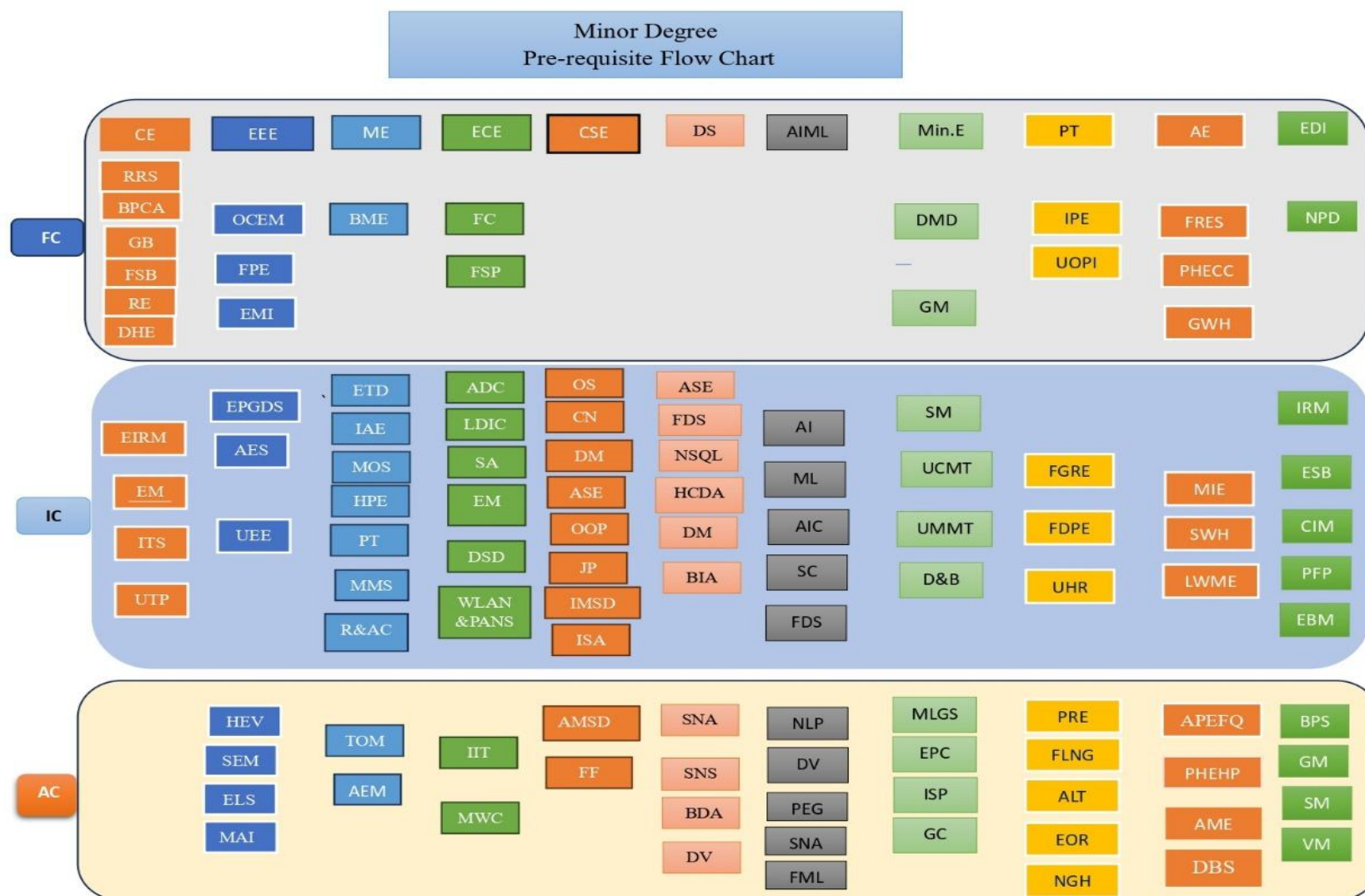
Minor Degree in Entrepreneurship Development & Incubation

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MB07	New Product Development	FC	3			3	50	50	100	-
2501MB08	Entrepreneurship & Small Business Management	IC	2			2	50	50	100	-
2501MB09	Insurance & Risk Management	IC	3			3	50	50	100	-
2501MB10	Change & Innovations Management	IC	3			3	50	50	100	-
2501MB11	Personal Financial Planning (or) E-Business management	IC	3			3	50	50	100	-
2501MB12										
2501MB13	Business Policy & Strategic Management (or)	AC	3			3	50	50	100	-

2501MB14	Green Marketing									
2501MB15	Startup Management (or) Venture Management	AC	3			3	50	50	100	-
2501MB16										
Total			20			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	



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

DS			OS	Operating Systems	FF	Flutter Fundamentals
			CN	Computer Networks		
			JP	Java Programming		
			IMSD	Introduction to MERN Stack Development		
			ISA	Information Security Analysis and Audit		
			DM	Data Mining		
			DM	Data Mining	SNA	Social Network Analysis
			FDS	Fundamentals of Data Science	DV	Data Visualization
			ASE	Agile Software Engineering	BDA	Big Data Analytics
			NSQL	NoSQL Databases	SNSW	Social Networks and Semantic Web
AIML			BIA	Business Intelligence & Analytics		
			HCDA	Health Care Data Analysis		
			ML	Machine Learning	DV	Data Visualization
			AI	Artificial Intelligence	PEG	Prompt Engineering and GenAI
			AI C	AI Chatbot	SNA	Social Network Analysis
Min. E	DMD	Development of Mineral Deposits	FDS	Fundamentals of Data Science	FML	Federated Machine Learning
	GM	Green Mining	SC	Soft Computing	NLP	Natural Language Processing
			SM	Surface Mining	MLGS	Mine Legislation and General Safety
			UCMT	Underground Coal Mining Technology	EPC	Environmental Pollution & Control
			UMMT	Underground Metal Mining Technology	ISP	Industrial Safety Practices
PT			DB	Drilling & Blasting	GC	Ground Control
	IPE	Introduction to Petroleum Engineering	FGRE	Fundamentals of Geology and Reservoir Engineering	PRE	Petroleum Refinery Engineering
	UOPI	Unit operations in Petroleum Industry	FDPE	Fundamentals of Drilling and Production Engineering	FLNG	Fundamentals of Liquefied Natural Gas
			UHR	Unconventional Hydrocarbon Resources	NGH	Natural Gas Hydrates
					ALT	Artificial Lift Techniques
Ag. E	GWH	Ground Water Hydrology	LWME	Land and Water Management	EOR	Enhanced Oil Recovery
	PHECC	Post-harvest Engineering of Cereal Crops	SWH	Surface Water Hydrology	DBS	Design of Bio-Energy Systems
			MIE	Micro Irrigation Systems	PHEHP	Post-Harvest Engineering for Horticultural Produce
					AME	Agricultural Machinery and Equipment
	FRES	Fundamentals of Renewable Energy Sources			APEFQ	Agriculture Process Engineering and Food Quality

EDC	NPD	New Product Development	ESB	Entrepreneurship and Small Business Management	BPS	Business Policy & Strategic Management
			CIM	Change & Innovations Management	GM	Green Marketing
			PFP	Personal Financial Planning	SM	Startup Management
			EBM	E-Business Management	VM	Venture Management
			IRM	Insurance and Risk Management		

Major (Core) Courses (MCC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CH01	Engineering Chemistry	FC	2		1	3	50	50	100	-
2501MA01	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
2501PH01	Solid State Physics	FC	2		1	3	50	50	100	-
2501PT06	Geology & Sedimentology for Petroleum Engineers	FC	1	1	2	4	50	50	100	-
2501PT10	Petroleum Geology & Exploration Techniques	FC	1	1	2	4	50	50	100	-
2501MA02	Differential Equations & Vector Calculus	FC	2		1	3	50	50	100	LA&C
2501MA05	Numerical Methods & Integral Transforms	IC	2	1		3	50	50	100	-
2501MA06	Complex Variables & Statistical Methods	IC	2	1		3	50	50	100	-
2501IT01	Business Intelligence Lab	FC			2	2	50	50	100	-
2501CS01	Programming for Problem Solving Using C	FC	2		2	4	50	50	100	BIL
2501ME01	Engineering Graphics	FC	1		2	3	50	50	100	-
2501ME03	Engineering Workshop	FC			1	1	100	-	100	-
2501PT01	Drilling Engineering	IC	2		2	4	50	50	100	GSPE & PGET
2501PT04	Fluid Mechanics for Petroleum Engineers	IC	1	1	2	4	50	50	100	-
2501PT09	Petroleum Formation Evaluation	IC	1	1		2	50	50	100	PGET
2501PT08	Instrumentation & Process Control	IC	2		2	4	50	50	100	-

2501PT05	Fundamentals of Liquefied Natural Gas	IC	3			3	50	50	100	FMPE
2501PT02	Elements of Reservoir Engineering	IC	2		2	4	50	50	100	GSPE
2501PT11	Petroleum Production Engineering	IC	1	1		2	50	50	100	ERE
2501PT12	Petroleum Refinery Engineering	IC	3			3	50	50	100	PPE
2501PT07	Heat Transfer in Petroleum Operations	IC	1	1	2	4	50	50	100	FMPE
2501PT14	Safety & Environmental Engineering Practices in Petroleum Industry	IC	2			2	50	50	100	-
2501PT17	Well Workover & Stimulation	AC	1	1		2	50	50	100	ERE
2501PT13	Reservoir Modelling & Simulation	AC	1	1	2	4	50	50	100	ERE
2501PT15	Surface Production Operations	IC	2			2	50	50	100	-
2501PT16	Unconventional Hydrocarbon Resources	AC	1	1		2	50	50	100	ERE
2501PT03	Enhanced Oil Recovery	AC	2	1		3	50	50	100	PPE
Total			42	13	26	81				

Engineering Chemistry
(Common to CE, ME, PT & Min. E)

Course Code: 2501CH01

L T P C
2 0 1 3

Course Outcomes:

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

- CO 1** Apply the knowledge of water treatment and specifications of potable water
- CO 2** Exemplify the principles of electrochemical cells and apply this knowledge to control corrosion
- CO 3** Summarize the essence of polymers and fuels – for sustainable energy solutions
- CO 4** Infer the preliminaries of engineering materials for industrial applications
- CO 5** Explore the fundamentals of Nano materials and integrate Green Chemistry for promoting sustainability

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

UNIT I:

Water Technology

Soft and hard water, Boiler troubles –Priming, foaming, scale and sludge, Caustic embrittlement, Industrial water treatment method (Zeolite and Ion-Exchange Process) – Internal treatment of water: Carbonate conditioning, Phosphate conditioning, Colloidal conditioning, Calgon conditioning.

Specifications of water for domestic use (ICMR and WHO); Domestic water purification – Candle filtration- activated carbon filtration; Disinfection methods- Ultra filtration, UV treatment, Ozonolysis, desalination of brackish water, reverse osmosis(RO)and electro dialysis.

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

UNIT II:

Electrochemistry and Corrosion

Electrodes– electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zinc-air battery, Secondary cells: Nickel-Cadmium (Ni-Cad), and lithium-ion batteries- Working principle of the batteries including cell reactions; Fuel Cells: Principle and working of hydrogen-oxygen Fuel cell.

Corrosion: Introduction to corrosion, Dry corrosion (Pilling Bed worth rule) electro chemical theory of corrosion (Mechanism), differential aeration cell corrosion, galvanic corrosion, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

Practice

1. Conductometric titration of strong acid vs weak base
2. Potentiometric titration of red-ox
3. P^H -metric titration of Acid-Base

UNIT III:

Polymers and Fuel Chemistry

Introduction to polymers, functionality of monomers, Thermo plastics and Thermo setting plastics:- Preparation, properties, and applications of PVC, and Bakelite.

Compounding of plastics: Injection molding, and Extrusion molding.

Biodegradable polymers: Introduction and their requirements.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels: Refining of petroleum, Octane and Cetane number, Alternative fuels: CNG, Ethanol and biodiesel.

Practice

1. Calorific value determination by Bomb Calorimeter.
2. Preparation of a Polymer (Bakelite)

UNIT IV:

Engineering Materials

Composites-Definition, Constituents, Fiber reinforced composites, properties, and Engineering applications

Refractories-Classification, Properties, Failures of Refractories and Applications.

Lubricants-Classification, Functions of lubricants, Properties of lubricating oils (Definition): Viscosity, Viscosity Index, Flash point & Fire point, Cloud point & Pour point and Applications of lubricants.

Building materials- Portland cement, constituents, Setting and Hardening of cement.

Practice

1. Determination of total acid number by potentiometric titration
2. Estimation of Calcium in port land Cement
3. Estimation of Saponification value of Fats/Oils

UNIT V:

Nano materials and Green Chemistry

Nano Materials: Introduction to Nano materials, chemical synthesis of Nano materials: Sol-gel method, characterization of Nano materials by SEM and TEM (includes basic principle of SEM and TEM), Applications of Nano materials (waste water treatment, lubricants and engines).

Green Chemistry: Principles of Green Chemistry and applications of green chemistry.

Various green chemical approaches – Microwave synthesis, Bio catalyzed reaction (only explanation with examples).

Practice

1. Preparation of Nano particle by Green Synthesis method.

Text Books:

1. Prasanta Rath, S. Aruna Kumari Engineering Chemistry, CENGAGE Learning, 2024. (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. H.F.W. Taylor, Cement Chemistry, ,Thomas Telford Publications, 2nd edition. (978-072-772-5929).
2. Dr S.S. Dara, Dr S.S. Umare, A Textbook of Engineering Chemistry, S. Chand Publication, 2022.(978-935-2-836-068).

Web Links:

1. <https://nptel.ac.in/courses/105107207>
2. <https://nptel.ac.in/courses/113104082>
3. <https://nptel.ac.in/courses/113108051>
4. <https://archive.nptel.ac.in/courses/104/105/104105039/>
5. <https://nptel.ac.in/courses/118102003>

Linear Algebra & 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 differential calculus for one and several variable functions
- CO4:** Calculate the Maximum value and Minimum value of a function of several variables
- CO5:** Compute areas and volumes using multiple integrals

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

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

Practice(Using any computational tool)

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

UNIT – II

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

Practice(Using any computational tool):

Computing eigen values and eigen vectors, matrix diagonalization.

UNIT – III

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

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

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

UNIT – IV

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

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

UNIT – V

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

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

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· ISBN 978-8184875607
- 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>

Solid State Physics
(Common to CE, ME, PT & Min. E)

Course Code:2501PH01

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1** Extend basic concepts of Elastic properties and bending of beams.
- CO2** Understand the basics of crystals and their structures
- CO3** Explain the basic concepts of Semiconductors and identify the type semiconductors using Hall effect.
- CO4** Classify the magnetic materials based on behavior of substances
- CO5** Summarize various types of electrical polarizations of dielectrics.

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

Elasticity of Materials: Stress – strain - Hooke’s law – stress - strain curve – generalized Hooke’s law with and without thermal strains for isotropic materials – different types of moduli and their relations – bending of beams – Bending moment of a beam – Depression of cantilever.

Practice:

1. Determination of rigidity modulus of a material by using Torsional Pendulum.
2. Determination of Young's Modulus of the material by method of single cantilever beam.
3. Determination of Moment of Inertia of a Fly Wheel.
4. Determination of Acceleration due to Gravity by using Compound Pendulum.

Unit-II

Crystal Structure and X-ray diffraction

Crystal Structure: Lattice and Basis – Crystal Systems – Bravais Lattice - Unit cell – Packing fraction – coordination number- Miller indices – Separation between successive (h k l) planes- Applications.

X-ray Diffraction: Bragg’s law-Bragg’s x-ray spectrometer – crystal structure determination by Laue’s and powder method- Applications.

Practice:

1. Determine the crystal structure of the sample using data.

Unit–III

Semi-conductor Physics

Origin of resistivity - Formation of energy bands in crystalline solids - classification of crystalline solids - Intrinsic semiconductors - Fermi level – extrinsic semiconductors - P-type and N-type -Dependence of Fermi energy on carrier concentration and temperature - Hall effect - Hall coefficient -Applications of Hall effect –Drift and Diffusion currents– Einstein’s equation. – P-N junction diode -Zener Diode - Applications

Practice:

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

Unit–IV

Magnetic materials: Introduction –Magnetic dipole moment– Magnetization– Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Bohr magneton –Classification of magnetic materials: Dia, para & Ferro–Domain concept of Ferro magnetism Hysteresis–soft and hard magnetic materials–applications of Ferromagnetic material.

Practice:

1. Study the variation of magnetic field along the axis of a circular coil carrying current by using Stewart and Gee’s apparatus.

Unit – V

Dielectric Materials: Introduction – Dielectric polarization–Dielectric polarizability, Susceptibility, Dielectric constant - Relation between D, E, P- Types of polarizations – Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) – Ferro electric materials - Frequency dependence of polarization - Applications.

Practice:

1. Determine dielectric constant of dielectric material using charge-discharge method.

Text Books:

1. “A Text book of Engineering Physics” by M N Avadhanulu, P G Kshirsagar & T.V.S.Arun Murthy S Chand & Company Ltd, 11th edition. **ISBN:** 81-219-0817-5
2. “Engineering Physics” by R K Gaur and S L Gupta, Dhanpat Rai Publications. **ISBN:** 978-8189928223
3. “Physics for Engineers” by T.Vijaya Krishna, Cengage publications. **ISBN:** 978-93-5350-755-8

Reference Books:

1. “Engineering Physics” by M.R.Srinivasan, New Age international publishers (2009). **ISBN:** 978-1848290501
2. “Text book of Engineering Physics” by S. O. Pillai, New Age international publishers (2012). **ISBN:** 9788122420753
3. “Introduction to Solid State Physics” by Charles Kittel, Wiley publications 8th edition (2012) **ISBN:** 978-1-119-45416-8

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>

Geology & Sedimentology for Petroleum Engineers

	L	T	P	C
Course Code: 2501PT6	1	1	2	4

Course Outcomes:

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

- CO1:** Explain the general facts of the earth.
- CO2:** Explain the formation of different structures.
- CO3:** Describe the origin of rocks, especially sedimentology.
- CO4:** Describe the different depositional environments and basins.
- CO5:** Apply the uses of micro fossils in oil exploration.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

The Earth: Introduction to origin, age, internal structure, and constitution of earth; Introduction to earth's lithosphere, atmosphere, hydrosphere, and biosphere. Plate tectonic theory, tectonic elements of continents and oceans; continental drift.

UNIT – II

Domain of Structural Geology: Concepts of strike and dip; parameters controlling deformation of rocks; deformation in rocks – descriptions of folds, joints, faults and their classifications; unconformity; geological maps and sections; map symbols.

UNIT – III

Origin of igneous, sedimentary, and metamorphic rocks

Sedimentology: Subaerial weathering processes: physical and chemical weathering; distinction between soil, alluvium, and sediments;

Sedimentary textures: grain size, particle shape, sorting and fabric and their effect on porosity and permeability of sedimentary rocks;

Sedimentary structures: stratification and bedforms, bedding plane markings; paleocurrent analysis.

UNIT – IV

Sedimentary Rocks and Depositional Environments: Diagenesis of siliciclastic sediments. Classification of siliciclastic sedimentary rocks: rudaceous, argillaceous, and lutaceous sedimentary rocks; carbonate sedimentary rocks: classification, diagenesis.

Introduction to different types of sedimentary basins, and depositional environments: Eh-pH fence diagram; continental (fluvial, lake, aeolian), marginal marine (estuarine, lacustrine), shallow marine (tidal flat, beach, deltaic), shelf and deep marine environments.

UNIT – V

Concepts of palaeontology: Fossils, their mode of preservation and significance as indices of age and climate; Concept of index fossils and their uses in oil exploration.

Integrated Lab With 2 Credits

Practices:

1. Study of Sedimentary rocks in Hand Specimen: Sandstone – Detailed study of Different types of Sandstone, Ex. Arkose, Arenite, Wacke with respect to texture (grain size, shape and angularity/roundness),
2. Shale – Detailed study of different types of shales (glaucous, fossiliferous, and carbonaceous) & their depositional environment.
3. Limestone- Detailed study of different types of Limestone and their depositional environment).
4. Study of shapes of pebbles.
5. Grain size analysis of sediment (Mean, Median, Standard deviation, Skewness, Kurtosis).
6. Measurement of the strike and dip.
7. Location of observed outcrops on the Toposheet and Preparation of geological map of the area.
8. Study of Isopach maps and construction of sections.
9. Construction of panel and fence diagrams
10. Study of porosity and permeability from samples

Additional Practices:

1. Identification of minerals
2. Measurement of thickness of beds.
3. Field trips to the different deltaic environments of Godavari delta.

Textbooks:

- 1 Introduction to Sedimentology, Sengupta S.M. eISBN: 978-93-883-2799-2
- 2 Depositional Sedimentary Environments, Reineck H.E. and Singh I.B, Springer eISBN: 978-3-642-81498

Reference Books:

- 1 Elements of Mineralogy, Gribble, C. D., Rutley's, 27th Edition. CBS Publishers. eISBN: 978-94-011-6832-8
- 2 Principles of Physical Geology, David Duff, Homes, Nelson Thornes Ltd; 4th Revised edition. eISBN: 041240320X
- 3 Textbook of Physical Geology, Mahapatra, G.B., CBS Publishers. eISBN: 9788123901107

Web Links:

- 1 web.crc.losrios.edu/~jacksonh/classes/earthscience/Chapter1.pdf
- 2 science.jrank.org/pages/3820/Landform.html
- 3 www.manitoba.ca/iem/min-ed/kidsrock/origins/index.html
- 4 [https://ocw.mit.edu/courses/earth-atmospheric-and-astro/12...sedimentary .../ch11.pdf](https://ocw.mit.edu/courses/earth-atmospheric-and-astro/12...sedimentary.../ch11.pdf)
- 5 www.ucmp.berkeley.edu/fosrec/ONeill.html

Petroleum Geology & Exploration Techniques

Course Code: 2501PT10

L	T	P	C
1	1	2	4

Course Outcomes:

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

- CO1:** Explain its properties, origin and migration of petroleum in different rocks.
- CO2:** Explain the entrapment of oil and gas.
- CO3:** Apply the different geological approaches for exploration of oil and gas deposits.
- CO4:** Utilize the principles of gravity and magnetic prospecting to explore the subsurface rocks favorable for hydrocarbon deposits.
- CO5:** Apply different seismic refraction and reflection techniques in selected areas of structural interest revealed by the gravity and magnetic methods to locate oil bearing structures.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Physical and chemical characteristics of crude oil, Origin of petroleum: diagenesis, catagenesis and metagenesis. Source rock and maturation, Reservoir rocks and cap rocks. Migration of hydrocarbons: mechanism, pattern, and barriers.

Unit-II

Entrapment of oil and gas: types and mechanism.

Geology of sedimentary basins of India –producing and prospective basins, KG basin Mumbai Offshore and Cambay Basin

UNIT – III

Exploration Philosophy and Principles. Stages and norms of exploration. Geological techniques and procedures of petroleum exploration. Geological mapping. Geochemical methods of prospecting: Soil geochemical surveys; Hydro-geochemistry as a tool for oil exploration

UNIT – IV

G and M Methods: Gravity and magnetic prospecting, Instruments of G&M survey, Gravity and magnetic data correction, Interpretation of G&M anomaly, Correlation of Gravity anomaly with seismic anomaly and applications in oil exploration.

UNIT – V

Body waves and surface waves, Rayleigh, Love, P and S wave, Seismic acquisition principle, Seismic refraction and reflection surveys and their applications in oil exploration, Land and marine sources, Geophone, Hydrophone and Vibroses survey, Seismic Fold, Signal and Noise, Seismic Processing, CDP/CMP and NMO, DMO, 2D and 3D seismic surveys.

Integrated Lab With 2 Credits

Practices:

1. Megascopic identification of source, reservoir, and cap rocks
2. Preparation of litho stratigraphic columns, litho stratigraphic correlation.
3. Identification of differences between clastic and carbonate reservoir rocks
4. Measurement of porosity of reservoir rocks
5. Measurement of permeability of reservoir rocks
6. Preparation of structural contour map and location of Oil Water Contact (OWC)
7. Basics of Contouring (Hand Drawn and Computerised)
8. Gravity Data Processing and Interpretation
9. Magnetic Processing and Interpretation
10. Seismic data interpretation (Shallow seismic-Hammer source)

Additional Practices:

1. Identifying Play, Lead and Draggable prospects from seismic data.
2. Identifying Play, Lead and Draggable prospects from gravity data.
3. Identifying Play, Lead and Draggable prospects from magnetic data.

Textbooks:

- 1 Reservoir Seismology , Mamdough, R. Gadallah, Pennwell Books, Pennwell Publishing Company, Tusa, Oklahoma. eISBN: 0-87814-411-0
- 2 Applied Geophysics, Telford, W M, Geldart, L.P., Sheriff, R.E. and Keys, D.E., Oxford and IBH Publishing Co Pvt Ltd. eISBN:0-521-32693-1

Reference Books:

- 1 Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip. eISBN: 978-2710806998
- 2 Applied Geophysics, W. M. Telford, L.P. Geldart, R.E. Shariff, Cambridge University Press. eISBN: 9780521339384

- 3 Exploration Geophysics: An Introduction, M.Gadallah, R.Fisher, Springer Publications.
eISBN: 978-3-540-85160-8

Web Links:

- 1 <https://link.springer.com/article/10.1007/s13369-019-03778-x>
- 2 www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-09-13a.pdf
- 3 www.geol-amu.org/notes/b8-4-4.htm
- 4 https://www.eoas.ubc.ca/courses/eosc350/content/methods/meth_6/raypaths.html

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

Course Code: 2501MA02	L	T	P	C
	2	1	0	3

Course Outcomes:

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

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

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Ordinary Differential Equations of First Order and First Degree:

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

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

UNIT – II

Linear Differential Equations of Higher Order:

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

Equations reducible to Linear differential equations with constant coefficients: Cauchy's homogeneous Linear Equations, 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/111/101/111101153/>
- 5 <https://archive.nptel.ac.in/courses/111/105/111105122/>

Numerical Methods & Integral Transforms

(Common to EEE, PT & Min. E)

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 · ISBN 978-8184875607
- 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. ISBN 978-1498739641
- 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

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 9789354600364.
- 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>

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>

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
 - a. Objective: Understand if and else Conditional statements in C.
<https://www.hackerrank.com/challenges/conditional-statements-in-c/problem?isFullScreen=true>
 - b. Roots of a Quadratic Equation.
 - c. Generate electricity bill.
<https://maya.technicalhub.io/owl-program-details/66868f6730bfbd35127c9ba7>
 - d. Simulate a calculator using switch case.
 - e. 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-Dimensional 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: N^{th} 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=CHEFSTLT
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/6686546930bfbd35127c869c
8	Volume of Sphere	https://maya.technicalhub.io/owl-program-details/6686565530bfbd35127c8818
9	Required Points	https://maya.technicalhub.io/owl-program-details/66865b1130bfbd35127c8a04
10	Instant Noodles	https://maya.technicalhub.io/owl-program-details/66865ddb30bfbd35127c8c0a
11	Find Second Number	https://maya.technicalhub.io/owl-program-details/668660a530bfbd35127c8cde
12	Kmph to Mps	https://maya.technicalhub.io/owl-program-details/668663ce30bfbd35127c8dfb
13	Inches to Centimeters	https://maya.technicalhub.io/owl-program-details/6686665e30bfbd35127c8f3a
14	Capacity	https://maya.technicalhub.io/owl-program-details/668678aa30bfbd35127c95b9
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/66866c4a30bfbd35127c90b4

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

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	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

Practice:

1. Introduction to Engineering Graphics

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

2. Construction of Cycloids and Involute

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

3. Introduction to Orthographic Projection

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

4. Projection of straight lines-I:

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

5. Projection of straight lines-II:

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

6. Projection of planes:

- a) Regular planes perpendicular to both reference planes, Parallel to one reference plane and inclined to the other reference plane

Ex: Rectangle, Pentagon, Hexagon and Rhombus

7. Projection of planes

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

8. Projection of solids

- a) Axis Perpendicular to H.P and Axis Perpendicular to V.P

Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

- b) Axis Parallel to H.P and V.P

Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

9. Projection of solids

- a) Projection of Solids with axis inclined to one reference plane and parallel to another plane

Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

10. Development of Surfaces

- a) Development of Prisms and Cylinder simple cases

11. Development of Surfaces

- a) Development of Pyramids and Cone simple cases

12. Conversion of Isometric views to Orthographic views

- a) Practice figure - 1

- b) Practice figure - 2

Additional Practice:**1. Conversion of Isometric views to Orthographic views**

- a) Practice figure - 3

- b) Practice figure - 4

2. Conversion of Orthographic views to Isometric views

- a) Practice figure - 1

- b) Practice figure - 2

Text Books:

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

Reference Books:

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

Web Links:

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

Engineering Workshop

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

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Practice:

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

Additional Practice:

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

Text Books:

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

Drilling Engineering

Course Code: 2501PT01

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1:** Apply basic Concepts of well design
- CO2:** Apply basic Concepts of drilling technology
- CO3:** Evaluate drill mud for pressure control
- CO4:** Evaluate the equipments and their purpose
- CO5:** Apply the testing tools and analysis of well 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	-	-	-	-	-	-	-	-	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	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

UNIT – I

Well Planning and Well Design:

Drilling programme preparation, Type of well, Prospect, GTO, Introduction to wellbore pressures

UNIT – II

Introduction to drilling Technology:

Rotary / top drive drilling, Types of onshore/offshore rigs, Introduction to hardware system (Land Rig), power generation system, Hoisting, Rotary and Drilling Fluid circulation system, mud pumps, Rig selection criteria. Horsepower calculations for draw-works and rotary. Advantages and disadvantages of top drive system.

UNIT – III

Introduction, functions, types, compositions, properties of mud, Field test, Rheology, Additives and contamination, Selection of drilling fluids and mud, Conditioning equipment, Mud

calculations, Hydrostatic pressure, Volume, Weight related calculations during drilling and tripping

UNIT – IV

Well tubular: Casing String and casing seat selection, Drill String

Drill Bits: Classification and design criteria of drag, rotary, roller, diamond and PDC bits.

Bit Selection: Conventional and Log-based. Introduction to tri-axial loading, Well Head Equipment.

Cement Selection: Functions, classification of cement, Cement additives, Methods of cementation, Equipment and accessories, Field problems pertaining to cementation job, Cement slurry calculations

UNIT – V

Well Problems and Solutions: Fatigue failure, Pipe sticking, Lost-circulation, Sloughing shale, Swabbing, surge, gas cap drilling.

Oil Well Fishing: Fish classification, tools and techniques

Integrated Lab With 2 Credits

Practices:

1. Measurement of drilling fluid Equipment: The Baroid mud balance
2. Measurement of mud viscosity. Equipment: Marsh funnel
3. Measurement of pH of mud. Equipment: pH meter and hydrino pH dispenser
4. Determination of mud rheology (Viscosity, Gel strength, and Yield point). Equipment: The Baroid rheometer
5. Determination of the loss of liquid from a mud. Equipment: Standard API filter press
6. Measurement of a drilling mud cake and evaluate resistivity. Equipment: Baroid digital resistivity meter
7. Measurement of the effect of adding bentonite on mud properties.
8. Drilling fluid contamination test (Salt, Gypsum & Cement contamination) and their effect on the drilling fluid properties.
9. Measurement of solid and liquid content and emulsification characteristics of drilling fluid. Equipment: Sand content set, fann emulsion and electrical stability testers
10. Determination the amount of Calcium Carbonate (CaCO_3) and Magnesium Carbonate (Dolomite) in a sample of alkaline earth carbonates such as oil well cores or drilled cuttings. Equipment: Calcimeter and Procedure is as per ASTM D 4373-84
11. Measurement of Oil, water, solid and clay content. Equipment: Oil/ water retort kit

Additional Practices:

1. Measurement of water ratios for Portland cement slurry. (Effect of water ratio on free water separation normal and minimum water content and thickening time)
Equipment: The atmospheric consistometer
2. Measurement of compressive strength of cement test moulds and effect of temperature and pressure on setting of the slurry.
Equipment: Compressive strength testing machine
3. Measurement of compressive strength of cement test moulds and effect of chemicals on flash setting and retardation
Equipment: Compressive strength testing machine

Textbooks:

- 1 Petroleum Engineering: Drilling and Well Completions c.gatlin eISBN: 978-0136621553
- 2 Applied Drilling Engineering A. T. Bourgoyne eISBN: 9781555630010

Reference Books:

- 1 Hussain Rabia, Oil Well Drilling Engineering, Principles & Practice, Graham & Trotman, eISBN: 9780860106616
- 2 Well Control Problems Solutions : Neal A J.dams eISBN: 9780878141241

Web Links:

- 1 <https://www.sciencedirect.com/science/article/pii/B9780123838469000047>
- 2 <https://petroleumpdf.com/drilling-and-well-completions-by-carl-gatlin-pdf-free-download/>
- 3 <https://www.scribd.com/doc/232062873/Carl-Gatlin-Drilling-Well-Completion-pdf>
- 4 <https://www.scribd.com/document/306762429/Bit-selection-guidelines-pdf>
- 5 https://petrowiki.spe.org/PEH:Drilling_Problems_and_Solutions

Fluid Mechanics For Petroleum Engineers

Course Code: 2501PT04

L	T	P	C
1	1	2	4

Course Outcomes:

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

- CO1:** Explain the basic fluid properties and types of fluids.
- CO2:** Derive the equations related to fluid statics
- CO3:** Classify the kinematics and dynamics of fluid flow and derive its equations
- CO4:** Demonstrate the concept of flow measurement and dimensional analysis
- CO5:** Classify the pumps and compressors and solve the energy calculations

Mapping of Course Outcomes with Program Outcomes:

CO/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	2	3	-	2	-	-	-	-	-	-	-
CO3	2	3	-	2	-	-	-	-	-	-	-
CO4	2	3	-	2	-	-	-	-	-	-	-
CO5	2	3	-	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Fluid properties

Definition of fluid; Properties of fluids: Viscosity, compressibility and bulk modulus; Shear stress in a moving fluid; Difference between liquids and gases, compressible and incompressible fluids; Newtonian and non- Newtonian fluids.

UNIT – II

Fluid statics

Continuum concept of a fluid: Statics of fluid systems, pressure and the variation of pressure due to gravity in a static fluid; Manometers: U-tube, differential and inclined manometers.

UNIT – III

Kinematics and dynamics of fluid flow

Fluid kinematics: Classification and types of flow; Velocity field and acceleration; Continuity equation and its applications;

Fluid dynamics: Reynolds experiment, laminar and turbulent flows, nature of turbulence and boundary layer; Euler's equation of motion; Bernoulli's theorem; Momentum equations and energy losses in fluid flow.

UNIT – IV

Dimensional analysis and flow measurement

Dimensional analysis: Dimensions of physical quantities, dimensional homogeneity, Buckingham pi theorem, important dimensionless numbers.

Flow measurement: Application of Bernoulli's equation in pitot tube, venturi meter, orifice meter, rota meter, triangular and rectangular notch, mass flow meters, etc.

UNIT – V

Pumps and compressors

Classification of pumps: Characteristic curves, selection criteria; Types of compressors: COP and selection criteria; Compressible fluid flow; Ideal gas relations and energy calculations.

Integrated Lab With 2 Credits

Practice:

1. Identify laminar and turbulent flows
2. Measure the point velocities
3. Verify Bernoulli's equation
4. Calibrate Rotameter
5. Study the Variation of Orifice coefficient with Reynolds Number
6. Determine Venturi coefficient
7. Study Friction losses in Fluid flow in pipes
8. Study the coefficient of Discharge in a V-Notch
9. Study the coefficient of contraction for a given open orifice
10. Study the Characteristics of Centrifugal Pump

Additional Practice:

1. Study Pressure drop and void fraction in a fluidized bed
2. Study Pressure drop and void fraction in a packed bed
3. Study the Characteristics of reciprocating Pump

Textbooks:

- 1 Unit Operations of Chemical Engineering of, McCabe, W.L., J.C. Smith & Peter
eISBN: 9780072848236
- 2 Transport Processes and Unit Operations, Christie J. Geankoplis, P
eISBN: 9780205059393

Reference Books:

- 1 Introduction to Fluid Mechanics, Fox, R.W. and A.T. McDonald, 5th Edition, John
eISBN: 9781119721024
- 2 Chemical Engineering, Vol-1: Fluid flow, Heat Transfer and Mass Transfer, J.M. Coulson
and J.F. Richardson, Pergamon Press, 4th Edition. eISBN: 9780750644440
- 3 Fluid Mechanics for Chemical Engineers, Noel De Nevers, Tata McGraw-Hill.
eISBN: 9780071238243

Web Links:

- 1 www.mhhe.com/engcs/chemical/mccabe/graphics/toc.pdf
- 2 www.unimasr.net/ums/.../UniMasr.com_919e27ecea47b46d74dd7e268097b653.pdf
- 3 home.zcu.cz/~kovarikp/MT/freestudy/FLUID.../FLUID_MECHANICS_D203.pdf
- 4 <https://www.coursehero.com>
- 5 www.qzu.zj.cn/hgx/jpkc/hgyl/kj/huagongyuanli/syjx/801.html

Petroleum Formation Evaluation

Course Code: 2501PT09

L	T	P	C
1	1	0	2

Course Outcomes:

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

- CO1:** Apply the methods for core analysis and interpretation
- CO2:** Make use of subsurface properties of reservoir.
- CO3:** Interpret the different log data using different open hole interpretation techniques.
- CO4:** Explain the basics of casedhole logging in evaluate formation.
- CO5:** Apply principles of production logging techniques in production 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	3	-	-	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	-	-	-	-	3	-
CO4	3	-	-	-	-	-	-	-	-	3	-
CO5	3	-	-	-	-	-	-	-	-	3	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Formation Evaluation Overview:

Direct and Indirect Methods, classification and logging tools. Mud Logging and cutting analysis log, Coring and Core analysis.

Petrophysical Measurements: Rock-fluid interaction, Bore hole environment and basic concepts of well log analysis and application

UNIT – II

Introduction to properties measurements:

Rock-forming minerals, types of rocks, reservoirs, source rocks, migration Archie's formulation, Capillary pressure and Leverett J-function, elastic rock properties, fluid measurements, effect of clay minerals on physical properties measurements.

UNIT – III

Openhole Well Logging: Principle, Logging tools, application & Limitations Spontaneous Potential Log, Gamma Ray Log.

Resistivity Measurement: Electrical, induction logging and micro-resistivity log

Porosity Logs: Density & Litho-density log, neutron log, sonic (acoustic) log, Electromagnetic Propagation tools. Nuclear Magnetic Resonance log

UNIT – IV

Cased Hole Logging: introduction, objectives and methods

Well Integrity evaluation: CBL and VDL logs, Ultrasonic Imaging tools

Casing inspection tools: Electromagnetic and acoustic CIT

Log Reservoir fluid Saturation Determination: tool principle and application

UNIT – V

Production Logging: Introduction, type of tools, principles, limitations and applications

Log Interpretation and Analysis Techniques: Standard log interpretation methods.

Quick-Look Interpretation: Crossplots, and Overlays Lithology/ Minerology Identification

Porosity Determination Water saturation and Resistivity Determination Clean sand & Shaly sand interpretation.

Textbooks:

- 1 Log Interpretation Principles/Applications, Schlumberger
- 2 Well Logging and Formation Evaluation, Toby Darling, Elsevier, New York. eISBN: 9780080457956

Reference Books:

- 1 Well Logging & Reservoir Evaluation, Oberto Serra, Editions Technip. eISBN: 9782710808817
- 2 Formation Evaluation, Edward J. Lynch, Harper & Row.

Web Links:

- 1 Sample Examination Manual, R.G.Swanson, Shell Oil Company, Published by AAPG
- 2 https://link.springer.com/chapter/10.1007%2F978-3-319-29710-1_3
- 3 [petrowiki.org/Types of logs](http://petrowiki.org/Types%20of%20logs)
- 4 www.pe.tamu.edu/blasingame/data/z_zCourse_Archive/P663.../GR%20Log.PDF
- 5 <https://www.sciencedirect.com/science/article/pii/S0376736108705788>

Instrumentation & Process Control

Course Code: 2501PT08

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1:** Choose the instrument based on static and dynamic characteristics.
- CO2:** Categorize the various types of thermometers & pressure gauges
- CO3:** Explain the processes with appropriate instrumentation diagrams
- CO4:** Interpret the responses of first&second order systems with examples
- CO5:** Explain tuning a control loop and characteristics of control valves

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Fundamentals: Elements of instruments, Functions of instruments and Characteristics of an instruments.

Industrial Thermometers: Expansion thermometers and its types, Static accuracy and response of thermometry. Thermoelectricity-Industrial Thermocouples-Thermocouple wires- Thermocouple wells and response of thermocouples; Thermal coefficient of resistance- Industrial resistance-thermometer bulbs and circuits. Radiation receiving elements-Radiation pyrometers-photoelectric and optical pyrometers.

UNIT – II

Pressure and vacuum: Liquid column manometers-Measuring elements for gauge pressure and vacuum indicating elements for pressure gauges-Static accuracy and response of pressure gauges.

Composition analysis: Spectroscopic analysis by absorption, emission and mass, Gas analysis by thermal conductivity, analysis of moisture.

UNIT – III

Flow Meters: Head flow meters-Area flow meters-Viscosity measurements.

Process Instrumentation: Controls Center-Instrumentation Diagram-Process analysis-Digital instrumentation and SCADA systems

UNIT – IV

Introduction to process dynamics and control: Response of first order systems – Physical examples of first order systems. Response of first order systems in series, higher order systems: Second order and transportation lag.

UNIT – V

Control systems, controllers and final control elements, Block diagram of a Petrochemical reactor control system. Closed loop transfer functions, Transient response of simple control systems.

Stability Criterion, Routh Test, Frequency control model, Controller tuning and process identification, Control valves.

Integrated Lab With 2 Credits

Practices:

1. Experiments with single capacity system.
2. Experiments with two capacity systems with interaction
3. Experiments with two capacity systems without interaction
4. Control valve characteristics
5. Calibration and determination of time lag of various first order instruments
6. Calibration and determination of time lag of various second order instruments
7. Experiments on multi process trainer set up with computer
8. Experiments on I/P and P/I converters set up
9. Level control trainer
10. Temperature control trainer

Additional Practices:

1. Experiments on proportional, reset, rate mode of controllers
2. Estimation of damping coefficient for U-tube manometer
3. Calibration of various temperature instruments like Thermocouple, RTD and Thermistor

Textbooks:

- 1 Process Systems Analysis and Control, Donald Coughanowr, 3rd Ed. McGraw-Hill. eISBN: 9780071121866
- 2 Chemical Process Control: An Introduction to Theory and Practice, George Stephanopoulos, Pearson Education India, 1st Ed. eISBN: 9780131286290

Reference Books:

- 1 Process Control and Instrumentation Technology, Curtis D. Johnson, 8th Edition, Pearson publisher. eISBN: 9788120330290
- 2 Petrochemical Instrumentation, Dr. N. Stalin, Dr. Anil Kumar Thandlam, Ch. Venkatrao, Dr. J. Samson Isaac, 1st Edition, Scientific International Publishing House, ISBN: 9789356254695

Web Links:

- 1 https://www.globalspec.com/learnmore/sensors_transducers_detectors/temperature_sensing/industrial_thermometers
- 2 <https://engineerexcel.com/vacuum-pressure/>
- 3 <http://radix.co.in/families/temperature-sensors-rtd>
- 4 <http://nptel.ac.in/courses/103103037/>
- 5 http://www.bgu.ac.il/chem_eng/pages/Courses/oren%20courses/Chapter_10

Fundamentals of Liquefied Natural Gas

Course Code: 2501PT05

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the LNG value chain
- CO2:** Classify the different liquefaction technologies of LNG
- CO3:** Explain the components of LNG receiving terminals
- CO4:** Summarize LNG storage and transportation facilities
- CO5:** Identify major equipment and safety aspects of LNG industry

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction: Overview of LNG industry -History of LNG industry – Base load LNG – Development of an LNG Project – World and Indian Scenario– Properties of LNG.

UNIT – II

Propane precooled mixed refrigerant process – Description of Air products C3MR LNG process–. Description of Conoco Phillips optimized cascade (COPOC) process – Liquefaction– LNG flash and storage.

Other Liquefaction Processes: Description of Linde MFC LNG process- Precooling and Liquefied Petroleum Gas (LPG) recovery – Liquefaction and sub cooling- Trends in LNG train capacity –strategy for grassroots plant- offshore LNG production.

UNIT – III

Gas pre-treatment: Slug catcher– NGL stabilization column – Acid gas removal unit – Molecular sieve dehydrating unit Receiving terminals in India – Main components and description of marine facilities – LNG tanks– Process descriptions. –Mercury and sulphur removal unit–NGL recovery–Nitrogen rejection–Helium recovery.

UNIT – IV

LNG Shipping Industry: LNG fleet – Types of LNG ships – Moss – Membrane – prismatic; Cargo measurement and calculations,
Cryogenic heat exchangers: Spiral– Wound heat exchangers – Plate & fin heat exchangers – Cold boxes.
Centrifugal compressors –Axial compressors – Reciprocating compressors;
LNG pumps and liquid expanders –Loading Arms and gas turbines, Description of Regasification.

UNIT – V

Submerged combustion vaporizers- Open rack vaporizers–Shell and tube vaporizers: direct heating with seawater, and indirect heating with seawater.
Safety design of LNG facilities – Security issues for the LNG industry – Environmental issues– Risk-based analysis of an LNG plant.
Ambient air vaporizers: Direct heating with ambient air – Indirect heating with ambient air.

Textbooks:

- 1 LNG: Basics of Liquefied Natural Gas, Stanley Huang, Hwa Chiu and Doug Elliot, 1st Edition, PETEX. eISBN: 978-0886982171
- 2 Marine Transportation of LNG (Liquefied) and related products, Richard G. Wooler, Gornell Marine Press. eISBN: 9780608024646

Reference Books:

- 1 Natural Gas by Sea: The Development of a new technology, Roger Rooks, Withers by Publishers eISBN: 9780856140549
- 2 Marine Transportation of Liquefied Natural Gas, Robert P Curt, Timothy D. Delaney, National Maritime Research Centre.

Web Links:

- 1 <http://folk.ntnu.no/skoge/prost/proceedings/aiche2008/data/papers/P139095.pdf>
- 2 https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook_demos/lng/html/index.Htm
- 3 [http://petrowiki.org/Liquified_natural_gas_\(LNG\)](http://petrowiki.org/Liquified_natural_gas_(LNG))
- 4 <http://www.chebeague.org/fairwinds/risks.htm>
- 5 http://www.beg.utexas.edu/energyecon/LNG_Safety_and_Security_Update_2012.pdf

Elements of Reservoir Engineering

Course Code: 2501PT02

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1:** Apply basic Concepts of Reservoir Engineering
- CO2:** Evaluate the porosity and Permeability from reservoir
- CO3:** Estimate the oil and gas properties of reservoir
- CO4:** Apply Basic radial Flow differential equation and stabilized well inflow Estimation for Different system of equations, immiscible fluid displacement and water influx models
- CO5:** Estimate the reserves by curve 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	3	-	-	-	-	-	-	-	2	-
CO2	2	3	-	-	-	-	-	-	-		-
CO3	2	3	-	-	-	-	-	-	-	2	-
CO4	2	3	-	-	-	-	-	-	-	2	-
CO5	2	3	-	-	-	-	-	-	-	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

Reservoir rocks and structures, Classification of sedimentary oil reservoirs

Fundamental concepts: Introduction to Hydrocarbon Reservoir, Pressure-Temperature diagram, Fluid pressure regimes.

UNIT – II

Rock properties: Porosity & Permeability, Types & Determination, Permeability in Series & parallel combination of beds Fluid saturation, Wettability, surface and interfacial tension, Capillary Pressure, Permeability- Klinkenberg effect, averaging absolute permeabilities, Rock compressibility, net pay thickness, reservoir heterogeneity.

UNIT – III

Crude oil properties: Density, gravity, viscosity, gas solubility, bubble point pressure, oil formation volume factor

Natural gas properties: Compressibility, gas formation volume factor, viscosity

UNIT – IV

Flow of Fluids through Porous Media : Fluid types, flow regimes, Darcy's law, single and multiphase flow, linear, radial & spherical flow, steady state, unsteady state and pseudosteady state flow, GOR, WOR equation

UNIT – V

Reserve Estimation: Reservoir drives, resource & reserve concept, Different reserve Estimation Techniques: Volumetric, MBE, decline curve analysis;, latest SPE/ WPC/ IS classification

Integrated Lab With 2 Credits

Practices:

1. Determination of effective porosity by gas expansion method.
2. Determination of porosity and pore size distribution by mercury injection.
3. Measurement of surface tension with the ring Tensiometer.
4. Determination of fluid density using Pycnometer and hydrometer methods.
5. Liquid viscosity measurement using capillary tube viscometer (Ostwald type).
6. Determination of capillary pressure of reservoir rock (core) using porous plate method.
7. Measurement of contact angle (between oil, water and solid surface) using imaging method.
8. Measurement of air permeability.
9. Absolute permeability measurement of water.
10. Determination of relative permeability of oil-water using unsteady state method.
11. Determination of relative permeability of gas-oil using unsteady state method.

Additional Practices:

1. Determination of water content in a given sample.
2. Measurement of interfacial tension with the ring Tensiometer.

Textbooks:

- 1 Fundamentals of Reservoir Engineering, L.P.Dake, Elsevier science eISBN: 9780080568980
- 2 Applied Petroleum Reservoir Engineering, Third Edition, B.C Craft and M.Hawkins, Revised By Ronald E.Terry & J.Brandon Rorgers, Prentice Hall, New York. eISBN: 9780133155617

Reference Books:

- 1 Reservoir Engineering Handbook, Tarek Ahmed, 4th Edition, Gulf Professional Publishing. eISBN: 9781856178037
- 2 Basic Reservoir Engineering, Rene Cosse, Editions, Technip eISBN: 9782710806301

Weblinks:

- 1 https://author.energy-community.org/enc-author-prd/dam/jcr:4c5bb3db-e989-4b7d-a33e244f4a51164a/1_PetroleumResEng_Basics.pdf
- 2 https://petrowiki.org/Fluid_sampling
- 3 https://petrowiki.org/Material_balance_in_oil_reservoirs
- 4 https://en.wikipedia.org/wiki/Darcy%27s_law
- 5 https://www.researchgate.net/publication/250088881_Reserves_Estimation_The_Challenge_for_the_Industry

Petroleum Production Engineering

	L	T	P	C
Course Code: 2501PT11	1	1	0	2

Course Outcomes:

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

- CO1:** Explain the production engineers role and activities involved in the field.
- CO2:** Derive the equations related to well performance and optimization
- CO3:** Demonstrate the various types of artificial lift methods in production
- CO4:** Explain the different types perforation methods used in production
- CO5:** Outline the various types of well stimulation techniques.

Mapping of Course Outcomes with Program Outcomes:

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

Petroleum Production System (Surface & Subsurface Equipment)

Role of Production Engineer/activities performed at various levels of field development and its exploitation. Petroleum Production System-Well Head Equipment, Christmas tree, valves, hangers, flow control devices, packers, tubular and flow lines

UNIT – II

Well Performance analysis and Optimization

Reservoir considerations, Introduction to inflow performance, Productivity index. Formation damage diagnosis, Skin effect, IPR in case of different drive mechanism. Vogel IPR equation. Pressure loss in tubing, multiphase flow regimes. Choke performance, types of chokes. Overall production system pressure losses, Nodal system Analysis.

UNIT – III

Artificial Lift Technology

Basic principles and descriptions of Artificial Lift Methods, Continuous and Intermittent Flow Gas Lift, Design of Gas Lift System, Plunger Lift, Chamber Lift, Sucker Rod Pumping (SRP), Electrical Submersible Pumping (ESP), Hydraulic Pumping (HP).

UNIT – IV

Well Perforation

Introduction, Well Perforating Methods, Perforating Gun Types, Shaped Charge, Type, Size, Depth and Orientation of perforation holes, Shot Density, Standoff, Explosives in perforation, Explosive Train.

UNIT – V

Well Stimulation Techniques

Importance of Well Stimulation, Acid Solutions for Acidizing, Acid Additives, Matrix Acidizing, Fracture Acidizing, Hydraulic Fracturing, Wave Technology, Microbial Stimulation.

Text Books:

- 1 Petroleum Production Engineering: A Computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2019 eISBN: 9780750682701
- 2 Petroleum Production Systems, M.J. Economides, A.Daniel Hill & C.E.Economides, Prentice Hall. eISBN: 9780137031580

Reference Books:

- 1 Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
- 2 The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books. eISBN: 9780878140312

Web Links:

- 1 https://petrowiki.org/Production_system
- 2 <https://www.globalspec.com/reference/33548/203279/chapter-3-reservoir-deliverability>
- 3 <https://www.slb.com/resource-library/oilfield-review/defining-series/defining-artificial-lift>
- 4 <https://www.drillingmanual.com/well-perforation-methods-techniques-in-oil-gas-completion/>
- 5 <https://www.petrosync.com/blog/what-is-well-stimulation/>

Petroleum Refinery Engineering

Course Code: 2501PT12

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify the types of petroleum feed stocks and products by their properties
- CO2:** Make use of process knowledge to solve operational problems and increase the efficiency
- CO3:** Apply the knowledge of crucial processes to meet the end product demands
- CO4:** Prioritize the demand of various petrochemicals to optimize the processes
- CO5:** Classify various petrochemical products and their uses

Mapping of Course Outcomes with Program Outcomes:

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

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 of Petroleum:

Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as True Boiling (TBP), American Society for Testing Materials (ASTM).

UNIT – II

Properties of Crude and Petroleum Products:

Various types of Average Boiling Points of Crude Oil & Petroleum Fractions.

Types of Gases & their Composition, Types of Gasoline & it's Important Properties and tests such as ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content etc, Various Types of Naphtha and their Important Properties & Applications.

Important Tests & Properties of Kerosene such as Flash& Fire Point, Smoke Point, Aniline Point etc.,

Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc.

Heavy Fractions like Lube Oil, Bitumen, Asphalt etc & their Important Properties such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.

UNIT – III

Processing of Petroleum:

Pretreatment of Crude (Dehydration & Desalting), Pumping of Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux, ADU & VDU.

UNIT – IV

Thermal & Catalytic Cracking:

Thermal cracking – Processes, operating parameters, feed stock selection and product yields, Advantages –Types and functions of secondary processing – Visbreaking – Processes, operating parameters and advantages–Coking –Operating parameters and advantages. Fluid catalytic cracking –processes, operating parameters, feed stock selection and product yields –Advantages.

UNIT – V

Treatment Techniques:

Physical Impurities found in Crude& their Removal, Sweetening Techniques, Production and Treatment of LPG & their Methods, Dehydration and Sweetening of Gases, Gasoline Treatment such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Treatment of kerosene.

Textbooks:

- 1 Petroleum Refining: Technology and Economics ,J.H.Gary and G.E.Handwerk, 5th Edition, Marcel Dekkar, Inc. eISBN: 9780203907924
- 2 Elements of Petroleum Processing, D S Jones, Wiley–Blackwell. eISBN: 9780471964896

Reference Books:

- 1 Petroleum Refining Engineering, WL Nelson, 4th Edition, McGraw Hill Company eISBN: 9780070462687
- 2 Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers eISBN: 9780846404385
- 3 Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company eISBN: 9782710810650

Web Links:

- 1 <https://www.scribd.com/doc/.../Surface-Production-Operations-Volume-1-Oil-System>
- 2 www.academia.edu/.../Ken_Arnold-Surface_Production_Operations_Volume_1_3rdE
- 3 <https://byjus.com/chemistry/petroleum/>
- 4 <https://www.slideshare.net/.../surface-production-operations-volume-iv-pumps-compr...>
- 5 https://www.researchgate.net/publication/359449933_Petroleum_sludge_treatment_and_disposal_techniques_a_review

Heat Transfer in Petroleum Operations

Course Code: 2501PT07

L	T	P	C
1	1	2	4

Course Outcomes:

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

- CO1:** Explain the various modes of heat transfer and derive the equations for conduction heat transfer
- CO2:** Classify the relation between boundary layers and estimate the convection coefficients
- CO3:** Explain the concepts of heat transfer with phase change
- CO4:** Demonstrate the concept of radiation heat transfer
- CO5:** Identify the types of heat exchangers and design the double pipe heat exchanger.

Mapping of Course Outcomes with Program Outcomes:

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

Heat transfer by conduction

Importance of heat transfer in petrochemical engineering operations; Modes of heat transfer; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres; Thermal conductivity measurement; Effect of temperature on thermal conductivity.

UNIT – II

Heat transfer by convection

Mechanism, thermal and velocity boundary layers, boundary layer thickness, relationship between hydrodynamic and thermal boundary layer thickness for flow over flat plates; Estimation of convection and its heat transfer coefficient; Correlation for heat transfer in laminar and turbulent flow; Natural convection under different conditions; Physical significance of Grashoff's and Rayleigh's numbers.

UNIT – III

Phase change Heat transfer

Pool boiling: Boiling curve, hysteresis in the boiling curve, nucleate boiling; Condensation: Physical mechanisms, types of condensation, factors affecting condensation.

UNIT – IV

Heat transfer by radiation

Introduction, theories of radiation, electromagnetic spectrum, emissivity; Radiative properties, absorptivity, reflectivity and transmissivity; Concept of black and grey body, radiation intensity, laws of black body radiation, non-black surfaces, radiation between black and grey surfaces.

UNIT – V

Heat exchangers

Classification of heat exchangers: Classification according to transfer processes, number of passes, surface compactness, construction features, flow arrangements, heat transfer mechanisms; Shell and tube heat exchanger, fouling, LMTD and its correction factor; Concept of effectiveness: NTU method, definition of effectiveness, effectiveness NTU relations in counter-flow and parallel flow configurations. Double pipe heat exchangers: Construction, various steps for the design.

Integrated Lab With 2 Credits

Practices:

1. Determine overall heat transfer coefficient of composite wall
2. Determine thermal conductivity of a metal rod
3. Determine natural convective heat transfer coefficient for a vertical tube
4. Determine forced convective heat transfer coefficient for air flowing through a pipe
5. Determine overall heat transfer coefficient in double pipe heat exchanger
6. Determine Stefan – Boltzmann constant
7. Determine emissivity of a given plate at various temperatures
8. Determine the radial distribution of heat in composite cylinder
9. Determine thermal conductivity of pipe insulation
10. Determine the thermal conductivity of insulating powder at various heat inputs
11. Determine critical heat flux point for pool boiling of water.

Additional Practices:

1. Determine the performance analysis of Shell and Tube Exchanger
2. Estimate un-steady state film heat transfer coefficient between the medium in which the body is cooled
3. Study the temperature distribution along the length of a pin-fin under natural.

Textbooks:

- 1 Unit Operations of Chemical Engineering, McCabe, W.L., J.C Smith and Peter Harriott, 7th Edition, McGraw-Hill. eISBN: 9780072848236
- 2 Heat Transfer, Holman, J.P., 9th Edition, Tata McGraw-Hill. eISBN: 9780071122306

Reference Books:

- 1 Heat Transfer, Y.V.C. Rao, Universities Press (India) Pvt. Ltd. eISBN: 9788173713842
- 2 A Text Book on Heat Transfer, Sukhatme, P., 5th Edition, Universities Press (India) Pvt. Ltd. eISBN: 9788173715440
- 3 Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer, Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H., Vol.1, 6th Edition, Reed Elsevier India eISBN: 9780750644440

Web Links:

- 1 <http://nptel.ac.in/courses/103103032/9>
- 2 http://www.srmuniv.ac.in/sites/default/files/downloads/unit_II_convective_heat_transfer.pdf
- 3 <http://pages.mtu.edu/~fmorriso/cm310/lectures/2015heatlecture09.pdf>
- 4 https://file.scirp.org/pdf/EPE20090200004_95602315.pdf
- 5 <http://pages.mtu.edu/~fmorriso/cm310/lectures/2015heatlecture08.pdf>

Safety & Environmental Engineering Practices In Petroleum Industry

Course Code: 2501PT14

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Study the forms of hazards and safety Practices in petroleum industry.
- CO2:** Study of HSE Regulations and regulatory agencies for Oil and Gas Industry..
- CO3:** Explain the environmental issues in drilling and production operations.
- CO4:** Make use of the hazop study concepts for safe Practices in Petroleum industry.
- CO5:** Make use of HSE Policies. Disaster & crisis management in Petroleum Industry.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Safety in Petroleum industry; Setting & layout of petroleum plant. Forms of hazards: chemical, toxic, explosion, electrical, mechanical, radiation, noise hazards. Control and prevention of hazards.

UNIT – II

HSE: Definition and Explanations. Different HSE practises, implementation and evaluations. HSE Regulations and regulatory agencies for Oil and Gas Industry.

UNIT – III

Environmental issues, Impact during oil and gas operations and solutions.

Air Pollution in oil & gas industry: Sources, Damage and mitigation. Water Management: Pollution and pollutant, production water management.

Drilling Waste: Drilling fluid waste, Rock cutting, oily sludge, etc.

Offshore safety. Offshore oil spill and oil spill control. Safety and Environmental Management Systems, SEMS

UNIT – IV

Risk Analysis: hazard and operability (HAZOP) studies. hazard analysis (HAZAN), fault tree analysis, consequence analysis, scenario and probabilistic assessment. Onshore and Offshore Emergency Management Plans.

Safety System: Manual & automatic shutdown system, blow down systems. Gas detection system. Fire detection and suppression systems. Personal protection system & measures.

UNIT – V

HSE Policies. Disaster & crisis management in Petroleum Industry.

Environment: Environment concepts, impact on eco-system, air, water and soil. The impact of drilling & production operations on environment, Environmental transport of petroleum wastes.

Text Books:

- 1 Crowl, D.A., Louvar, J. F., “Chemical Process Safety – Fundamentals with Applications”. Prentice-Hall, Pearson. eISBN: 9780134857848
- 2 Environmental Control in Petroleum Engineering: John C Reis eISBN: 9780080505756

Reference Books:

- 1 CCPS,” Guidelines for Engineering Design for Process Safety”, AIChE eISBN: 9780470938263
- 2 Environmental management in Petroleum Industry: S. K. Wahi eISBN: 978-8122403770
- 3 The prevention of Oil pollution: J. Wardley-Smith eISBN: 9789401173476

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc18_oe04/preview
- 2 https://en.wikipedia.org/wiki/Hazard_and_operability_study

Well Work Over & Stimulation

Course Code: 2501PT17

L	T	P	C
1	1	0	2

Course Outcomes:

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

- CO1:** Apply basic Concepts of effective completion types.
- CO2:** Evaluate the reservoir problem
- CO3:** Evaluate Operations and Tools for completions
- CO4:** Explain about Various Completion fluids and its chemistry
- CO5:** Apply the treatment methods for well 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	-	-	-	-	-	-	-	-	-

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 Completion. Well Completion design (Data gathering, well control and barriers in completion, completion types, safety and environment effect by Completion operation) Reservoir Completion (Open Hole Completion techniques, Perforating, Hydraulic Fracturing)

UNIT – II

Introduction Differentiate between reservoir problem v/s workover problem, Work-over operations, types of workover , Work over fluids. Scraping, well circulation, Shut-off, Squeeze cementing. Handling water and gas coning. Evaluation of workover jobs

UNIT – III

Specialized Components (wellheads, packers, expansion joints, safety valves, artificial lifting equipment). Completion Installation (installation types, procedures) Packers-Production packers, Packer's calculation, Well activation. Repair of wells, Paraffin and scale removal. Corrosion, Bacteria & Scale control. Sand control, Screens, Gravel packs.

UNIT – IV

Completion Fluids and Production Chemistry (types of Completion fluids, Formation compatibility, Mineral scales, Salt deposition, Waxes, Asphaltenes, Hydrates) Sand Control (rock strength and sand production prediction, mitigating sand production, formation grain size distribution, sand control methods)

UNIT – V

Well treatment; acidizing of oil & gas wells, Hydro-perforation. Hydraulic fracturing

Textbooks:

- 1 Well Completion Design, Jonathan Bellarby, Elsevier. eISBN: 9780080932521
- 2 Well Completion and Servicing, D. Perrin, Michael Caron, Georges Gaillot, Editions Technip eISBN: 9782710807650

Reference Books:

- 1 Production Operations: Well Completions, Workover, and Stimulation eISBN: 9780930972004
- 2 Well Stimulation Treatments, 2nd Ed eISBN: 9780886982096

Web Links:

- 1 <https://www.scribd.com/document/485014588/well-completion>
- 2 <https://www.sciencedirect.com/science/article/abs/pii/S0376736108002100>
- 3 <https://www.petrosync.com/blog/well-intervention/>
- 4 https://wiki.aapg.org/Types_of_completions
- 5 <https://www.petrosync.com/blog/well-intervention/>

Reservoir Modelling & Simulation

Course Code: 2501PT13

L	T	P	C
1	1	2	4

Course Outcomes:

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

- CO1:** Apply basic Concepts of Reservoir modelling and simulation.
- CO2:** Estimate the Basic Equations for single phase flow analysis
- CO3:** Apply Solution techniques of single phase flow equations
- CO4:** Evaluate the Multiphase flow simulation
- CO5:** Apply Basic single and multiphase flow for History matching.

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-	-	-	-	-

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 reservoir simulation. Concepts of modelling and simulation. Introduction to integrated reservoir modeling. Use of geophysical, geological, petro physical and engineering data with geostatistical methods to create reservoir description.

UNIT – II

Basic Equations for single phase flow. Continuity equation in various flow geometries, Derivation of Generalized flow equations, Different form of flow equations, initial and boundary conditions.

Finite Difference Approximation to linear flow equations. Method of grid constructions, Approximation of spatial and time derivatives, Implementation of initial and boundary conditions, Explicit and implicit formulations, well representation, treatment of source and sink terms; Stream tube; automatic time step control; simulation of naturally fractured reservoir.

UNIT – III

Solution techniques of single phase flow equations. Linearization techniques; incompressible, slightly compressible and compressible flow problems; Use of Balance Calculation in Reservoir Simulation.

UNIT – IV

Multiphase flow simulation. Concept of Black oil and compositional models; Conservation equations in a multiphase flow system; Flow equations; Finite difference approximation; Simultaneous Solution method, Implicit Pressure Explicit Saturation method, Sequential Solution method. Multiphase flow in two and three dimensions

UNIT – V

History matching. Inverse modeling, parameterization, objective function formation, calibration and tuning algorithm, Bayesian formulation and uncertainty quantification, optimization algorithms.

Integrated Lab With 2 Credits**Practices:**

1. Reservoir simulation basics. To have basic Understanding the basic concepts of simulation and modelling.
2. Overview: Geological model and flow model and transition
3. Introduction, Historical background, application of simulator, Types of model and designing of various models depending on reservoir complexities, rock properties, fluid properties – concept of black oil model, compositional model.
4. Building, running and analyzing a “black oil” reservoir simulation model by importing contour map data. To build, run, and analyze a black oil reservoir model in IMEX by importing contour map file and reservoir properties.
5. Perform history-matching of IMEX reservoir model.
6. To analyze match between simulation and production data.
7. Streamline simulation Introduction to streamline simulation & comparison of conventional/Streamline simulation
8. Integration with Economics
9. Special Concept on Coning and Compositional Models Simulation. Optimization using Economic and Techno-economic evaluation, Computation of economic indices viz."
10. Perform history-matching of reservoir or core model.
11. To analyze match between simulation and experimental data, and determine rock-fluid parameters.
12. History matching Model calibration performance -Oil & Gas field simulation

Additional Practices:

1. Reservoir optimization Oil & Gas field simulation
2. Uncertainty quantification- Oil & Gas field simulation

Textbooks:

- 1 K. Aziz, A. Settari, Petroleum Reservoir Simulation. Applied Science Publisher. eISBN: 9780853347873
- 2 Turgay Ertekin, J.H. Abou-Kassem, and G.R. King, Basic Applied Reservoir Simulation. Society of Petroleum Engineers. eISBN: 9781555630898

Reference Books:

- 1 Chen, Zhangxin. Reservoir simulation: mathematical techniques in oil recovery. Society for Industrial and Applied Mathematics eISBN: 9780898717075
- 2 Shahab D. Mohaghegh, Data-Driven Reservoir Modeling. Society of Petroleum Engineers eISBN: 9781613995600

Web Links:

- 1 <https://www.spe-aberdeen.org/wp-content/uploads/2018/06/Devex-2018-Introduction-to-Reservoir-Simulation.pdf>
- 2 https://www.researchgate.net/publication/256667120_The_basic_equations_of_fluid_mechanics_in_form_characteristic_of_the_finite_volume_method
- 3 https://petrowiki.spe.org/PEH:Reservoir_Simulation
- 4 https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/240503/747973_FULLTEXT01.pdf?sequence=1
- 5 <http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/ETD-TAMU-3035/MA-DISSERTATION.pdf?sequence=1>

Surface Production Operations

Course Code: 2501PT15

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Explain the concept of classification and design of separators
- CO2:** Demonstrate the concept of surface facilities
- CO3:** Identify the various storage and transportation methods for oil and gas
- CO4:** Explain the flow assurance mitigation and pigging operations
- CO5:** Design principles and sizing of heat exchangers.

Mapping of Course Outcomes with Program Outcomes:

CO/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	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Separation and Treatment of produced fluid

Classification of separators, Components of separator, Types of separators, Liquid level control and relative advantages / disadvantages of different types of separators, Dehydration & Desalting of Oil, Demulsification, Effluent Treatment, and Design of Separator.

UNIT – II

Surface facilities for Production System Group Gathering Station, Central Tank farm, Feeder and Trunk pipeline system,

UNIT – III

Storage and Transportation of Oil and Gas

Storage tank for Oil, storage of LPG, Underground storage, Measurement-metering of Oil and Gas

UNIT – IV

Flow assurance and Mitigation Scale & Paraffin Deposition and their Mitigation, Flow improver (Pour point depression and Drag reducer, heat treatment), pigging in pipe lines

UNIT – V

Design of principles and sizing of heat exchangers: Process design of Shell & Tube heat exchangers - Double pipe heat exchangers- Plate and frame heat exchangers- Air cooled heat exchangers- Heat recovery units- Fired heaters- Materials of construction & mechanical design of heat exchangers.

Text Books:

- 1 Petroleum and Gas Field Processing, H.K .Abdel-Aal and Mohamed Aggour and M.A. Fahim, Marcel Dekkar Inc. eISBN: 9780203911099
- 2 Surface Production Operations, Ken Arnold & Maurice Stewart, Vol. 1 & 2, 3 Edition, Gulf Professional Publishing. eISBN: 9780884158219

Reference Books:

- 1 Surface Production Operations: Volume IV: Pumps and Compressors Authors: Maurice Stewart, Gulf Professional Publishing Published Date: 1st December 2018 eISBN: 9780128098950
- 2 Engineering Data Book, 12th Edition (Electronic), FPS Version, Volume I & II, Gas Processors Suppliers Association (GPSA).
- 3 Plant Design and Operations, Ian Sutton, 2nd Edition, Gulf Professional Publishing, 2017. eISBN: 9780128128848
- 4 Essentials of Oil and Gas Utilities: Process Design, Equipment, and Operations, Alireza Bahadori, Gulf Professional Publishing; 1 edition, 2016. eISBN: 9780128030899

Web Links:

- 1 <https://www.scribd.com/doc/.../Surface-Production-Operations-Volume-1-Oil-System->
- 2 www.academia.edu/.../Ken_Arnold_Surface_Production_Operations_Volume_1_3rdE
- 3 blog.agrostar.in/surface_production_operations_vol_2_design_of_gas_handling_syst...
- 4 <http://acreditation.uni.edu.pe/wp-content/uploads/2017/05/Design-of-OilGasSeparators-%E2%80%93-From-Hydrocarbon-Stream.pdf>
- 5 <https://pdfs.semanticscholar.org/5d3a/972503a6e99621738a67021c145fc2269ce8.pdf>

Unconventional Hydrocarbon Resources

Course Code: 2501PT16

L	T	P	C
1	1	0	2

Course Outcomes:

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

- CO1:** Explain the present global energy scenario
- CO2:** Determine the Characteristics of a Tight Reservoir and Oil
- CO3:** Illustrate the origin and characterize shale gas
- CO4:** Demonstrate the Characteristics of Coal Bed Methane and Gas Hydrates
- CO5:** Explain the heavy oil reservoirs and their challenges

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction

Introduction to Unconventional Hydrocarbon resources, Coal Bed Methane: Geological controls in CBM plays, Resource estimation, Drilling, completion and production performance of a CBM well, Indian Scenario

UNIT – II

Tight Gas and Oil

Characteristics of a Tight Reservoir; What makes them Tight; The Permeability Jail; Where to find Tight Reservoirs; Drilling Practices for Tight reservoirs; Formation Evaluation; Hydraulic Fracturing, Post Fracture Reservoir evaluation; New Technologies

UNIT – III

Shale Gas/ Oil

Introduction, geology, important occurrences, petrophysical properties, hydro fracturing, horizontal wells, production profiles.

UNIT – IV

Coal Bed Methane and Gas Hydrates

Characteristics of Coal Bed Methane Gas; Drilling Practices for Coal Beds; Workflow for Coal Bed Formation Evaluation, Cleat, Gas Content; Hydraulic Fracturing, Depressuring and Dewatering issues Success and Lessons learnt so far; Gas Hydrates: Minerology, Chemistry and physical properties, stability, challenges and pitfalls

UNIT – V

Non-Conventional Oil

Introduction to Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales; origin and occurrence worldwide, resources, reservoir characteristics, new production technologies

Textbooks:

- 1 Unconventional Gas Reservoirs: Evaluation, Appraisal, and Development, Islam M.R., Gulf Professional Publishing, 2014 eISBN: 978-0128017682.
- 2 Coal Bed Methane: From Prospects to Pipeline, Thakur P., Aminian K., Schatzel S., Elsevier Science Publishing, 2015. eISBN: 978-0128002138

Reference Books:

- 1 Geophysical Characterization of Gas Hydrates: 14 (Geophysical Developments), Michael Riedel, Satinder Chopra, Society of Exploration Geophysicists; 1st edition, 2010 eISBN: 978-1560802454
- 2 Shale Gas: Exploration and Environmental and Economic, Anurodh Mohan Dayal, Devleena Mani, Elsevier Science Publishing, 2017. eISBN: 978-0128041519.

Web Links:

- 1 <https://link.springer.com/article/10.1007/s13202-021-01404-x>
- 2 https://spgindia.org/10_biennial_form/P260.pdf
- 3 <https://www.iogp.org/wp-content/uploads/2016/10/An-introduction-to-shale-oil-and-gas-Jul2015-1.pdf>https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
- 4 https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
<https://www.open.edu/openlearn/science-maths-technology/living-without-oil/content-section-1>
- 5 oil/content-section-1.

Enhanced Oil Recovery

Course Code: 2501PT03

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Explain the basic features and technical foundations of the most common EOR methods
- CO2:** Explain the basic geological factors for flooding of reservoirs
- CO3:** Apply screening criteria to a given reservoir to select a displacement method both technically and economically
- CO4:** Make Use of rock, fluid, and reservoir data for the Displacement of fluids in the reservoir
- CO5:** Apply screening criteria to a given reservoir to select a chemical method for flooding

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	2	-
CO4	3	-	-	-	-	-	-	-	-	2	-
CO5	2	-	-	-	-	-	-	-	-	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Principles of enhanced oil and gas recovery methods. IOR, EOR& EGR. Screening criteria for EOR methods.

UNIT – II

Geological Factors in Enhanced Oil Recovery

Reservoir heterogeneities, Examples of geological factors in enhanced recovery projects

Natural fractures,

Determination of Residual Oil Saturation based on Geophysical Well logging techniques,

Determination of residual saturation, Well-log-derived oil saturation determination in open hole, Residual oil saturation determination in cased wellbore

UNIT – III

Immiscible displacement: Injection well location, production well completion, surface installation. Miscible drive: Miscible slug flooding, thermodynamic miscibility, ternary diagrams, methods of miscible drive. Benham's correlations, physical and mathematical modelling.

UNIT – IV

Displacement of fluids in reservoir: capillary force; viscous force; phase trapping; mobilization of trapped phases, and alteration of viscous/capillary force ratio.

UNIT – V

Design aspects of chemical flooding. Case studies of surfactant, alkali, polymer, ASP flooding. WAG process, SWAG process, and Chemical augmented WAG process. Foam flooding.

Textbooks:

- 1 Enhanced Oil Recovery: Mechanisms, Technology, and Feasibility" by Ajay Mandal and Keka Oja. eISBN: 978-0128200810.
- 2 Applied Enhanced Oil Recovery, Aural Carcoane, Prentice Hall eISBN: 9780130442727

Reference Books:

- 1 Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, eISBN: 9781851666171
- 2 Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier eISBN: 978-3-319-31421-1
- 3 Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, eISBN: 9780132816014

Web Links:

- 1 <https://www.ogj.com/oil-drilling-and-production/production-operations/ior-eor.html>
- 2 [http://www.ccop.or.th/ppm/document/INWS4/INWS4DOC03c_Norway_GUNNA R.pdf](http://www.ccop.or.th/ppm/document/INWS4/INWS4DOC03c_Norway_GUNNA_R.pdf)
- 3 https://petrowiki.org/Polymer_waterflooding
- 4 https://www.glossary.oilfield.slb.com/en/Terms/a/alkaline_flooding.aspx
- 5 https://petrowiki.org/Conformance_improvement

Minor Stream Courses

Pipeline and Petroleum Transport Engineering:

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT27	Introduction To Petroleum Engineering	FC	3			3	50	50	100	-
2501PT35	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
2501PT34	Transportation of Petroleum Products	FC	3			3	50	50	100	-
2501PT31	Pipeline Engineering	FC	3			3	50	50	100	-
2501PT29	Operational & Maintenance of Pipelines	IC	3			3	50	50	100	PE
2501PT26	Flow Assurance	IC	2			2	50	50	100	IPE
2501PT28	Midstream Project Economic Analysis	IC	3			3	50	50	100	TPP
2501PT33	Storage & Transportation of Crude oil & Natural Gas	IC	3			3	50	50	100	TPP & UOPI
2501PT25	Data Analytics & AI For Process Industry	IC	3			3	50	50	100	UOPI
2501PT30	Petroleum Economics Policies & Regulations	AC	3			3	50	50	100	MPEA
2501PT32	Pipeline Project Management	AC	3			3	50	50	100	OMP
Total			32			32				

Introduction To Petroleum Engineering

Course Code: 2501PT27

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1:** Identify the various streams in the petroleum industry.
- CO 2:** Outline the onshore and offshore reservoirs.
- CO 3:** List out the various artificial lift techniques.
- CO 4:** Illustrate various attributes in mid-stream processing and storage.
- CO 5:** Describe the crude oil products and their specifications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	3	-
CO2	2	-
CO3	2	-
CO4	3	-
CO5	3	-

UNIT-I

What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector- Midstream Processing-Downstream Processing-Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II

Exploration & Production-Indian and World Scenario of Petroleum and Natural Gas Resources- The Reservoir-Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs

Reservoir Drives. Exploration and Drilling Rigs- Rig Components-Drill and drill bits-Drilling fluids.

UNIT III

Well Completions Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.

Artificial Lift: Principles and operation of Rod Pumps Down Hole Pumps - Gas Lift - Plunger Lift- Electrical submersible pumps.

UNIT IV

Separation of Reservoir Fluids- Manifolds and Gathering - Production Separators - Gas Treatment and Compression - Oil & Gas Storage.

Midstream processing: Transportation of Crude Oil & its Products and Natural Gas- World and Indian pipeline scenario- Design of Oil and Gas pipelines Safety aspects of pipelines- Environmental issues.

UNIT V

Crude Oil Refining: Classification and Composition - Constituents - Products and their specifications- Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Text Books:

1. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, ABB ATPA Oil and Gas. eISBN: 978-1329783454
2. John R. Fanchi and Christiansen, R.L. Introduction to Petroleum Engineering, John Wiley & Sons. eISBN:9781119193463

Reference Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; Elsevier publications, 2nd Edition. eISBN: 0-444-99564-1
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier eISBN: 978-1-85617-689-7

Web Links:

1. <https://www.studentenergy.org>
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Pipeline_transport
4. https://petrowiki.org/Production_system

Unit Operations in Petroleum Industry

Course Code: 2501PT35

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Understand the Heat and Mass Transfer Principles
- CO2: Prioritize Proficiency in Conduction Mechanisms
- CO3: Explain Mastery of Convective Heat Transfer
- CO4: Apply Knowledge of Heat Exchange Equipment and Evaporation
- CO5: Distinguish Mass Transfer and Distillation Techniques

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction: Objective, scope and outcome of the course.

Conduction: Introduction to unit operation and its application in petroleum engineering. Heat Transfer and its application, Modes of heat transfer one dimensional and two-dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

Unit – II

Convection: Convective heat transfer, natural and forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, Fouling factor, Heat transfer with and without phase change conditions.

Unit – III

Heat Exchange equipment: Introduction to double pipe, shell and tube exchangers, condensers, extended surface equipment.

Evaporation- Type of evaporators and their applications single and multiple effect evaporators, operation of forward– backward and mixed feed operations.

Unit – IV

Mass transfer and its application: Analogies in transfer process, basic concept of diffusion and interphase mass transfer. Mass transfer theory film theory Penetration and surface renewal theory.

Unit – V

Distillation: Rectification, reflux ratio, calculation of numbers of plates by McCabe Thiele method, optimum reflux ratio

Basic introduction to absorption, liquid liquid extraction, leaching

Drying: Equilibrium mechanism theory of drying, drying rate curve

Text Books:

1. Heat and Mass Transfer: Fundamentals and Applications by Yunus A. Çengel and Afshin J. Ghajar. eISBN: 978-9339223199
2. Introduction to Chemical Engineering Thermodynamics" by J.M. Smith, H.C. Van Ness, and M.M. Abbott. eISBN: 978-0070145870

Reference Books:

1. Transport Processes and Separation Process Principles" by Christie John Geankoplis. eISBN: 9789332549432
2. Process Heat Transfer" by Donald Q. Kern. eISBN: 978-0074632178

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc22_me139/preview
2. https://www.engineeringtoolbox.com/convective-heat-transfer-d_430.html
3. <https://www.thomasnet.com/articles/process-equipment/double-pipe-heat-exchangers/>
4. <https://pages.mtu.edu/~fmorriso/cm3120/lectures/2020%20CM3120%20First%20Diffusion%20Lecture%209.pdf>
5. <http://www.dempt.co.za/mso2015/handout4.pdf>

Transportation of Petroleum Products

Course Code: 2501PT34

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Understand the Pipeline Construction and Operation.
- CO2: Prioritize Proficiency in Instrumentation and Control.
- CO3: Apply Knowledge of Safety, Traffic Management, and Supply Scenarios.
- CO4: Understand the Product Quality Control and Bulk Distribution.
- CO5: Make Awareness of Pricing Mechanisms and Conservation Efforts.

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-

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: Objective, scope and outcome of the course.

Basics of Pipeline construction: operation and protection. Pump and compressor.

Unit – II

Instrumentation and Control: Metering and measurements of oil and gas.

Traffic management, Fire and safety rules. Indian and Global supply scenario of petroleum and petroleum products.

Unit – III

Product quality control. Bulk distribution and handling-domestic, commercial and industrial. Storage of petroleum products in fixed installations. Standards and regulations.

Unit – IV

Role of International oil companies and OPEC pricing mechanism. Administered and market determined, pricing mechanism in India.

Unit – V

Conservation of petroleum & its products. Spot and other market control mechanism.

Text Books:

1. Petroleum Transportation and Production: Oil Spill and Pollution Control by Marshall Sittig, Noyes Publications.eISBN: 9780815507017
2. Petroleum Storage & Transportation: Petroleum liquids transportation, William E. Swales, National Petroleum Council. Committee on Petroleum Storage & Transportation. eISBN: 9780686292821.

Reference Books:

1. Petroleum Transportation Handbook, Harold Sill Bell, McGraw-Hill. eISBN: 9780070049336
2. Green Gasoline: A Green Spark Transportation Fuel, Mohammad Aslam; Shrikant Maktedar; Anil Kumar Sarma, Green Chemistry Series, 2023. eISBN: 9781837670843.

Web Links:

1. <https://www.eit.edu.au/resources/pipeline-systems-designing-construction-maintenance-and-asset-management/>
2. <https://blog.epcland.com/instrumentation-and-control-engineering/>
3. <https://archive.org/download/za.sans.10087.3.2008/za.sans.10087.3.2008.pdf>
4. <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2010/11/WPM31-OPECPrisingPowerTheNeedForANewPerspective-BassamFattouh-2007.pdf>
5. https://ongcindia.com/documents/77751/2593733/syllabus222_20.pdf

Pipeline Engineering

Course Code: 2501PT31

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Illustrate pipeline route selection and survey operations.
- CO2: Apply the pipeline mechanical design and pipeline protection.
- CO3: Summarize the natural gas transmission in pipelines.
- CO4: Explain the performance of compressors and coolers
- CO5: Facilitate the fundamentals of transient 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	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	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

Elements of pipeline design: Fluid properties – Environment - Effects of pressure and temperature - Supply / Demand scenario - Route selection for onshore and offshore - Codes and standards - Environmental and hydrological considerations – Economics - Materials / Construction – Operation - Pipeline protection - Pipeline integrity monitoring.

Pipeline route selection, survey, geotechnical guidelines, construction and commissioning: Introduction - Preliminary route selection - Key factors for route selection - Engineering survey - Legal survey - Construction / As-built survey - Geotechnical design

Unit – II

Materials selection: Elements of design – Materials designation standards.

Pipeline mechanical design: Codes and standards – Location classification – Pipeline design formula – Expansion and flexibility – Joint design for pipes of unequal wall thickness – Valve assemblies – Scraper traps – Buoyancy control – Crossings – Depth of cover – Aerial markings – Warning signs.

Pipeline construction: Construction – Commissioning.

Pipeline protection, Instrumentation, and Pigging: Pipeline coating – Cathodic protection – Cathodic protection calculations for land pipelines – Internal corrosion – Flow meters and their calibration – Sensors – Pigs.

Unit – III

Natural gas transmission: General flow equation – Steady state - Impact of gas molecular weight and compressibility factor on flow capacity - Flow regimes - Widely used steady-state flow equations – Summary of the impact of different gas and pipeline parameters on the gas flow efficiency – Pressure drop calculation for pipeline in series and parallel – Pipeline gas velocity – Erosional velocity – Optimum pressure drop for design purposes – Pipeline packing – Determining gas leakage using pressure drop method – Wall thickness / pipe grade – Temperature profile – Optimization process – Gas transmission solved problems.

Unit – IV

Gas compression: Types of compressors – Compressor drivers – Compressor station configuration – Thermodynamics of isothermal and adiabatic gas compression – Temperature change in adiabatic gas compression – Thermodynamics of poly-tropic gas compression – Gas compressors in series – Centrifugal compressor horsepower – Enthalpy / Entropy charts (Mollier diagram) – Centrifugal compressor performance curve-Reciprocation compressors.

Coolers: Gas coolers – Air-cooled heat exchangers – Heat transfer equations for coolers – Fan air mass flow rate – Required fan power – Gas pressure drop-in coolers – Iterative procedure for calculations based on unknown T₂.

Unit – V

Liquid flow and pumps: Fully developed laminar flow in a pipe – Turbulent flow – Multiphase flow - Centrifugal pumps – Retrofitting for centrifugal pumps (Radial-flow) – Pump station control – Pump station piping design.

Transient flow in liquid and gas pipelines: Purpose of transient analysis – Theoretical fundamentals and transient solution technique – Applications – Computer applications – Corrosion, Safety and Maintenance Considerations.

Text Books:

1. Pipeline Design and Construction: A Practical Approach, M. Mohitpour, H. Golshan and M.A. Murray, 2nd Edition, ASME Press. eISBN: 9780791802037
2. Pipeline Engineering, Henry Liu, Lewis Publishers (CRC Press). eISBN: 9781420041429

Reference Books:

1. Outlines of Chemicals Technology, Dryden, C.E., Edited and Revised by Gopala Rao, M. and M. Sittig, 2nd Edition, Affiliated East-West press eISBN: 9788185336601
2. Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair, George A. Antaki, CRC Press. eISBN: 9780824707128

Web Links:

1. <http://petrowiki.org/Pipelines>
2. <http://www.pipingguide.net/2008/01/piping-codes-standards.html>
3. <http://naturalgas.org/naturalgas/transport/>
4. <http://physics.bu.edu/~duffy/py105/Firstlaw.html>
5. http://petrowiki.org/Centrifugal_pumps

Operational & Maintenance of Pipelines

Course Code: 2501PT29

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Explain the Elements of Pipeline operation and maintenance
- CO2: Explain the Operation and maintenance organization in pipeline
- CO3: Explain overview of pipeline system operation
- CO4: Apply pipeline system maintenance
- CO5: Explain the Valves and operations in pipeline

Mapping of Course Outcomes with Program Outcomes:

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

Unit – I

Elements of Pipeline Operation and Maintenance, Background and History, Trends in Pipeline System Development, Pipeline Transmission Systems, Operation and Maintenance Elements

Unit – II

Operation and Maintenance Organization, Introduction, General Functions in a Pipeline Organization Factors that Influence Organizational Structure, Organizational Structure of a Pipeline Codes, Policies and Procedures, Asset Management

Unit – III

Overview of Pipeline System Operation, Pipeline Operational Planning, Gas Pipeline Transportation, Liquid Transportation, Heavy oil Transportation, Special Operational Activities, Special Issues

Unit – IV

Pipeline System Maintenance, Overview of Pipeline Maintenance Activities, Right-of-way and Site Maintenance, Pipeline Pigging, Pipeline Repair, Pipeline Segment Replacement, Pipeline Protection/Corrosion Control, Pipeline Welding Techniques and Branch Connections, operation of pumps and compressors including maintenance

Unit – V

Valves & Operators, General and History, Valve Standards/Applicable Codes, Definition and Types for Pipeline Applications, Valve Operators, Automatic Line-Break Controls, Side/Takeoff Valves, Station Tie-ins, Valve Assemblies, Valve Automation For Liquid Pipelines, Valve Characteristics, Pressure Drop, Valve Application Ranking and Identification, Valve Maintenance Requirement

Text Books:

1. Pipeline Design and Construction: A Practical Approach, M. Mohitpour, H. Golshan and M.A. Murray, 2nd Edition, ASME Press eISBN: 9780791802037
2. Pipeline Engineering, Henry Liu, Lewis Publishers (CRC Press) eISBN: 9781420041429

Reference Books:

1. Piping Calculation Manual, E. ShashiMenon, McGraw-Hill eISBN: 9780071502113.
2. Pipeline Planning and Construction Field Manual, E. ShashiMenon, Gulf Professional Publishing eISBN: 9780123858817
3. Pipeline Rules of Thumb Handbook, E. W. McAllister, 7 Edition, eISBN: 9780128018942
4. Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair, George A. Antaki, CRC Press eISBN: 9780824707128.

Web Links:

1. <http://petrowiki.org/Pipelines>
2. <http://www.pipingguide.net/2008/01/piping-codes-standards.htm>
3. <http://naturalgas.org/naturalgas/transport>
4. <http://physics.bu.edu/~duffy/py105/Firstlaw.htm>
5. http://petrowiki.org/Centrifugal_pump

Flow Assurance

Course Code: 2501PT26

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1: Solve flow assurance calculations and size the piping & distribution system.
- CO2: Explain the concepts of non-Newtonian fluid & friction, transient flow, transient flow and heat transfer fundamentals.
- CO3: Apply the concepts of emulsion, phase behavior, hydrocarbon flow, single, two, three & four phase regimes during design
- CO4: Apply three phase gas-liquid-solid flow
- CO5: Explain the concepts of wax management, asphaltenes, hydrate remediation interprets phase behavior and hydrocarbon flow

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I:

Introduction to flow assurance:

Pipe friction; Friction in Non-circular pipes; Friction loss in components.

UNIT-II:

Fluid Flow and Heat Transfer Fundamentals:

Non-Newtonian Fluid & Friction; Transient flow; Transient flow; Simplified liquid flow solution; Heat Transfer Fundamentals; U-Value; Steady State / Transient Heat Transfer; Thermal management strategy and Insulation; Simulation Results & Program Testing

UNIT –III:

Composition & properties of Hydrocarbons:

Emulsion, Phase Behavior, Hydrocarbon Flow; Single, two, three & four phase regimes; conservation equations; 2 & 3 fluid models; friction, deposition & entrainment, solving two-phase three fluid equations; gas & Liquid slug including boiling & condensation.

UNIT-IV:**Hydraulics:**

Two Phase Liquid-Liquid Flow; Two Phase Liquid-Gas Flow, Two Phase Liquid-Solid Flow; Three Phase Gas-Liquid-Liquid Flow; Three phase Gas-Liquid-Solid Flow

UNIT-V:**Hydrates, Wax & Asphaltenes:**

Physics & Phase Behavior; Hydrate Prevention; Hydrate Remediation; Hydrate Control Design Philosophies; Recovery of Thermodynamic Hydrate Inhibitors.

Wax; Wax Management; Wax remediation; Asphaltenes; Asphaltene control design philosophies

Text Books:

1. Pipe Flow-1 Single Phase Flow Assurance – Over Bratland (e-Book). eISBN: 9780123820356.
2. Subsea Engineering Handbook – Yong Bai & Qiang Bai – Gulf Professional Publishing. eISBN: 9780123852402

Reference Books:

1. Pipe Flow-2 Multi Phase Flow Assurance – Over Bratland (e-Book). eISBN: 9780123858749
2. Natural Gas Hydrates in Flow Assurance – Dendy Sloan et.al – GPP. eISBN: 9780123865488.
3. Natural Gas Hydrates, Experimental Techniques and their applications, Yuguang Ye, Changling Liu, Springer Berlin Heidelberg. eISBN: 9783540937240

Web Links:

1. https://en.wikipedia.org/wiki/Flow_assurance
2. https://en.wikipedia.org/wiki/Non-Newtonian_fluid
3. <http://www.oilfieldwiki.com/wiki>
4. <https://en.wikipedia.org/wiki/Hydraulics>
5. <http://spe-iran.org/workshop1>

Midstream Project Economic Analysis

Course Code: 2501PT28

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Understand the petroleum economics in all its aspects: reserves, investments, players, costs, benchmarking.
- CO2: Explain the concepts and make simplified forecast of oil production.
- CO3: Understand of Oil and Gas Market as well as International Trading.
- CO4: Apply cash flow techniques in economic analysis and evaluations
- CO5: Understand of different kind of international agreements and especially Production Sharing Agreements

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit-I

Introduction: Petroleum Industry, the main aspects.

Midstream and Downstream segments. The modern tendencies and the current condition of the industry.

Unit-II

Reserves and production forecast. Reserves classification. Approaches in production forecast. Decline curve, decline rate. Frequently used exponential decline curve. Oil and Gas Market. Main Players

Crude oil supply and demand. Crude oil characteristics, pricing, benchmarks. Sale contracts. Gas sales. International oil trading. Platts quotations. Wet and paper barrel, hedging.

Unit-III

Cash flow Capital and operating expenditures. Constructing a project Cash Flow. Economic Decision Tools. Economic indicators and yardsticks. The time value of money. Discounted Cash Flow.

Unit-IV

Risk and Uncertainties. Probability and frequency distribution. Sensitivity and risk analyses. Decision tree analysis. Monte Carlo simulation. Financing and Ownerships. Source of financing. Cost of capital

Unit-V

Petroleum Industry Accounting. Costs and taxes. Depreciation, Depletion and Amortization. Oil Company's annual report. Budgeting, planning, scheduling. Authorization for expenditure (AFE) Economic Analysis. Rate acceleration projects. Equipment replacement. Leasing. International Agreements Production Sharing Agreement

Text Books:

1. Fraser H.Allen and Richard D.Seba, Economics of Worldwide Petroleum Production. Third Edition eISBN: 9781560325010
2. Rognvaldur Hannesson, Petroleum Economics: issues and strategies of oil and natural gas production eISBN: 9783540240483

Reference Books:

1. Project Finance for the International Petroleum Industry, Robert Clews, 2016. eISBN: 9780750655541

Web Links:

1. <https://www.petrosync.com/blog/oil-and-gas-industry/>
2. https://mdpi-res.com/d_attachment/energies/energies-16-04117/article_deploy/energies-16-04117.pdf?version=1684225862
3. <https://www.smartsheet.com/content/project-cash-flow>
4. <https://medium.com/analytics-vidhya/building-a-probabilistic-risk-estimate-using-monte-carlo-simulations-cf904b1ab503>
5. <https://www.pwc.com/id/en/publications/assets/eumpublications/financial-reporting-in-the-oil-and-gas-industry.pdf>

Storage & Transportation of Oil & Natural Gas

Course Code: 2501PT33

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Recognize specified equipment for testing various samples
- CO2: Apply various apparatus/equipment for the analysis of various petroleum products
- CO3: Illustrate the storage facilities for petroleum products.
- CO4: Identify the physical properties of different petroleum products
- CO5: Choose transport properties of different petroleum products

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction

Crude oil Trade, Selection of Port Location, Ship Building/Shipyards

Unit – II

Natural Gas Regasification Technology

Commercial Sourcing of Natural Gas, Different Kinds of Regasification Techniques, Regasification Process & Cold Utilization, Synchronization of Degasified natural gas and Pipelines, Current Status in India.

Unit – III

Crude Oil Transportation

Transportation techniques of crude oil, Pipeline specification, Corrosion Prevention techniques, Pressure drop, Pumps and Booster station, Wax deposition and prevention, Chemical treatment.

Unit – IV

Design Basic Engineering Aspects of Terminal Design, Design of Liquefaction Train, Ship Building/Shipyards, Storage Facilities.

Unit – V

Characteristics Of Storage Technical Qualities and Storage, Properties of Storage Reservoir, Rocks & Fluids. Flow through Storage Reservoir; Gas Flow Performance, Gas Deliverability.

Design & Development of Underground Storage Fields: Operation of Storage Fields. Recent Developments Advanced Storage Techniques, Case Histories.

Text Books:

- 1 Oilfield Processing: Crude Oil (Oilfield Processing of Petroleum R. Solvay, Pennwell Books). eISBN: 9780878143181.
- 2 Advances in Environmental Control Technology: Storage Tank Paul Cheremisinoff Gulf Professional Publishing; 1ST edition eISBN: 9780884153518

Reference Books:

- 1 Natural Gas Transportation, Storage and Use, Mark Fennell Amazon Digital Services, Inc., 2011. eISBN: 9781463706146
- 2 Natural Gas: Production, Processing and Transport, Alexandre Rojey, Editions OPHRYS eISBN: 9782708007275

Web Links:

- 1 <https://www.samco.in/knowledge-center/articles/crude-oil-trading-the-ultimate-beginners-strategyguide/#:~:text=Strategies%20%26%20Tips%20for%20Crude%20Oil%20Trading%201,Trading%20Strategy.%20...%204%20Spread%20Trading%20Strategy.%20>
- 2 https://en.wikipedia.org/wiki/Natural_gas
- 3 <https://www.breakthroughfuel.com/blog/oil-in-motion-visibility-into-crude-oil-transportation>
- 4 <https://crp.trb.org/acrpwebresource2/overview-of-air-cargo-terminal-design-aspects/>
- 5 <https://www.osti.gov/biblio/780306>

Data Analytics & AI For Process Industry

Course Code: 2501PT25

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Understand the Data Analytics and AI
- CO2: Explain the concepts in Data Science Languages.
- CO3: Apply the Knowledge of Data Warehousing and OLAP
- CO4: Apply Mastery of Statistical Methods and Techniques
- CO5: Explain the Competence in Classification and Big Data Tools

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit-I

Introduction: Introduction to Data Analytics and Artificial Intelligence- Some illustrations of AI problems-Data-Information-Knowledge-Applications of Data Analytics-Introduction to the Languages of Data Science: R, SQL, and Python.

Unit-II

Data warehousing: Introduction to Data warehousing, Concepts of Data warehousing-OLAP-Data Preparation and Visualization.

Unit-III

Descriptive Statistics: Central Tendency and Variability, Inferential Statistics-Probability-Central Limit Theorem-Exploratory Data Analysis-Hypothesis Testing-Linear Regression.

Unit-IV

Classification: KNN, Naïve Bayes and Logistic Regression-K-means and Hierarchical Clustering-Decision Trees-Support Vector Machines-Neural Networks-Association Rule Mining.

Unit-V

Introduction to Big Data and Hadoop: Managing Big Data-Hadoop Ecosystem Tools (Sqoop and Hive).

Introduction to Spark: Big Data Analysis using Spark R-Spark SQL-Case studies

Text Books:

1. Thomas A. Runkler, Data Analytics: Models and Algorithms for Intelligent Data Analysis. Springer 2012. eISBN: 9783642201526
2. Wes McKinney, Python for Data Analysis. O'Reilly 2013. eISBN: 9781449323592.

Reference Books:

1. Keith R. Holdaway, Harness Oil and Gas Big Data with Analytics: Optimize Exploration and Production with Data-Driven Models. Wiley (2014). eISBN: 9781118468220.
2. Robert Haining, Spatial Data Analysis: Theory and Practice. Cambridge University Press (2003). eISBN: 9780521777865

Web links:

1. <https://www.coursera.org/articles/ai-in-data-science>
2. <https://www.digitalvidya.com/blog/introduction-to-data-warehousing/>
3. <https://www.geeksforgeeks.org/descriptive-statistics/>
4. <https://www.datasciencecentral.com/comparing-classifiers-decision-trees-knn-naive-bayes/>
5. <https://www.geeksforgeeks.org/hadoop-components-functionality-and-challenges-in-big-data/>

Petroleum Economics, Policies & Regulations

Course Code: 2501PT30

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Identify the importance of petroleum sector in the world economy
- CO2: Explain various analysis and techniques of economics in petroleum industry
- CO3: Apply project evaluation methods in petroleum industry
- CO4: Identify the Demand and Marketing of Petroleum Products
- CO5: Study the laws and regulations in petroleum industries.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction: Role and Value of Oil and Gas - Government and corporate interests, Evolution of national oil companies -Organization of Petroleum Exporting Countries - Political Environment related to Petroleum Industry. Principles, Methods, and Techniques of Petroleum Engineering Economics: Time value in capital expenditures, Depreciation, and depletion in oil projects- Financial measures and profitability analysis.

Unit – II

Risk analysis: Analysis of alternative selections and replacements- Risk, uncertainty, and decision analysis, Break even and sensitivity analysis- Optimization Techniques.

Unit – III

Application and Project Evaluation: Oil fields exploration and drilling operations-Oil fields' estimation of oil reserves and evaluation of an oil property- Project financial analysis. Project development and Joint development utilization Oil fields production operations- Oil transportation- Crude oil processing.

Unit – IV

Demand and Marketing of Petroleum Products: Crude oil fundamentals - Price of crude - Crude oil prices in transactions. Internal Markets and Prices -Marketing and sale of Motor – Aviation – Lubricant -Asphalt and Propane. Transportation: Fundamentals of transportation –Pipelines -Oil tankers - Downstream transportations. Distribution of Petroleum Products.

Unit – V

Petroleum or Oil & Gas Policies and Regulations: Petroleum and Oil & Gas Rules and Regulations in India – The Oil fields Regulations and Development Act –NELP & OALP – Functions of Directorate General of Hydrocarbons – Petroleum and Natural Gas Regulatory Board.

Text Books:

- 1 Petroleum Economics and Engineering, Third Edition, Hussein K. Abdel- Aal, Mohammed A. Alsahlawi, CRC Press, 2013. eISBN: 9781466583714
- 2 The Global Oil & Gas Industry: Management, Strategy and Finance, Andrew Inkpen & Michael H. Moffett, 2011. eISBN: 9780123858804

Reference Books:

- 1 Petroleum Economics, Jean Masseron, Technip; 4th revised Edition, 2000.eISBN: 9782710807573.

Web Links:

- 1 <https://ivypanda.com/essays/petroleum-industrys-ethical-and-societal-overview/>
- 2 https://en.wikipedia.org/wiki/Mathematical_optimization
- 3 [https://www.pmcclounge.com/types-of-project-management-life-cycle/#:~:text=%20Types%20of%20Project%20Management%20Life%20Cycle%20,S mall%2C%20usable%20pieces%20of%20the%20project...%20More%20](https://www.pmcclounge.com/types-of-project-management-life-cycle/#:~:text=%20Types%20of%20Project%20Management%20Life%20Cycle%20,Small%2C%20usable%20pieces%20of%20the%20project...%20More%20)

Pipeline Project Management

Course Code: 2501PT32

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Explain pipeline integrity management and framework
- CO2: Apply Engineering concepts for pipeline integrity
- CO3: Explain Elements of a pipeline integrity management system
- CO4: Apply Integrity hazard and threat susceptibility and assessment
- CO5: Explain the Consequences assessment for pipelines

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Pipeline Integrity Management: Integrity Management (IM) core purpose, Key Integrity Management Terminology, First Hydrocarbon Transmission Pipelines, Reservoirs and Legislation, Pipeline Integrity Management Eras, History and Evolution , Pipeline Integrity Management Framework

Unit – II

Engineering Concepts for Pipeline Integrity: Design of Pipelines, Line Pipe, Pipeline Routing, The Design Process, Pipeline Construction Elaboration of contents of required Offshore pipelines

Unit – III

Elements of a Pipeline Integrity Management System (PIMS), Management Systems and Pipeline Integrity, Integrity Management Program (IMP), PIMS: Management System and Integrity, Management Program Linkage, PIMS Policy and Commitment, PIMS Planning:

Purpose and High Level Processes, PIMS Implementation, Conformance and Compliance Verification and Action Plans, Management Review: Integrity Performance and KPIs

Unit – IV

Integrity Hazard and Threat Susceptibility and Assessment, Introduction, Threat Management Cycle, Pipeline Integrity Threat Assessment Process, Pipeline Integrity Hazards and Threats, Pipeline Integrity Hazard Identification, Threat Susceptibility Assessment, Pipeline Threat Assessment

Unit – V

Consequence Assessment for Pipelines

Introduction, Pipeline Consequence Categories, Consequence Assessment Process, Consequence Analysis: Fluid Discharge and Dispersion, Consequence Classification along the Pipeline, Validation of the Consequence Classification, Consequence Assessment Results, Content and Format

Text Books:

1. Pipeline Integrity Management Systems, A practical Approach, Rafael. G. Mora, Phil Hopkins, Edgar I. Cote, Taylor & Francis, ASME press, 2016 eISBN: 9780791875767
2. Pipeline Design and Construction: A Practical Approach, M. Mohitpour, H. Golshan and M.A. Murray, 2nd Edition, ASME Press, 2007. eISBN: 9780791802037

Reference Books:

1. Piping Calculation Manual, E. Shashi Menon, McGraw-Hill, 2004. eISBN: 9780071408810.
2. Pipeline Planning and Construction Field Manual, E. Shashi Menon, Gulf Professional Publishing, 2011. eISBN: 9780123858774.
3. Pipeline Rules of Thumb Handbook, E. W. McAllister, 7 Edition, 2009. eISBN: 9780123819787.

Web Links:

1. <http://petrowiki.org/Pipelines>
2. <http://www.pipingguide.net/2008/01/piping-codes-standards.html>
3. <http://naturalgas.org/naturalgas/transport/>
4. <http://physics.bu.edu/~duffy/py105/Firstlaw.html>
5. http://petrowiki.org/Centrifugal_pumps

Minor Stream: Fire and Safety in Petroleum Industries

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT39	Fundamentals of Petroleum Engineering	FC	2			2	50	50	100	-
2501PT38	Fire Risk & Control	FC	3			3	50	50	100	-
2501PT41	Occupational Health & Safety	FC	3			3	50	50	100	-
2501PT45	Statutory Rules & Regulation	FC	3			3	50	50	100	-
2501PT36	Advances In Sustainable Development	IC	3			3	50	50	100	OHS
2501PT40	Hazard Identification & Risk Assessment	IC	3			3	50	50	100	OHS
2501PT46	Structural Fire Protection System	IC	3			3	50	50	100	FRC
2501PT42	Process Safety & Security	IC	3			3	50	50	100	OHS
2501PT44	Safety In Engineering Industry	AC	3			3	50	50	100	HIRA
2501PT43	Safety In Drilling	AC	3			3	50	50	100	HIRA
2501PT37	Disaster Risk Management	AC	3			3	50	50	100	-
Total			32			32				

Fundamentals of Petroleum Engineering

Course Code: 2501PT39

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO 1:** Identify the various streams in the petroleum industry.
- CO 2:** Outline the onshore and offshore reservoirs.
- CO 3:** List out the various artificial lift techniques.
- CO 4:** Illustrate various attributes in mid-stream processing and storage.
- CO 5:** Describe the crude oil products and their specifications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	3	-
CO2	2	-
CO3	2	-
CO4	3	-
CO5	3	-

UNIT-I

What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector- Midstream Processing-Downstream Processing-Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II

Exploration & Production-Indian and World Scenario of Petroleum and Natural Gas Resources- The Reservoir-Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs - Reservoir Drives. Exploration and Drilling Rigs- Rig Components-Drill and drill bits- Drilling fluids.

UNIT III

Well Completions Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.

Artificial Lift: Principles and operation of Rod Pumps Down hole Pumps - Gas Lift - Plunger Lift- Electrical submersible pumps.

UNIT IV

Separation of Reservoir Fluids- Manifolds and Gathering - Production Separators - Gas Treatment and Compression - Oil & Gas Storage.

Midstream processing: Transportation of Crude Oil & its Products and Natural Gas- - World and Indian pipeline scenario- Design of Oil and Gas pipelines Safety aspects of pipelines- Environmental issues.

UNIT V

Crude Oil Refining: Classification and Composition - Constituents - Products and their specifications- Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Text Books:

1. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, ABB ATPA Oil and Gas. eISBN: 978-1329783454
2. John R. Fanchi and Christiansen, R.L. Introduction to Petroleum Engineering, John Wiley & Sons. eISBN:9781119193463

Reference Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; Elsevier publications, 2nd Edition. eISBN: 0-444-99564-1
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier eISBN: 978-1-85617-689-7

Web Links:

1. <https://www.studentenergy.org>
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Pipeline_transport
4. https://petrowiki.org/Production_system

Fire Risk & Control

Course Code: 2501PT38

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1:** Know the fundamentals of fire & explosion and their general requirements.
- CO 2:** Apply their learning in implementing fire safety requirements at the work place to minimize fire incidence.
- CO 3:** Develop skill set or competency in assessing /analyzing or comparing fire safety system requirements towards minimization of fire & explosion in
- CO 4:** Do the inspection/ audit at the workplace in accordance with required requirements.
- CO 5:** Use an engineered approach in establishing or maintaining updated fire prevention measures specific to the organizational scope.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	1	--	-	1	-	-	1	-	-	1	-
CO2	1	-	-	1	-	-	1	-	-	1	-
CO3	-	-	-	1	-	-	2	-	-	2	-
CO4	1	-	-	1	-	-	3	-	-	2	-
CO5	2	-	-	2	-	-	1	2	-	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	3	-
CO2	2	-
CO3	2	-
CO4	3	-
CO5	3	-

UNIT I:

Fire Chemistry

Physics and chemistry of fire, Fire Properties of Solids, Liquids and Gases, Fire spread, Toxicity of Products of Combustion, Theory of Combustion and Explosion, Vapour Clouds, Flash Fire, Jet Fires, Pool Fires, Unconfined Vapour Cloud Explosion, Shock Waves, Auto-Ignition, Boiling Liquid expanding Vapour Explosion. Toxic effects of combustion gases.

UNIT II:

Fire Prevention & Protection

Sources of Ignition- Fire Triangle, Principles of Fire Extinguishing, Active and Passive Fire Protection Systems, Various Classes of Fires, A, B, C, D, E types of Fire Extinguishers, Fire Stoppers, Hydrant Pipes, Hoses, Monitors, Fire Watchers, Lay Out of Stand Pipes, Fire Station,

Fire Alarms and Sirens, Maintenance of Fire Trucks, Foam Generators, Escape from Fire, Rescue Operations, Fire Drills, Notice, First Aid for burns

UNIT III:

Fire Alarm & Detection System

Industrial fire Protection System , Sprinkler-Hydrants -Stand Pipes, Special Fire Suppression Systems (Deluge and Emulsifier), Selection Criteria of the above Installations, Reliability, Maintenance , Evaluation and Standards, Alarm and Detection Systems, Other Suppression Systems (CO₂ System - Foam System , Dry Chemical Powder (DCP) System, Halon System), Need For Halon Replacement, Smoke Venting, Portable Extinguishers, Flammable Liquids, Tank Farms, Indices of In flammability, Fire Fighting Systems

UNIT IV:

Fire Assurance & Measurements

Fire Load, Fire Resistant Material and Fire Testing, Structural Fire Protection, Structural Integrity, Exits and Egress, Fire Certificates, Fire Safety requirements for high-rise Buildings.

UNIT V:

Fire & Explosion Principles

Principles of Explosion, Detonation and Blast Waves, Explosion Parameter, Explosion Venting, Inert Gases, Plant for Generation of Inert Gas, Rupture Disc in Process Vessels & Lines Explosion, Suppression System based on Carbon Dioxide (CO₂) & Halons Hazards in LPG, Ammonia (NH₃), Sulphur Dioxide (SO₃), Chlorine (CL₂) etc. Indian Explosive Act and Rules, Static and Mobile Pressure Vessel (SMPV) rules.

Textbooks

1. Rao and Saluja (1997), Electrical Safety, Fire Safety Engineering and Safety Management, New Delhi: Khanna Publishers. eISBN: 9788174090144
2. Prekash Sesha (2017), Manual of Fire Safety, New Delhi: CBS Publication eISBN: 9789386419277

Reference books

- 1 M. Ya Roytman (1975), Principles of fire safety standards for building construction, Washington DC: Amerind. eISBN: 9780846300590.
- 2 V K Jain (2001), Fire Safety in Building, New Delhi: New Age International. eISBN: 9788122413485
- 3 Purkiss and Yuan Li (2013), Fire Safety Engineering Design of Structures, Florida: CRC Press. eISBN: 9780415502362.

Web links

1. <https://maiif.org/wp-content/uploads/2017/08/Guide-for-Conducting-Marine-Fire-Investigations-Chapter-1.pdf>
2. <https://fire.nv.gov/uploadedfiles/firenv.gov/content/bureaus/FST/4-ifipp-PSsm.pdf>
3. <https://www.scribd.com/doc/296196433/Fire-Protection-of-Buildings>
4. <https://mohua.gov.in/upload/uploadfiles/files/Chap-7.pdf>

Occupational Health & Safety

Course Code: 2501PT41

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Understand the types of occupational hazards in the workplace and their effects on human health.
- CO2: Identify the root causes of workplace illness and adapt effective ways to control it.
- CO3: Apply effective industrial hygiene program for the workplace and monitor its effectiveness.
- CO4: Develop and standardize the most effective occupational health and safety program in the workplace.
- CO5: Distinguish Biological and Ergonomic 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	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	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:

Human Anatomy, & Hazard

Definition- Anatomy and Physiology of human organs – The lungs, Skin, Ear, Eyes and skin – Functions of organs – Impairment of organs – Effects of various hazards on organs; Cardiopulmonary resuscitation; Audiometric tests, eye tests, vital functional tests; Exposure routes of toxic materials and protective mechanisms; Recognition of health hazards, and Methods for measuring and evaluating health hazards.

UNIT II:

Physical Hazards

Noise-exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, hearing conservation programs; vibration, types, effects, instrument measurement procedure, permissible exposure limit; Ionizing and Non-Ionizing radiation, types, effects, monitoring instruments, control programs; Thermal Heat stress - Methods for controlling thermal exposures.

UNIT III:**Chemical Hazards**

Chemical hazards-Classification-dust, fumes, mist, vapor, fog, gases, types, concentration, Threshold Limit Value (TLV) - Methods of Evaluation- Sampling methodology- Industrial Hygiene calculations, Air Sampling Methods; dust sample collection devices, personal sampling, methods of control; Toxicology, classes of toxicants- sources; human health risk assessment and Environmental risk assessment. Weapons of Mass Destruction (WMD)-Toxic Chemicals-effects Effects of various chemicals on human health- Lead, nickel, chromium, manganese toxicity, gas poisoning – prevention methods.

UNIT IV:**Occupational Health & Toxicology**

Concept and spectrum of health - Medical Surveillance, Medical Surveillance Program Development, Emergency Treatment, Non-Emergency Treatment; Occupational-related diseases; evaluation of physiological requirements of jobs – parameters of measurements – personal hygiene.

UNIT V:**Biological & Ergonomic**

Classification of Bio-hazardous agents –bacterial agents, viral agents, fungal, parasitic agents, -infectious diseases; Biohazard control program, employee health program-laboratory safety program-animal care and handling; Ergonomics-Concepts, objectives, Work Related Musculoskeletal Disorders –Carpal Tunnel Syndrome (CTS)- Tendon pain disorders of the neck- back injuries, Ergonomic management program; Pandemic and Management with Case Study

Textbooks

1. National Safety Council. (2010). Handbook of occupational safety and health. Chicago, IL: Author. eISBN: 9780879122747
2. Stellman, J. M. (Ed.). (2012). Encyclopedia of occupational health and safety (Vols. I and II). Geneva, Switzerland: International Labour Organization. eISBN: 9789221267120
3. Leatham, D. G., & Reynolds, J. R. (2018). Occupational health and safety (3rd ed.). eISBN: 9780128147204

Reference Books

1. Plog, B. A., Quinlan, P. J., & Villareal, J. (2012). Fundamentals of industrial hygiene (6th ed.). National Safety Council. eISBN: 9780879122846
2. Allsopp, W. D., & Mastor, M. S. (2018). Occupational safety and health engineering (4th ed.). eISBN: 9781119395680.
3. Plog, B. A., & Lees, F. N. (2021). Fundamentals of industrial hygiene (6th ed.). eISBN: 9781119550124.

Web links

1. <https://byjus.com/biology/human-body-anatomy/>
2. <https://egyankosh.ac.in/bitstream/123456789/70614/1/Unit-1.pdf>
3. <https://www.acgih.org/science/tlv-bei-guidelines/tlv-chemical-substances-introduction/>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6309353/>

Statutory Rules & Regulation

Course Code: 2501PT45

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1:** Know the fundamentals of abbreviation as per different statues for safety, health, welfare and environment.
- CO 2:** Demonstrate understanding of basic terms and definitions as per different acts and rules.
- CO 3:** Understand statutory requirements concerning safety, welfare and health of workers engaged in industries
- CO 4:** Apply the legal aspects granting of license for storage, transportation and usage of explosive and flammable substance as per various acts and rules
- CO 5:** Evaluate the compliance legal and other requirements in a workplace

Mapping of Course Outcomes with Program Outcomes:

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

Factories Act 1948

Definitions, preliminary, inspecting staff, Health, Safety, Provisions relating to hazardous processes, welfare, working hours of adults, Employment of young persons, Special provisions, Penalties, Supplemental. All related amendments.

UNIT II:

Dock Workers (Safety, Health & Welfare) Act, 1986

Definitions, Powers of Inspectors, Power of Govt. to direct Inquiry, Obligation of Dock workers, General Provisions relating to rules and regulations. Dock workers (SHW) Rules- Definitions, Inspection Procedure, Inquiry into certain accidents, Advisory Committee, Inquiry in Public. Dock workers (SHW) Regulations- Definitions, Power of Inspectors. Penalties, Responsibilities, Safety Officers, Reporting of accidents, Emergency Action Plan, Safety

Committee, Occupational Health services for dock workers, various safety and health regulations in brief.

UNIT III:

Explosives Act 1884, Petroleum Act 1934.

Explosives Act: Definitions; Grant of license, Notice of Accidents, Inquiry into ordinary and serious accidents, Punishment for offences, Extension of definition to other explosive substances.

Petroleum Act - Definitions, Control over Petroleum import, transport, storage, production, refining and blending, Need for license, exemption. Inspection and sampling for testing, Notice of Accidents and Inquiries. Petroleum Rules - Definitions, brief idea on the rules relating to safety aspects in transport, storage, refining and blending of petroleum, Notice of Accidents.

UNIT IV:

Social Legislations In India

Workmen's Compensation Act. ESI Act & Rules. Public Liability Act & Rules- Substantive provisions in the above Acts and Rules.

UNIT V:

Environmental Legislations in India

Pollution Water Act: Definitions, Powers and Functions of Central, State and Joint Boards, Provisions regarding prevention and control of water pollution, Penalties, Central & State Water Laboratories, Power to make rules, Power of supersession and overriding effect. Rules on Consent for Establishment.

Air Act - Definitions, Power & Functions of Boards, Prevention & Control of Air Pollution, Penalties, Application for Consent as per Air Rules. Environment (Protection) Act- Definitions, general powers of central government, prevention, control and abatement of environmental pollution. EP Rules-Definitions, standards for emission, prohibition and restrictions on siting and operation of industries.

MSIHC Rules- Definitions, Duties of Authorities, Notification of Major Accidents Safety Reports, On-site & Off-site Emergency Plan, Giving safety information to public. Chemical Accidents (Emergency Planning, Preparedness and Response) Rules- Definitions, Constitution, functions & powers of various Crisis groups.

Textbooks:

1. Ganguly, S., & Changeriya, K. (2018). Health safety and environment (safety management). New Age International. eISBN: 9789386240424.
2. Sharma, J. P. (2019). Factories Act, 1948. LexisNexis India eISBN: 9789351436870.

Reference books:

1. Sahu, G. J. (2014). Environmental jurisprudence and the Supreme Court: Litigation, interpretation, implementation. LexisNexis India. eISBN: 9789351436160
2. Diwan, S., & Rosencranz, A. (2001). Environmental law and policy in India: Cases, materials and statutes (2nd ed.). Oxford University Press. eISBN: 9780195672280

Web Links:

1. <https://unacademy.com/content/bpsc/study-material/general-awareness/factories-act-1948/>
2. <https://indiacode.nic.in/bitstream/123456789/1867/1/A1986-54.pdf>
3. <https://www.acgih.org/science/tlv-bei-guidelines/tlv-chemical-substances-introduction/>
4. <https://egyankosh.ac.in/bitstream/123456789/17197/1/Unit-5.pdf>
5. <https://www.clearias.com/environmental-laws-india/>

Advances in Sustainable Development

Course Code: 2501PT36

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO-1: Recall and describe the three pillars of sustainable development: social, environmental, and economic, and explain their interconnectedness.
- CO-2: Explain the significance of the Anthropocene era and its implications for Earth's environment, climate, and resources.
- CO-3: Understand and discuss the major global trends, including population growth, urbanization, and the challenges related to energy, water, food, and globalization.
- CO-4: Apply critical thinking to analyze the roles and contributions of various actors in advancing sustainable development initiatives.
- CO-5: Analyze and evaluate the effectiveness of global policy frameworks and sustainability indicators in addressing contemporary challenges and propose potential improvements or adaptations.

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I:

Concept Of Sustainable Development

Understand the Foundations of Sustainable Development: Analyze Global Trends and Contemporary Challenges, Evaluate Stakeholder Roles, and Contributions. The Three Pillars of Sustainability, Sustainable Development Goals (SDGs), Stakeholders in Sustainable Development, Policies and Strategies for Sustainability, Sustainable Communities.

UNIT II:

Sustainability and The Triple Bottom Line

Introduction to Sustainability and the Triple Bottom Line, Economic Sustainability, Social Sustainability, Environmental Sustainability, The Triple Bottom Line Framework,

Sustainability Reporting and Metrics, Sustainable Supply Chain Management, (CSR), Sustainable Business Models, Green Marketing and Consumer Behaviour.

UNIT III:

Sustainable Development and International Response

Role of developed countries in the development of developing countries, international summits, Stockholm to Johannesburg, Rio Principles, Agenda 21, Conventions, Agreements, Tokyo Declaration, Doubling Statement, Transboundary issues:

UNIT IV:

Sustainable Development of Socio-Economic Systems

Demographic dynamics of sustainability, Policies for socio-economic development, Strategies for implementing eco-development programmed, Sustainable development through trade, Economic growth, Urbanization and Sustainable Cities, Sustainable Energy and Agriculture, Sustainable Livelihoods, Ecotourism.

UNIT V:

Framework For Achieving Sustainability

Sustainability indicators, Hurdles to Sustainability, Operational guidelines, Interconnected prerequisites for sustainable development, Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities, Business and Industry, Science and Technology for sustainable development, Constraints and barriers for sustainable development.

Textbooks

1. Boubel, R. W., Fox, D. L., & Stern, A. C. (2011). Fundamentals of air pollution (4th ed.). Academic Press. eISBN: 9780123821732.
2. Cunniff, P. E. (1987). Environmental noise pollution. McGraw-Hill. eISBN: 9780471189435

Reference books

1. CPHEEO, Ministry of Urban Development, GoI. (1999). Manual on water supply and treatment. New Delhi, India: Author. eISBN:
2. Masters, G. M. (2011). Introduction to environmental engineering and science. New Delhi, India: Prentice-Hall of India. eISBN: 9788131717086

Web links

1. <https://byjus.com/commerce/meaning-and-features-of-sustainable-development/>
2. <https://www.era-environmental.com/blog/sustainability-management-triple-bottom-line>
3. <https://www.un.org/en/our-work/support-sustainable-development-and-climate-action>
4. <https://www.tandfonline.com/doi/full/10.1080/1331677X.2021.1989319>
5. <https://tracextech.com/5-widely-used-sustainability-frameworks-and-standards/>

Hazard Identification & Risk Assessment

Course Code: 2501PT40

L T P C
3 0 0 3

Course Outcomes:

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

- CO1: Identify the Hazard and risk analysis
- CO2: Summarize impacts of petroleum industry wastes and waste treatment methods.
- CO3: Demonstrate the oil mines regulations in various petroleum industry operations.
- CO4: Make use of the hazop study concepts for safe Practices in Petroleum industry.
- CO5: Illustrate the fire triangle, different methods of suppression of hydrocarbon fires.

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I:

Hazard Identification

Introduction - Hazard - Process - Hazard - Monitoring - Risk - Issues - Perception - Management Assessment-Analysis-Safety Audits-Management System Audits-Check Lists-Material Safety Data.

UNIT II:

Risk Analysis

What If Analysis-Event Tree-Fault Tree Analysis-Hazard and Operability Studies- Coarse Hazard Studies-Human Error Analysis-Safety Review System-Hazard Warning Methods-Hazard Warning Analysis- Plant Safety Audit.

UNIT III:

Software for Risk Analysis

Basic Concepts of Risk Analysis - Quantitative - Qualitative Methods - Hazard Models System-Hazard Assessment Systems - Principles of Applications of Software's- ALOHA - Hazard Operability Studies (HAZOP) - EFFECTS - Hazard Analysis (HAZAN) - PHAST - SAFETI - Failure Mode and Effect Analysis (FMEA).

UNIT IV:**Risk Control & Management**

Impact estimation: Property, People, Man and Machine System, Job and Personal Risk Factors-Standards-Selection and Training-Body Size and Posture-Body Dimension (Static/Dynamic)-Adjustment Range- Penalties. - Guide Lines for Safe Design and Postures-Evaluation and Methods of Reducing Posture Strain.

UNIT V:

Man-Machine Interface-Controls-Types of Control-Identification and Selection-Types of Displays-Compatibility and Stereotypes of Important Operations-Fatigue and Vigilance-Measurement Characteristics and Strategies for Enhanced Performance Human Factor Engineering & Behavioral based safety.

Text Books

1. American Institute of Chemical Engineers (AIChE). (1992). Guidelines for hazard evaluation procedures (2nd ed.). Centre for Chemical Process Safety. eISBN: 9780470926063
2. American Institute of Chemical Engineers (AIChE). (2000). Guidelines for chemical process quantitative risk analysis (2nd ed.). Centre for Chemical Process Safety. eISBN: 9780470926070.

Reference Books

1. Lees, F. P. (1996). Loss prevention in the process industries (2nd ed.). Butterworth-Heinemann. eISBN: 9780750628223
2. National Safety Council. (n.d.). Accident prevention manual for business and industry, Vol. I. eISBN: 9780879123222

Web Links

1. <https://www.osha.gov/safety-management/hazard-Identification>
2. <https://www.investopedia.com/terms/r/risk-analysis.asp>
3. <https://clickup.com/blog/risk-management-software/>
4. <https://www.investopedia.com/terms/r/risk-control.asp>
5. <https://www.upm.com/investors/governance/risk-management-and-control/>

Structural Fire Protection System

Course Code: 2501PT46

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO-1: To explain the building's materialistic properties and their effect on fire exposure.
- CO-2: Resolve the structural fire safety issues and challenges in occupancies by applying their skills and potential.
- CO-3: Analyze or assess the fire safety conditions at the workplace and recommend for best fire-resistant and retardant material for minimizing fire vulnerabilities.
- CO-4: Use their skills and potential to assist in planning and designing passive fire protection systems at the workplace.
- CO-5: Design and develop a new methodology, process/ procedure for structural fire protection.

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I:

Fire & Life Safety

Life Safety Objectives- Life safety, Property protection, Environmental protection; Fire Development- Fire behaviour, Human Behavior, Fire detection and Fire protection (Active/passive); Conceptual framework of fire safety-Scenario analysis, QRA; Fire Resistance- Objective example and fire design; Effect of temperature on the building material – Steel, Concrete. Wood, Glass & Plastics.

UNIT II:

Classification of Buildings, Zoning

Classification of buildings, Zoning- Building by-laws Compartments and compartmentation, elements of building contributing to a compartment; Standard Time-Temperature curves for building and oil/gas fires and associated standards;

UNIT III:**Fire Severity & Fire Resistance**

Fire Severity & Fire Resistance- fire resistance, fire severity, fire resistance test, specifying fire resistance, fire resistance of assemblies. Means and methods of enhancing fire resistance of materials; fire doors; fire stops; products of combustion from various materials;

UNIT IV:**Health Effects of Smoke and Fire Products**

Health effects of smoke and fire products- burns; Stack effect; smoke vents; pressurization of staircases; evacuation planning; special aspects of fire safety in high-rise and multi-occupancy premises. Layout, separation, and segregation for fire safety in industrial facilities; exposure protection.

UNIT V:**Introduction to Fire Modelling**

Introduction to fire modelling- Various fire modelling methods, Applications; Advanced calculation methods- fire models, thermal response model, advanced structural models, hand calculation methods.

Text books

1. M. Ya Roytman (1975), Principles of fire safety standards for building construction, Washington DC: Amerind. eISBN: 9780750623451
2. V K Jain (2001), Fire Safety in Building, New Delhi: New Age International. eISBN: 9788122413485.

Reference books

1. A. K. Dass (2014), Principles of Fire Safety Engineering: Understanding Fire and Fire Protection, New Jersey: Prentice Hall. eISBN: 9789389347241
2. Bureau of Indian Standards (2008), Selection, Installation and Maintenance of Automatic Fire Detection and Alarm System – Code of Practice”, New Delhi: IS 2189:2008. eISBN: 9389347246

Web links

1. <https://www.iafc.org/about-iafc/sections/fire-life-safety>
2. <https://www.findlaw.com/realestate/land-use-laws/types-of-zoning.html>
3. https://www.venicefse.org/edizione2019/wp-content/uploads/2019/11/VanCoile_FireResistance_11_exclVideo-1.pdf
4. <https://www.airnow.gov/sites/default/files/2021-08/how-smoke-from-fire-can-affect-your-health-2021-v1-d1.pdf>
5. <http://www.fireng.org/p/introduction-to-fire-modelling.html>

Process Safety & Security

Course Code: 2501PT42

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO-1: Understand the typical sources of risk in a process plant by hazard identification and examination of systems and accidents.
- CO-2: Apply the knowledge of process safety and security to prevent high consequence incidents.
- CO-3: Analyze the risk and estimate the consequences of failure of the system.
- CO-4: Design safety and security systems for process industries to prevent major accidents from occurring.
- CO-5: Analyze the chemical plant security

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I:

Inherently Safer Design

Inherently safer design concepts and principles, Strategies, Approaches, Advantages, and disadvantages. Human factors in ISD, Process safety elements in ISD, Effective strategies of ISD; safety during startup and shutdown – safety checks in the design of the equipment, reactor safety, scrubbers and flares; safety in erection and commissioning of chemical plants. emergency safety devices.

UNIT II:

Safety In the Design of Chemical Process Plants

Design principles – reliability and safety in designing, Feasibility study, project organization and documentation, Types of contracts and liability, Basic engineering, detailed engineering, Understanding P&ID, and PFD. Material and heat balance, equipment, pipework, Assembly, commission, time schedule, aspects of safety licensing– new concepts in safety design and operation- Pressure vessel testing standards and methods.

UNIT III:**Reaction Kinetics**

Stoichiometry of chemical reactions- key components-extent of reaction, conversion, selectivity, and yield. Chemical thermodynamics-reaction enthalpy-temperature and pressure dependency, chemical equilibrium, Free Gibbs enthalpy, Pressure influence on Chemical equilibrium, Kinetics-reaction rate-rate laws, decomposition-estimation of the chemical parameter. Thermochemical screening- Differential scanning calorimeter, Accelerated rate calorimetry, Thermo-gravimetry analyzer, Reaction calorimetry, Case studies. Stability and sensitivity tests, Hazard prediction by thermodynamic calculations.

UNIT IV:**Safety In the Operation of Chemical Process Plants**

Properties of chemicals – Safety Data Sheets, Operational activities and hazards – safe operation of pumps, compressors, heaters, columns, reactors, pressure vessels, storage vessels, piping systems – effects of pressure, temperature, flow rate, and humidity on operations; corrosion and control its measures- condition monitoring; control valves – safety valves – pressure reducing valves, drains, bypass valves. Chemical splashes, eye irritation, and automatic showers. Storage -layouts-venting-relief valve size calculation- Hydrogen Safety-Handling-Storage, hazards, Preventive measures, case studies. Storage and handling of hazardous chemicals and industrial gases, safe disposal methods- safety in Pipeline transportation of materials, Color coding of pipelines. - Level and flow indicators, -Alarms, and lightning protection;

UNIT V:**Chemical Plant Security**

Safety vs Security, Concept of security, Security Threats and vulnerability, Security risk standards, Security Vulnerability Assessment methods-API 780, CCPS SVA, VAM-CF, Security Risk Factor Table, Applications of Dynamic Risk Assessment. Prevention of Security incidents in various infrastructures handling hazardous materials- Industrial Vigilance, Case studies. Cybersecurity in process plants.

Textbooks

1. Crowl, D. A., & Louvar, J. F. (2002). Chemical process safety: Fundamentals with applications. Prentice Hall. eISBN: 9780132560707.
2. Security risk assessment: In the chemical and process industry (Integrated Security Science Book). De Gruyter. eISBN: 9783110497762

Reference books

1. Lees, F. P. (2005). Lees' handbook of loss prevention in chemical process industries: Hazard identification, assessment and control (3rd ed.). Butterworth-Heinemann. eISBN: 9780750663062.
2. Arendt, J. L., & Lorenzo, V. (2000). Evaluating process safety in the chemical industry. Centre for Chemical Process Safety, American Institute of Chemical Engineers. eISBN: 9780816906296.

Web links

1. <https://www.icheme.org/media/8500/xxv-paper-33.pdf>
2. <https://www.linkedin.com/pulse/safety-design-process-plants-damian-connelly-6123687000219340800>
3. <https://byjus.com/jee/chemical-kinetics/>
4. https://www.mt.com/in/en/home/applications/L1_AutoChem_Applications/Process-Safety.html#:~:text=To%20ensure%20safe%20and%20compliant,or%20environmental%20degradation%20or%20pollution.
5. <https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/chemical-security>

Safety in Engineering Industry

Course Code: 2501PT44

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Develop management plans to prevent accidents in construction Industry.
- CO2: Prepare plans to safe guard workers in construction of high-risk Buildings.
- CO3: Ensure safety while operating construction machinery.
- CO4: Outline safety plans for demolition of buildings.
- CO5: Prepare fire safety plans for a given building.

Mapping of Course Outcomes with Program Outcomes:

CO/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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I:

Safety In Metal Working Machinery and Woodworking Machines

Introduction to manufacturing processes, General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machines, planar machine and grinding machines, CNC machines, Woodworking machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

UNIT II:

Principles of Machine Guarding

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding- Guarding and guarding devices- types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability- case studies, benefits of good guarding systems.

UNIT III:**Safety In Welding and Gas Cutting**

Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-color coding – flashback arrestor – leak detection- pipe line safety-storage and handling of gas cylinders. Underwater welding-Hazards and control measures

UNIT IV:**Safety In Cold Forming and Hot Working of Metals**

Cold working, power presses, point of operation safeguarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot- operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safeguards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. Rapid Prototyping-Hazards and control measures.

UNIT V:**Safety In Finishing, Inspection and Testing**

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal.

Textbooks

1. National Safety Council (1988). Accident prevention manual (13th ed.). Engineering and Technology. eISBN: 9780879120269
2. International Labour Organization. (n.d.). ILO encyclopaedia of occupational health and safety (Part XIII, Manufacturing industries). eISBN: 9789221092032

Reference books

1. Grimaldi, J. V., & Simonds, R. H. (2011). Safety management (9th ed.). Prentice Hall. eISBN: 9780256066982
2. Krishnan, N. V. (2018). Safety management in industry (7th ed.). Jaico Publishing House. eISBN: 9788172240295

Web links

1. <https://www.scribd.com/presentation/554701362/Unit-1-Copy>
2. https://www.dir.ca.gov/dosh/cal_vpp/best_Practices_symposiums/machine-guarding.barry-blodgett.pdf
3. https://www.lsu.edu/ehs/references/university-safety-manual/4J_Welding_cutting.php
4. <https://rlsdhamal.com/safety-in-hot-and-cold-processes-manufacturing-of-steel/#:~:text=Good%20insulation%20over%20hot%20metal,dusts%2C%20fumes%2C%20gases%20etc.>
5. https://www.engr.washington.edu/files/mycoe/safety/Workplace_A.PDF

Safety in Drilling

Course Code: 2501PT43

L T P C
3 0 0 3

Course Outcomes:

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

CO-1: Describe the function, working principle of Drilling rig and its various components.

CO-2: Calculate drilling efficiency and selection of Drilling tubulars & Circulation.

CO-3: Demonstrate the various safety issues considered during drilling.

CO-4: Detail and suggest prevention of Kick Causes and Indicators

CO-5: Describe about Safety Issued in Oil and Gas 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	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I:

Introduction To Drilling Rig and Components

Hoisting System: Component Parts; Derricks, Mast, Substructures, Weight Indicator, Wire Line and Draw Works, Power System: Prime Moves, Transmission System, Rotary System: Swivel, Kelly, Rotary Table.

UNIT II:

Fundamentals of Drilling Tubulars & Circulation

Tubulars: Drill Pipe, Tool Joint, Casing Pipe, Design Consideration, Circulation System: Drilling Fluid Types, Preparation and Conditioning System, Additive, Pumping System, Cutting Removal, Pressure Loss Circulation, Drilling Practices: Bit Choice, Weight on Bit, Rotary Speed, Hydraulic Effect, Air- Gas Drilling, Coring, Drilling Efficiency.

UNIT III:

Cementation & Safety Issues in Drilling

Cementing Operations: Cement Types, Additives, Process and Equipment, Complication: Lost Circulation, Fishing, Blow Outs, Well Planning: GTO, Safety Consideration in well Completion

UNIT IV:**Basics of Well Control**

Oil field Pressure, Kick Causes and Indicators, well control equipment's, Types of Well control, Kill Sheet.

UNIT V:**Production**

Well Completion Practices: Well- Head Assemble, Installation and Testing, Activation, Well Testing, Self-Flowing Wells, Gas Lift: Sucker Rod and Down Hole Motor Pumping of Oil, Safety Issued in Oil and Gas Production.

Textbooks

1. IADC Well CAP Drilling Well Control and Blowout Prevention Training Program (2017). International Association of Drilling Contractors. eISBN:
2. API Recommended Practice 51 Recommended Practice for Blowout Prevention Equipment Systems for Drilling Wells (2016). American Petroleum Institute. eISBN:

Reference books

1. Taylor, I. L. (Ed.). (n.d.). Methods of exploration and production of petroleum resources (Vol. V). eISBN:
2. Hyne, F. J. (1991). Dictionary of petroleum exploration, drilling & production. PennWell Books. eISBN:

Web links

1. https://en.wikipedia.org/wiki/List_of_components_of_oil_drilling_rigs
2. <https://www.slideshare.net/slideshow/q931de1b03/41904147>
3. <https://www.saigaogroup.com/news/cementing-complex-problems.html>
4. https://petex.utexas.edu/images/book_previews/Practical-Well-Control_previewwtrmrk.pdf
5. [https://en.wikipedia.org/wiki/Completion_\(oil_and_gas_wells\)](https://en.wikipedia.org/wiki/Completion_(oil_and_gas_wells))

Disaster Risk Management

Course Code: 2501PT37

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO-1: Understand basic concept and appreciate the institutional framework in India for disaster preparedness and mitigation.
- CO-2: Characterize and analyzes natural and manmade hazards, to identify their causes, mechanisms and evaluate their significance for the human population.
- CO-3: Create strategies and implementation plan for Prevention, Responsive mitigation and recovery during industrial or natural disasters.
- CO4: Apply the best Practices and gaps from case studies on natural and manmade disasters.
- CO5: Explain relief and rehabilitation in disasters

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-

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 - Hazards and Disasters

Introduction - Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes. Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, Institutional framework in India for disaster preparedness and mitigation, Common disaster types in India; Legislations in India on disaster management; National disaster management policy; The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles.

UNIT II:

Natural Disaster: Earthquake, Landslide and Forest Fire

Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, Landslide and land degradation: Causes – tectonic conditions – erosion – avalanches – rock fall –damage

assessment. Forest fire, causes, control and prevention, urban fire, building construction and structural fire protection, electric hazard, shock and protection, aircraft fire, actions required for rescue and fire fighting in air crafts.

UNIT III:

Floods, Tsunami Marine Environment Pollution and Control

Floods: General characteristics causes – geomorphology and floods – flood forecasting – river and coastal flood – flash flood – lake outburst – risks, environmental planning – flood control and management. Drought control and management, Cyclone and Tsunami: Structure and nature of cyclones and Tsunamis – characteristics hazard donation – factors-hazard potential – impact assessment. Coastal and marine environment pollution and control – marine environment degradation – land use changes in coastal zones – wave – tidal storms – erosion habitat pollution – sediment discharge and control. Droughts Causes – vulnerability – tides – famines – desert and desertification.

UNIT IV:

Man Made Disaster

Manmade hazards: Toxic chemicals, noise pollution, industrial disaster and accident, Terrorist disaster / War, Hazardous wastes, reactivity, toxicity, nuclear war, biological weapons, biodiversity extinction and deforestation. causes and adverse effects Epidemics. National & Worldwide Scenario: History of disasters - various disasters in various countries - Worldwide Aid and Agencies, Study of different case studies on natural disaster & man-made disaster.

UNIT V

Relief And Rehabilitation in Disasters

Relief and rehabilitation in disasters at local, national and global levels, Disaster Risk Assessment, understanding hazards, vulnerability and exposure, risk analysis and risk mapping techniques, Disaster risk reduction, Disaster Preparedness and response, disaster recovery and rehabilitation, emergency planning and preparedness, post disaster assessment and recovery planning, reconstruction and infrastructure building, vulnerability and capacity assessment, Community Engagement and public awareness, communication strategies for raising public awareness about disaster risk, Case Studies and Practical real applications : Analysing real world disaster and their application

Textbooks

1. Donald Hyndman, David Hyndman “Natural Hazards and Disasters” Third Edition, JHJK Publisher: Cengage Learning, Inc; 3rd ed. edition (25 August 2010) eISBN: 9780495416657
2. Coppola P Damon, 2007. Introduction to International Disaster Management, Carter, Nick 1991. eISBN: 9780123738900.

Reference Books

1. Government of India, Ministry of Home Affairs, National Disaster Management Division, 2004, Disaster Management in India – A Status Report eISBN:
2. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012) eISBN:

Web links

1. <https://www.msajce-edu.in/academics/civil/LectureNote/GE8071-LN.pdf>
2. <https://egyankosh.ac.in/bitstream/123456789/112449/1/Unit-2.pdf>

UNIVERSITY 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
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, 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
Total			19		13	32					

Artificial Intelligence

Course Code: 2501AI02

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Illustrate the historical development of AI, key milestones and contributors.
- CO2:** Apply the basic principles of AI in problem solving
- CO3:** Apply Local Search Algorithms and Optimization Techniques.
- CO4:** Choose the appropriate representation of Knowledge.
- CO5:** Summarize the expert systems and real time applications

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Introduction: What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Practice:

1. Introduction to LISP :
 - To demonstrate simple recursive functions and list manipulation in LISP
2. Introduction to Prolog :
 - Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

UNIT-II

Problem formulation: Problem Definition Production systems, Control strategies, Search strategies. Problem characteristics, Problem Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies

Practice:

1. Implementation of DFS for water jug problem using LISP/PROLOG
2. Implementation of BFS for tic-tac-toe problem using LISP/PROLOG

UNIT-III

Problem solving methods: Problem graphs, Matching, Indexing and Heuristic functions Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

Practice:

1. Implementation of TSP using heuristic approach using LISP/Prolog
2. Implementation of Hill climbing to solve 8 Puzzle Problem

UNIT-IV

Knowledge representation: Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic Structured representation of knowledge Basic plan generation systems – Strips Advanced plan generation systems – K strips Strategic explanations Why, why not and how explanations.

Practice:

1. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.
2. Create a frame based representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

UNIT – V

Expert Learning: Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Practice:

1. Using PYTHON / LISP , develop an expert system to help users plan travel itineraries, including transportation, accommodation, and activities. Utilize knowledge about travel destinations, transportation options, and user preferences to generate personalized travel plans.
2. Using PYTHON / LISP , create an expert system to assist students in selecting courses, majors, or career paths based on their interests, skills, and academic performance. Use knowledge about educational programs, career prospects, and academic requirements to make personalized recommendations.

Text Books:

- 1 Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig , Pearson, 3rd Edition, ISBN: 978-9332543515
- 2 Artificial Intelligence: Structures and Strategies for Complex Problem Solving by George F. Luger, 2nd Edition, ISBN: 978-0805347807

Reference Books:

- 1 Artificial Intelligence, Saroj Kaushik, Cengage Learning India, ISBN: 978-8131510995
- 2 Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill, ISBN: 978-0-07-052263-3
- 3 Artificial Intelligence: Foundations for Computational Agents, David Poole and Alan Mackworth, Cambridge University Press, ISBN: 978-1107195394

Web Links:

- 1 <https://nptel.ac.in/courses/106105077>
- 2 <https://nptel.ac.in/courses/106106126>
- 3 <https://aima.cs.berkeley.edu>

Machine Learning

Course Code: 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 Jupiter/Spider notebook and working on basic commands.
2. Loading and apply key preprocessing techniques on the dataset and also analyse the dataset.

UNIT-II

Supervised Learning(Regression/Classification):Basic Methods:

Concept Learning: General-to-Specific Hypotheses Ordering, Find-S and Candidate Elimination Algorithm, Version Space, and Inductive Bias.

Bayesian Learning: Probability Overview, MLE and MAP Estimates, Gaussian Naive Bayes Classifier, Bayesian Networks.

Instance-based Learning: k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN, Distance Metrics and Curse of Dimensionality.

Practice:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Exercises to solve the real-world problems using Binary Classifier

4. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

UNIT-III

Linear Models and Regression: Linear Classification, Linear Regression, Non-linear Transformation, Logistic Regression.

Support Vector Machines: Decision Boundary and Support Vector: Optimization and Primal-Dual Problem, Soft Margin and Non-linear Decision Boundary, Kernel Functions and Radial Basis Functions introduction.

Practice:

1. Exercises to solve the real-world problems using Linear Regression
2. Exercises to solve the real-world problems using Logistic Regression
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients.

UNIT-IV

Classifier / Hypothesis Evaluation: Accuracy, Precision, Recall and F-Measures, Scores, Sampling, Bootstrapping and ROC, Hypotheses Testing and Cross-validation.

Unsupervised Learning:

Clustering : Partitional Clustering and Hierarchical Clustering, Cluster Types, Attributes and Salient Features, Hierarchical and Density-based Clustering Algorithms, Inter and Intra Clustering Similarity, Cohesion and Separation. MST and DBSCAN Clustering Algorithms.

Practice:

1. Develop a program for Bias, Variance, Remove duplicates , Cross Validation
2. Write a program to implement One-hot Encoding.
3. Write a program to implement Categorical Encoding.

UNIT – V

Ensemble Learning : Bagging and Boosting, Adaboost and Random Forest ,

Computational Learning Theory : Error and Noise Formalisms, Training vs. Testing, Theory of Generalization, PAC Learnability and VC Dimensions , Overfitting, Regularization and Validation.

Practice:

1. Write a program to demonstrate the working of Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
2. Use a sentiment analysis dataset from Twitter or other social media platforms, available on platforms like Kaggle and apply bagging and boosting techniques for prediction.

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Capstone Project:
Student Performance Prediction System

Objective: Predict a student's performance (pass/fail or score range) based on input features like study time, attendance, past grades, family background, etc.

Domain: Education

Techniques & Concepts Used:

- Supervised learning (Classification – Logistic Regression, SVM)
- Data preprocessing (handling nulls, encoding categorical variables)
- Evaluation metrics (accuracy, precision, recall)

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: 2501AI27

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the historical evolution, architecture, tools and applications of AI
- CO2:** Explain the fundamentals of Data Science, including its need, processes, and tools
- CO3:** Utilize pandas for effective data handling, including data structures, indexing, filtering, data summarization, and handling missing data.
- CO4:** Develop skills in data loading, storage, and file format management
- CO5:** Develop proficiency in data visualization techniques using Matplotlib

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Introduction to AI: Historical Evolution and AI today, Architecture of AI Systems, Theory (Knowledge, Logic, Search, Reasoning, Planning, Learning), Tools and Applications, Interface (Sensing, Actuation, Control), Domains and Scope of AI Applications, Inter-disciplinary Problem Solving, Intelligent/Expert Knowledge based Systems, Case-studies and Success Stories.

Practice:

1. Create a basic AI system architecture using a knowledge-based or expert system for a simple medical diagnosis system.

UNIT-II

Introduction To Data Science: Need for Data Science – What is Data Science Data Science Process – Business Intelligence and Data Science – Prerequisites for a Data Scientist – Tools and Skills required.

NumPy Basics: The NumPy ndarray: A Multidimensional Array Object, creating ndarrays, Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and Slicing, Boolean Indexing, Fancy Indexing, Data Processing Using Arrays, Expressing Conditional Logic as Array Operations, Methods for Boolean Arrays, Sorting, Unique

Practice:

1. Perform various data manipulation tasks using NumPy, such as creating multidimensional arrays, conducting operations between arrays, indexing, slicing, and applying Boolean and fancy indexing

UNIT-III

Getting Started with pandas: Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, Data Frame, Index Objects, Essential Functionality Reindexing, dropping entries from an axis, Indexing, selection, and filtering, Sorting and ranking, Summarizing and Computing Descriptive Statistics, Unique Values, Value Counts, Handling Missing Data, filtering out missing data.

Practice:

1. Analyse the dataset to derive meaningful insights, such as summarizing data trends or finding unique values

UNIT-IV

Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format, Reading TextFiles in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice:

1. Load data from multiple formats, including text files, JSON, XML, and Excel, and store it in various formats such as HDF5 or MongoDB

UNIT – V

Plotting and Visualization: A Brief matplotlib lib A PIprimer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, Plotting Functions in pandas, Line Plots, Bar Plots, Histograms and Density Plots, Scatter Plots.

Practice:

1. Create various plots (line, bar, histogram, scatter) using Matplotlib and pandas to visualize data from a dataset.

Text Books:

- 1 Python for Data Analysis, Wes McKinney, O'REILLY, 1st Edition, ISBN:978-1-449-31979-3
- 2 Doing Data Science, Rachel Schutt & O'neil, O'REILLY, 1st Edition, ISBN:978-1-449-35865-5

Reference Books:

- 1 Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media, ISBN : 978-9352130962
- 2 Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , Matt Harrison, O'Reilly, ISBN : ISBN 153359824X.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc24_cs133/preview
- 2 https://onlinecourses.nptel.ac.in/noc24_cs68/preview
- 3 <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>

AI in Health Care

Course Code: 2501AI28

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 HealthcareA Practical Introduction, Christo El Morr, Hossam AliHassan, 2019, ISBN : 978-3030045050

Web Links:

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

Deep Learning

Course Code: 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	-	-

UNIT-I

DEEP LEARNING CONCEPTS: Fundamentals about Deep Learning, Perception Learning Algorithms, Probabilistic modelling, Early Neural Networks, How Deep Learning different from Machine Learning, Scalars. Vectors, Matrixes, Higher Dimensional Tensors, Manipulating Tensors. Vector Data, Hyper parameters Vs Parameters - validation sets - Estimators, Bias, Variance, Overfitting and Underfitting, Introduction to Keras and TensorFlow and PyTorch.

Practice:

1. Installation and basic commands of scikit, TensorFlow and PyTorch
2. Implement Random Forest by using scikit, TensorFlow and PyTorch
3. Implement multilayer perceptron algorithm for MNIST Handwritten Digit Classification

UNIT-II

NEURAL NETWORKS: About Neural Network, Building Blocks of Neural Network, Introduction to Neural Networks, Feed-forward Networks, Deep Feed-forward Networks - Learning XOR, Gradient Based learning, Hidden Units, Back-propagation and other Differential Algorithms, Data Pre-processing for neural networks, Feature Engineering.

Practice:

1. Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
2. a) Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset
b) Design a neural network for predicting house prices using Boston Housing Price dataset.

UNIT-III

OPTIMIZATION TECHNIQUES: Optimizers – SGD (Stochastic Gradient Descent), Mini-batch Gradient Descent, MS prop (Root Mean Square Propagation), Adagrad (Adaptive Gradient Algorithm), Adadelta (Adaptive Delta), Adam (Adaptive Moment Estimation), Adamax (Adaptive Moment Estimation with Infinity Norm).

Activation Functions : sigmoid, tanh, ReLU, leaky ReLU, Soft Max, Linear Loss Functions - cross-entropy loss, the mean-squared error, the Huber loss, the hinge loss, L2 loss, mean absolute loss Regularization – L1, L2 and drop out. Learning Rate, Normalization

Practice:

1. Implement word embeddings for IMDB dataset.
2. Implement one hot encoding of words or characters.
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients. Also apply the optimization techniques.
4. Write a Python program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set

UNIT-IV

CONVOLUTIONAL NEURAL NETWORK: About CNN, Building a convolutional neural network, Input Layers, Convolution Layers, Pooling Layers, Dense Layers, Backpropagation Through the Convolutional Layer, Filters and Feature Maps, Backpropagation Through the Pooling Layers, Dropout Layers and Regularization, Batch Normalization

Pre trained CNN: LeNet, Alex Net, VGG16, ResNet.

Practice:

1. Build a Convolution Neural Network for MNIST Handwritten Digit Classification.
2. a) Use a pre-trained convolution neural network (VGG16) for image classification
b) Build a Convolution Neural Network for simple image (dogs and Cats) Classification
3. Student Portfolio Creation using GitHub, Hugging Face & Kaggl

UNIT – V

RNN

Recurrent Neural Networks ,Sequence-to-Sequence Modelling – Embedding - Recurrent Neural Networks - Bidirectional RNNs, Analysing Variable Length Inputs – Tackling seq2seq Problem – Beam Search and Global Normalization – Recurrent Neural Networks (RNN)– Hidden States – Perplexity – Character-level Language Models –Modern RNNs: Gated Recurrent Units (GRU), Long Short-Term Memory (LSTM).

Practice:

1. Implement a Recurrent Neural Network for IMDB movie review classification problem.
2. Implement Boosting algorithms using scikit, Tensorflow and PyTorch

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.

2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

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, DouweOsinga, 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:

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

UNIT – I

Overview of Natural Language Processing, Natural Language Processing and Python: Understanding Natural language Processing and applications, NLTK, Corpus and Dataset, understanding structure of sentence Defining Context free grammar, Morphological Analysis

Practice:

1. Word Analysis Learn about morphological features of a word by analysing it
2. Word Generation generate word forms from root and suffix information.

UNIT – II

Syntactic Analysis, Semantic analysis, Ambiguity resolution, Discourse integration, Preprocessing tokenization, stemming, lemmatization, Word tokenization and lemmatization

Practice:

1. Implement Porter Stemming Algorithm
2. NGrams learn to calculate bigrams from a given corpus and calculate probability of a sentence

UNIT – III

Feature engineering and NLP algorithms parsers, context free grammars, different types of parsers, POS tagging and different types of POS parsers.

Practice:

1. Morphology understanding the morphology of a word by the use of AddDelete table.
2. POS Tagging – calculate emission and transition matrix which will be helpful for tagging Parts of Speech

UNIT – IV

Basic statistical features of NLP: TFIDF, Vectorization Encoders and Decoders, Normalization, Advanced feature engineering and NLP algorithms Basics of Word2Vec

Practice:

1. Apply term frequency(TFIDF) to Measures the importance of a word to a specific document
2. Implement word embedding using word2vec

UNIT – V

Rule Based system for NLP, Machine Learning for NLP problems, Applications of NLP Text Summarization, Sentiment Analysis

Practice:

1. Chunking understand the concept of chunking and get familiar with the basic chunk tag set.
2. Building Chunker the importance of selecting proper features for training a model and size of training corpus in learning how to do chunking.

Text Books:

- 1 Python Natural Language Processing, Thanaki J, Packt Publishing Ltd, ISBN: 9781787121423
- 2 Springer Handbook of Speech Processing, Jacob Benesty, M. M. Sondhi, Yiteng Huang Springer, ISBN: 978-3-540-49127-9

Reference Books:

- 1 Speech & language processing, Jurafsky D, Pearson Education India, ISBN: 978-9332518414
- 2 Foundations of Statistical Natural Language Processing, Christopher, D. Manning and Hinrich Schütze, MIT Press, ISBN: 9780262133609

Web Links:

- 1 <https://www.nltk.org/data.html>
- 2 <https://www.analyticsvidhya.com/blog/2017/01/ultimateguidetounderstandimplemenntnaturallanguageprocessingcodesinpython/>
- 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	-	-

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. Bart., 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 tillage; Uniformity prediction for sowing, planting and transplanting; Crop disease detection, quantification of severity and mitigation; crop yield monitoring, and prediction of harvesting and threshing quality; AI for farm machinery management and custom hiring.

Practice:

1. Create a model using AI to navigate farm machinery and predict energy demand for various farm tasks.

UNIT – V

AI for Food Processing: Application of AI and ML in food processing and packaging. Non-destructive quality evaluation of food based on spectral data, Image based quality detection, varietal identification of fruits and vegetables, sorting of products and packages, decision making for the consumers and profit enhancement by the industry people by proper market survey using AI, new product formulation.

Practice:

1. Implement an AI solution for non-destructive quality evaluation of food products based on spectral data.

Text Books:

- 1 Artificial Intelligence in Agriculture: A Comprehensive Guide, Rajesh Singh, Anita Gehlot, and Lakhveer Kaur, 2021, ISBN: 978-1119714743.
- 2 Artificial Intelligence in Agriculture: A Systems Approach, Mohammad Naushad Emmambux, 2023 ISBN: 978-9819925243.

Reference Books:

- 1 Data Science and Artificial Intelligence for Agricultural Applications S. Raja, P. Vignesh, and R. Bhuvaneshwari, 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

Course Outcomes:

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

- 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:

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

Practice:

- 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)

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- Research Project: Analyze the impact of Industry 4.0 technologies on production excellence
- Case Study: Application of 3D printing in production optimization

Text Books:

- 1 Lean Thinking: Banish Waste and Create Wealth in Your Corporation, James P. Womack and Daniel T. Jones, Free Press, ISBN: 978-0743249270
- 2 The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, Jeffrey Liker, McGraw-Hill, ISBN: 978-0071392310

Reference Books:

- 1 Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, Mikel Harry and Richard Schroeder, Crown Business, ISBN: 978-0385494380
- 2 Production and Operations Analysis Steven Nahmias, Waveland Press, Inc., (7th Edition ,ISBN: 978-1478623069
- 3 Smart Manufacturing: Industry 4.0 and the Industrial Internet of Things, John Soldatos, Oliver Niggemann, and Thorsten Lehmhus, CRC Press,ISBN: 978-0367332336

Six Sigma for Production Excellence

Course Code: 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:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	-	2	-	1	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

Practice:

- 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

Practice:

- 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)

Practice:

- 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)

Practice:

- 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

Practice:

- 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

Text Books:

- 1 The Six Sigma Handbook, Thomas Pyzdek and Paul Keller, McGraw-Hill Education, 5th Edition, ISBN: 978-1260121827
- 2 Lean Six Sigma and Minitab: The Complete Toolbox Guide for Business Improvement, Quentin Brook, OPEX Resources, ISBN: 978-0954681388

Reference Books:

- 1 Six Sigma for Managers, Greg Brue, McGraw-Hill, ISBN: 978-0071455480
- 2 Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions, Michael George, McGraw-Hill, ISBN: 978-0071418218
- 3 Design for Six Sigma: A Roadmap for Product Development, Kai Yang and Basem El-Haik, McGraw-Hill, ISBN: 978-0071547673

Quality Excellence in Production

Course Code: 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

Practice:

- 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

Practice:

- 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

Practice:

- Research Paper: How ISO 9001 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

Practice:

- 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

Practice:

- Research Project: Quality by Design in modern manufacturing
- Presentation: The impact of Industry 4.0 on quality management in production

Text Books:

- 1 Juran's Quality Handbook: The Complete Guide to Performance Excellence, Joseph A. De Feo and J.M. Juran, McGraw-Hill Education, 7th Edition, ISBN: 978-1259643613
- 2 Quality Control and Management, James R. Evans and William M. Lindsay, Cengage Learning, ISBN: 978-1305662544

Reference Books:

- 1 The Certified Six Sigma Green Belt Handbook, Roderick A. Munro, Govindarajan Ramu, Daniel J. Zrymiak, ASQ Quality Press, ISBN: 978-0873898911
- 2 The Lean Six Sigma Pocket A Quick Reference Guide to Nearly 100 Tools for Improving Quality and Speed, Michael L. George, John Maxey, David Rowlands, McGraw-Hill, ISBN: 978-0071441193
- 3 Total Quality Management and Operational Excellence: Text with Cases, John S. Oakland, Routledge, ISBN: 978-1138198006

Digital Transformation for Production Excellence

Course Code: 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

Practice:

- 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.

Practice:

- 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

Practice:

- 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

Practice:

- 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.

Practice:

- 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

Text Books:

- 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

Course Outcomes:

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

- CO1:** Identify key differences between traditional, lean, and agile production systems.
- CO2:** Describe core strategies and technologies used in agile manufacturing.
- CO3:** List characteristics and components of an agile supply chain.
- CO4:** Demonstrate the use of Scrum or Kanban in managing a production task.
- CO5:** Explain how emerging technologies support agile and sustainable 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	3	2	-	-	-	-	-	-	-	-	-
CO2	2	-	3	-	2	-	-	-	-	-	-
CO3	-	2	-	-	1	1	-	-	-	-	-
CO4	-	-	1	2	2	-	-	2	2	2	-
CO5	2	-	-	-	-	3	-	-	-	-	2

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

Practice:

- 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)

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- Group Presentation: The impact of Industry 4.0 technologies on agile production
- Final Project: Develop a sustainable agile production system for a manufacturing company

Text Books:

- 1 Agile Manufacturing: Forging New Frontiers, Paul T. Kidd, Addison-Wesley Professional, ISBN: 978-0201631634
- 2 Agile Manufacturing: The 21st Century Competitive Strategy, A. Gunasekaran, Elsevier, ISBN: 978-0080435671

Reference Books:

- 1 Manufacturing Systems and Technologies for the New Frontier: The 41st CIRP Conference on Manufacturing Systems, Mamoru Mitsuishi, Kanji Ueda, Fumihiko Kimura, Springer, ISBN: 978-1848002661
- 2 Agile Supply Chain: Integrating Suppliers and Customers into the Network, Pamela Danese, Pietro Romano, Springer, ISBN: 978-1849960809
- 3 The Lean Mindset: Ask the Right Questions, Mary Poppendieck, Tom Poppendieck, Publisher: Addison-Wesley, ISBN: 978-0321896902

Process Excellence & Optimization

Course Code: 2501ME86

L	T	P	C
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

Practice:

- 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

Practice:

- 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,

Practice:

- 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

Practice:

- 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.

Practice:

- 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

Text Books:

- 1 "Process Optimization: A Statistical Approach", Ignacio Castillo, Michael A. O'Neill, Springer, ISBN: 978-144715292

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

Practice:

- 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,

Practice:

- 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

Practice:

- 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

Practice:

- 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,

Practice:

- Research Project: The impact of emerging technologies on risk management in production
- Final Project: Develop a comprehensive risk management strategy for a production organization

Text Books:

- 1 "Risk Management in Production: A Comprehensive Guide", Chris M. Hertig, Wiley, ISBN: 978-11194775

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,

Practice:

- 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,

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Textbooks

- 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)

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Text Books:

- 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: 2501ME58

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, 2010
- 3 Hans Bernhard Kief, Helmut Roschiwal, Karsten Schwarz, “The CNC Handbook: Digital Manufacturing and Automation from CNC to Industry 4.0”, Industrial Press Inc., U.S. ISBN 0831136367, Nov 2021
- 4 Janya Chanchaichujit, Albert Tan, Fanwen Meng, Sarayoot Eaimkhong, “Healthcare 4.0 Next Generation Processes with the Latest Technologies”, Palgrave Pivot, 2019, ISBN 978-981-13-8113-3

Web Links:

- 1 <http://www.mqtt.org/>
- 2 <https://opcfoundation.org/about/opc-technologies/opc-ua/>
- 3 <https://www.ethercat.org/default.htm>

Cost Excellence in Production

Course Code: 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:

CO/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	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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- Research Project: Future trends and challenges in cost management for production
- Final Project: Develop a comprehensive cost management strategy for a production organization

Text Books:

- 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
2501MB17	Introduction to Supply Chain Management	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT,AI ML, CSE(DS),PT,Min.E	-
2501MB18	Logistics & Distribution Management	FC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS),PT,Min.E	ISCM
2501MB19	Supply Chain Project Management	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB20	Supply Chain Innovation & Trends	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB21	Supply Chain Analytics	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB22	Demand Planning & Forecasting	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB23	Supply Chain Risk Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB24	Inventory Management & Control	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB25	E-Commerce & Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, CSE(DS), PT,Min.E	ISCM
2501MB26	Operations Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AI ML, 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, AI ML, CSE(DS), PT,Min.E	ISCM
Total			32			32					

Introduction to Supply Chain Management

Course Code: 2501MB17

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Analyze 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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-	-	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-0078096642
- 2 World Class Supply Management, Burt, Dobbler, Starling, TMH., 2019, ISBN-0070499330.

Reference Books:

- 1 Logistical Management, Donald J Bowersox, David J Closs, TMH, 9th Edition, ISBN-9780070435544
- 2 Reguram G, Rangaraj N., Logistics and Supply Chain Management Cases and Concepts: Macmillan India Ltd., New Delhi, ISBN-9780070221635.

Web Links:

- 1 <https://archive.nptel.ac.in/courses/110/105/110105141/>
- 2 <https://www.youtube.com/watch?v=Nrl0CtS1m8Y>

Logistics & Distribution Management

Course Code: 2501MB18

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the history and importance of Logistics
- CO2:** Explore the role of Logistics Management and its process.
- CO3:** Identify the need and scope of Distribution Management.
- CO4:** Examine different channels and policies of Distribution
- CO5:** Assess the strategies for Logistics and Distribution in global economy.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	1	-	-	-	-	-
CO2	-	1	-	-	-	1	-	-	-	-	-
CO3	-	1	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	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, 2004
- 2 Krishna K. Havaladar, Vasant M. Cavale Sales & Distribution Management McGraw Hill Latest Edition

Supply Chain Project Management

Course Code: 2501MB19

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the types project selection models
- CO2:** Describe project planning and organization
- CO3:** Apply the networking techniques
- CO4:** Examine the project control processes
- CO5:** Assess the role of project auditing

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	-	-	-	1	-	-	-	1	-
CO2	-	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.

Reference Books:

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 delhi 2010

Supply Chain Innovation & Trends

Course Code: 2501MB20

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 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	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	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 2008.

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	-	-	-	-	1	-	-	-	-	-
CO2	2	2	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: 0133800202
2. Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain by Michael Watson, Sara Lewis, Peter Cacciopi, Jay Jayaraman. 1st Edition. ISBN: 0133017370

Demand Planning & Forecasting

Course Code: 2501MB22

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Explain the concept of Demand Planning and how does it work.
- CO2:** Identify different steps involved in Demand Planning.
- CO3:** Analyze the different factors that influence Demand Forecasting.
- CO4:** Interpret various methods of Demand Forecasting.
- CO5:** Differentiate Demand Planning and Demand Forecasting.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	-	1	-	-	-	-	-
CO2	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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	-	-	1	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:9781040084625.

Web Links:

1. http://ndl.iitkgp.ac.in/he_document/nptel/nptel/courses_110_108_110108056_video_lec9
2. http://ndl.iitkgp.ac.in/he_document/nptel/courses_110_108_110108056_video_lec11

Inventory Management & Control

Course Code: 2501MB24

L	T	P	C
3	0	0	3

Course Outcomes:

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	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	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-978-8120300279
2. Handbook of Materials Management, Gopalakrishnan P. and Sanderashan M New Delhi prentice Hall of India, ASIN : B00K7YGKRQ.

Reference Books:

1. Proactive Procurement, Burt, David N, Englewood Cliffs, New Jersey, Prentice Hall Inc, ISBN-0137114656.
2. Purchasing and Material Management, Dobler, D.W. etc., New York, McGraw Hill, ISBN-0070370478

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105095/>
2. https://onlinecourses.nptel.ac.in/noc20_mg17/preview

E-Commerce & Supply Chain Management

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	-	1	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*: 978-0074637425 *ISBN-10*: 0074637428.
- 2 Wisner, Keong Leong and Keah-Choon Tan, PRINCIPLES OF SUPPLY CHAIN MANAGEMENT A BALANCED APPROACH, Thomson Press

Operations Management

Course Code: 2501MB26

L	T	P	C
3	0	0	3

Course Outcomes:

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	-	-	1	-	-	-	-	-
CO2	2	2	-	-	-	1	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-9780070583559 .
- 2 K Aswathappa& Sridhar Bhatt, Production & Operations Management, Himalaya, Mumbai, ISBN-13: 978-9350971888.

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_me30/preview
- 2 <https://archive.nptel.ac.in/courses/110/107/110107141/>

Supply Chain Ethics & Corporate Social Responsibility (CSR)

Course Code: 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	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	-	-	-	-
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/110/105/110105079/>
2. https://onlinecourses.swayam2.ac.in/cec19_mg24/preview

Sustainability											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-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					

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	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	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

Concept and Scope of Sustainable Development: Introduction to sustainable development Concept, nature and scope of Sustainable development. Globalisation and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty.

UNIT-II

Social Development and Participatory Approaches: 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

Human Development and Deprivation: 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

Governance, Decentralization, and Policies: 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

Role of CBOs, NGOs, Law, Education, and Media: Emerging of role of CBOs and NGO and human rights institutions. Role of law, education, media and international organisations.

Text Books:

1. Agrawal, A N . Indian Economy: Problems of development and planning. pune: Wishwa Prakashan. ISBN: 978-8122437959
2. Baldev Raj Nayar, Globalization and Nationalism: The Changing Balance Of India's Economic Policy. ISBN : 978-0761995364

Reference Books:

1. Urbanization in Developing Countries Basic Services and community Participation, Bidyut Mohanty , Institute of Social Science, Concept Publishing House. ISBN-10. 8170224756
2. Development Experience in the Indian Economy: Inter-State Perspectives, Brahmananda, P.R. and V.R. Panchmukhi (Eds.), Bookwell, Delhi. ISBN: 81-85040-35-4

Natural Disaster Management & Mitigation

Course Code: 2501CE66

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Explain the aspects of disaster management and adopt remedial measures.
- CO2:** Explain disaster risk assessment and coping measures.
- CO3:** Explain the vulnerability conditions.
- CO4:** Assess the impact of hazards on structures.
- CO5:** Adopt the rehabilitation procedures.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

UNIT – II

Overview of Disaster Situations: Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS- spread and transmissions -pandemic, endemic and epidemic.

UNIT – III

Flood: Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management-integrating technology and people.

UNIT – IV

Overview of Disaster Situations: Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

UNIT – V

Cyclone and Fire Disaster: Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

Text Books:

1. Disaster Management, RB Singh (Ed), Rawat Publications. (ISBN: 13- 978-8131600337).
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house. (ISBN: 13- 978-8189866464).

Reference Books:

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill. (ISBN:13-9780074631881).
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose. (ISBN:13- 978-0953614011).
3. Anthropology of Disaster management, Sachindra Narayan, Gyan Publishing house. (ISBN: 13- 978-8121206839).

Web Links:

1. https://www.iare.ac.in/sites/default/files/lecture_notes/dm%20notes.pdf

Waste Water Management

Course Code: 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: 13-978-0073401188).
2. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill, 2018. (ISBN: 13- 978-0070495395).

Reference Books:

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications. (ISBN: 978-81-7409-230-4)
2. Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi. (ISBN:13- 9788120336001)
3. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. New Delhi. (ISBN: 13- 978-8121915472).
4. Wastewater Treatment for pollution control and Reuse, Soli J Areivala, Sham R Asolekar, Mc- GrawHill, New Delhi. (ISBN: 9780070620995).

Web Links:

1. https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf
2. <http://www.civil.iitm.ac.in/dwww/sites/default/files/presentations>
3. https://www.researchgate.net/publication/221911472_Wastewater_Management

Integrated Solid Waste Management for A Smart City

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. AarneVeslind, Cengage Learning, 2nd Edition(SI Edition). (ISBN: 13- 978-8131520420).
2. Integrated Solid Waste management, George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Tata McGraw Hill. (ISBN: 13- 978-0070632370).

Reference Books:

1. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization (CPHEEO), India.
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website
3. Construction and Demolition Waste Management Rules, 2016, MoEF&CC
4. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.

Web Links:

1. <https://nptel.ac.in/courses/105/105/105105160/>
2. <http://swachhbharatmission.gov.in/sbmcms/index.html>
3. <http://swachhbharaturban.gov.in/>

Watershed Management

Course Code: 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: 9781420088700).

Reference Books:

- 1 Energy efficient electric motors by John. C. andreas - Marcel Dekker Inc Ltd-2nd edition (ISBN: 9781489914675).
- 2 Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition (ISBN: 9780077076788).

Web Links:

- 1 <https://nptel.ac.in/courses/108106022/>
- 2 <https://nptel.ac.in/courses/112105221/>
- 3 https://onlinecourses.nptel.ac.in/noc17_mm17/preview

Electric Power Generation, Transmission & Distribution Systems

Course Code: 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: 9788177000207).
2. Generation, Distribution & Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers (ISBN: 9789393159175).

Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 9780070151413).

Web Links:

1. <https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant>
2. <https://www.euronuclear.org/1-information/energy-uses.html>
3. <https://www.slideshare.net/9anku/electrical-distribution-system>

Sustainable Agriculture & Food Systems

Course Code: 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	PO 10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

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	PO 10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

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

Practice:

- 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

Practice:

- Research Project: Evaluate the sustainable procurement strategy of a specific company
- Individual Assignment: Develop a sustainable supplier selection criterion

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 14001, Water and energy conservation practices

Carbon Footprint in Production: Measuring and reducing carbon footprints, Carbon accounting and management,

Practice:

- 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

Practice:

- 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

Practice:

- Group Project: Develop a sustainability scorecard for a company's supply chain
- Final Exam: Comprehensive evaluation of SSCM principles and practices

Textbooks

- 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: 2501CE77

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	PO 10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

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

Practice:

- 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

Practice:

- 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)

Practice:

- 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 14001 and its implementation in production environments, Continuous improvement in EMS, Auditing and monitoring for environmental compliance

Sustainability Reporting and Certifications: Key certifications: LEED, Energy Star, ISO 50001, etc. Importance of sustainability reporting (GRI, CDP, etc.), Regulatory frameworks and standards for sustainable production

Corporate Social Responsibility (CSR) and Production: Role of CSR in promoting sustainability in production, Social responsibility of companies toward stakeholders

Practice:

- 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

Practice:

- 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	PO 10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- 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

Practice:

- 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		7	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:

1. 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:

1. 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: 978-0071776165
- 3 Securing DevOps: Security in the Cloud by Julien Vehent
ISBN: 978-1617294136

Web Links:

- 1 <https://www.coursera.org/specializations/cyber-security>.
- 2 <https://www.nptel.ac.in/courses/106105031/>.
- 3 CERT-In Guidelines- <http://www.cert-in.org.in/>

Ethical Hacking

Course Code: 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, Hactivism - 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:

1. 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:

1. 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:

1. Implement SSL handshake simulation in Python

UNIT – V

Modern Cryptographic Challenges and Future Trends: Quantum cryptography and post-quantum cryptography, Zero-knowledge proofs, Cryptanalysis: Attacks on cryptosystems (brute-force, side-channel attacks), Future trends in cryptography

Text Books:

- 1 Cryptography and Network Security: Principles and Practice by William Stallings
ISBN: 978-0134444284
- 2 Network Security Essentials: Applications and Standards by William Stallings
ISBN: 978-0134527338

Reference Books:

- 1 Understanding Cryptography: A Textbook for Students and Practitioners by Christof Paar, Jan Pelzl
ISBN: 978-3642041006
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C by Bruce Schneier ISBN: 978-1119096720
- 3 Post-Quantum Cryptography by Daniel J. Bernstein, Johannes Buchmann
ISBN: 978-3540887027

Web Links:

- 1 <https://www.openssl.org>
- 2 <https://cryptography.io>
- 3 <https://www.nist.gov>

Security Awareness and Social Engineering

Course Code: 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:

1. 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:

1. Perform a risk assessment for a small business, identifying potential security threats and designing mitigation strategies.

Text Books:

- 1 Security Awareness: Applying Practical Security in Your World
Author: Mark Ciampa Publisher: Cengage Learning ISBN: 978-1305500372
- 2 The Art of Deception: Controlling the Human Element of Security
Author: Kevin, D.Mitnick, Publisher: Wiley, ISBN: 978-0764542800

Reference Books:

- 1 Social Engineering: The Science of Human Hacking, Author: Christopher Hadnagy, Publisher: Wiley, ISBN: 978-1119433385

Cyber Security Policy and Strategy

Course Code: 2501IT39

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the key elements of cybersecurity policies and strategies.
- CO2:** Analyze global cybersecurity frameworks, laws, and regulations
- CO3:** Develop a cybersecurity risk management strategy for an organization.
- CO4:** Propose policies for safeguarding critical infrastructure.
- CO5:** Evaluate legal, ethical, and privacy issues in the context of cybersecurity.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Introduction to Cybersecurity Policies and Strategies: History and evolution of cybersecurity policies, Key concepts: threat landscape, vulnerabilities, risk, and controls, Cybersecurity governance models, Role of stakeholders: governments, organizations, and international bodies.

UNIT-II

Cybersecurity Governance and Risk Management: Frameworks for cybersecurity governance (NIST, ISO 27001, etc.), Enterprise risk management and cybersecurity, risk assessment, risk tolerance, and risk mitigation strategies
Role of leadership and organizational culture

UNIT III

National and International Cybersecurity Strategies: National cybersecurity strategies: US, EU, India, and other regions, International organizations in cybersecurity: UN, ITU, NATO, Cyber norms and diplomatic strategies, Cyber warfare and state-sponsored cyber activities

UNIT IV

Legal, Regulatory, and Compliance Frameworks: Data protection laws (GDPR, CCPA, etc.), Regulatory frameworks: HIPAA, PCI-DSS, SOX, Cybersecurity compliance challenges, Legal implications of cyber incidents

UNIT V

Emerging Issues in Cybersecurity Policy: Ethical issues in cybersecurity, The role of Artificial Intelligence (AI) and Machine Learning (ML), Cyber insurance and financial risks

Text Books:

- 1 Cybersecurity and Cyberwar: What Everyone Needs to Know, P.W. Singer and Allan Friedman, Oxford University Press, 2014, 978-0199918119
- 2 Cybersecurity Policy Guidebook, Jennifer L. Bayuk, Jason Healey, Paul Rohmeyer, John Wiley & Sons, 2012, 978-1118027806

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc23_cs127/preview
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Security in Emerging Technologies

Course Code: 2501IT40

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: 978-3030723006.

Reference Books:

- 1 Security and Privacy in Financial Cloud" by Kuan-Ching Li, CRC Press, ISBN: 978-0367337420.
- 2 Cybersecurity for Financial Services" by Siraj A. Shaikh, George Loukas, and David Haynes, Springer, ISBN: 978-1119569369.

Web Links:

- 1 <https://www.nist.gov/cyberframework>
- 2 <https://owasp.org>
- 3 <https://www.pcisecuritystandards.org>

Others											
Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Offered to Programs	Pre-requisite
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

Course Code:2501CE80

L T P C
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- 978-8170087960).

Web Links:

1. http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
2. <https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg>
3. <https://nptel.ac.in/downloads/105108077/>

Electric Energy Storage Systems

Course Code: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	-	-	-	-	-	-	-	-

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/108103009>

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: 9780071745130)
2. "Electric Safety Practice & Standards", Khaled Ismail, CRC Press, Taylor & Francis (ISBN: 9781138073999).

Reference Books

1. 'Electrical Safety- a guide to the causes & prevention of electric hazards', Maxwell Adams.J, The Institution of Electric Engineers, IET (ISBN: 9780852968062).
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning (ISBN: 9780877655800).

Web Links:

1. <http://nptel.ac.in/courses/103106071/5>
2. <https://www.electricalsafetyfirst.org.uk>

Hybrid & Electric Vehicles

Course Code:2501EE54

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Describe the History of Hybrid Electric vehicles
- CO2:** Classify the various electric drivetrain topologies
- CO3:** Articulate the Energy Storage Requirements in Hybrid & Electric Vehicles
- CO4:** Illustrate the Charging Infrastructure
- CO5:** Evaluate Energy Management Strategies used in hybrid & electric vehicle

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Introduction to Hybrid Electric Vehicles: History of hybrid & electric vehicles, social & environmental importance of hybrid & electric vehicles, impact of modern drive-trains on energy supplies-Challenges & Key Technologies of EVs – Challenges for EV Industry in India

UNIT – II

Electric Drive-trains: Basic concept of electric traction - introduction to various electric drivetrain topologies - Power flow control in electric drive-train topologies - fuel efficiency analysis

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, configuration and control of Induction Motor drives, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.

UNIT – III

Energy Storage: Introduction to Energy Storage Requirements in Hybrid & Electric Vehicles -Battery based energy storage & its analysis - Fuel Cell based energy storage & its

analysis - Super Capacitor based energy storage- Flywheel based energy storage & its analysis.

UNIT – IV

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

UNIT – V

Energy Management Strategies: Introduction to Energy Management Strategies used in hybrid & electric vehicle, Classification of different Energy Management strategies - Comparison of different Energy Management Strategies - Implementation issues of energy strategies - Effect of charging infrastructure on grid protection & control.

Text Books:

- 1 Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley-Blackwell (ISBN: 9781119942733).
- 2 Energy Management Strategies for Electric & Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer (ISBN: 9781493955237).

Reference Books:

- 1 Electric Vehicle Battery Systems, Sandeep Dhameja, Elsevier (ISBN: 9780750699167).
- 2 Advanced Electric Drive Vehicles, Ali Emadi, CRC Press (ISBN: 9781138072855).
- 3 Hybrid electric Vehicles Principles & applications with practical perspectives, Chris Mi, M. Abul Masrur, D. Wenzhong Gao, A Dearborn, John Wiley & Sons Ltd (ISBN: 9781118970560).

Web Links:

- 1 <https://nptel.ac.in/courses/108102121>
- 2 <https://nptel.ac.in/courses/108103009>
- 3 <https://www.nrel.gov/research/transportation-hybrid-electric.html>

Organizational Behaviour

Course Code: 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, 2009, ISBN : 9780070142961.
2. Principles of Solar Engineering, D.Yogi Goswami, Frank Krieth and Jan F. Kreider Taylor and Francis, 2nd Edition, 2000, ISBN : 9781560327141.

Reference Books:

1. Solar Energy- Fundamentals, Design, Modelling and Applications, G.N.Tiwari, Narosa publishing house. 1st Edition, 2002, ISBN : 9780849324093.
2. Solar Energy and Non-conventional Energy Sources, Domkundwar, Dhanpat Rai & Co, (P) Ltd., 2nd Edition, ASIN : B0BQWR83GF

Web Links:

1. <https://archive.nptel.ac.in/courses/115/103/115103123/>
2. <https://www.nrel.gov/research/re-solar.html>

Composite Materials

Course Code: 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 modulu.

UNIT – III

Metal Matrix Composites (MMC): Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Processing of MMC – powder metallurgy process- diffusion bonding – stir casting – squeeze casting, In-situ reactions-Interface-measurement of interface properties applications of MMC in aerospace, automotive industries

UNIT – IV

Polymer Matrix Composites: Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types

of fibres. Processing of thermoset matrix composites, thermoplastic matrix composites, structure and properties, structural defects, mechanical properties and applications

UNIT – V

Ceramic Matrix Composites (CMC): Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres, whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing), applications of CMC in aerospace, automotive industries- Carbon /carbon composites

Text Books:

1. Composite Material Science and Engineering, Krishan K , Chawla, Springer, 2nd Edition, 2015, ISBN 9788132233442: .
2. Composite Materials: Engineering and Science , Mathews F. L. and Rawlings R. D, Chapman and Hall, London, England, 1st Edition, ISBN : 9781855734739.

Reference Books:

1. Composite Materials Science and Applications, Deborah D.L. Chung, Springer London Ltd, 2nd Edition, 2010, ISBN9781848828308: .
2. Composite Materials Design and Applications, Daniel Gay, Suong V. Hoa & Stephen W. Tsai, CRC Press, 1st Edition, 2002, ISBN : 9781587160844.

Web Links:

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

Communication Systems

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.

Textbooks

- 1 Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe, TMH, 3rd Edition, ISBN: 0070648115
- 2 Communication Systems: Analog and Digital, R P Singh and S D Sapre, McGraw Hill India, Third Edition, ISBN: 1259004600.
- 3 Communication Systems – B. P. Lathi, BS Publication, ISBN: 8178000156.

Reference Books:

- 1 Principles of Communication Systems, Simon Haykin, John Wiley, 2nd Edition, ISBN: 0471178691
- 2 Electronics & Communication System, George Kennedy and Bernard Davis, TMH, ISBN: 0071077820.
- 3 Analog and Digital Communications: Theory and Lab Work- Abhay Gandhi, Cengage, ISBN: 9788131525876.

Web Links:

- 1 <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee08/>
- 2 https://onlinecourses.nptel.ac.in/noc21_ee74/previewAnalog

Electronic Measurements & Instrumentation

Course Code: 2501EC83

L	T	P	C
3	0	0	3

Course Outcomes:

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

CO1: Outline the performance characteristics of measuring Instruments.

CO2: Select signal generators for the given application.

CO3: Interpret the working principle of oscilloscopes.

CO4: Choose a suitable bridge for parameter measurement.

CO5: Make use of transducers for physical parameter measurement.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Performance Characteristics of Instruments: static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity, errors in measurement, Dynamic characteristics- speed of response, fidelity, lag, dynamic error, DC voltmeters, multi range, range extension/Solid state and differential voltmeters, AC voltmeters- multi range, range extension, shunt, thermocouple type RF ammeter, Ohmmeters series type, shunt type, multi-meter for voltage, current, and resistance measurements.

UNIT-II

Signal Generators & Wave Analysers: Fixed and variable, AF oscillators, standard and AF sine and square wave signal generators, Function generators, square, pulse, Random noise, sweep, arbitrary wave form, Wave Analysers, Harmonic distortion analysers, spectrum analysers, Digital Fourier analysers

UNIT-III

Oscilloscopes:

CRT features, Vertical amplifiers, Horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits. Simple CRO, triggered sweep CRO, dual beam CRO, dual trace oscilloscope, sampling oscilloscope, storage oscilloscope, digital readout oscilloscope, digital storage oscilloscope, Lissajous method of frequency measurement, standard specifications of CRO, probes for CRO, active and passive, attenuator type.

UNIT-IV

AC Bridges:

Measurement of Inductance, Maxwell's bridge, Anderson bridge, Measurement of Capacitance, Schering bridge, Wheatstone bridge, Wein bridge, Errors and precautions in using bridges, Q meter.

UNIT-V

Transducers:

Active and passive transducers, resistance, capacitance, inductance, strain gauges, LVDT, piezo electric transducers, Resistance thermometers, thermocouples, thermistors, Measurement of physical parameters-force, pressure, velocity, humidity, moisture, speed, proximity and displacement, data acquisition systems

Textbooks

- 1 Electronic Instrumentation, H.S.Kalsi, Tata MC Graw Hill, 2nd Edition, ISBN: 9780070702066.
- 2 Modern electronic Instrumentation and measurement techniques, A.D.Helfric, W.D.Cooper, PHI, 5th Edition, ISBN: 9332556067

Reference Books:

- 1 Electronic Instrumentation and measurements, David A Bell, PHI, 2nd Edition, ISBN: 8120323602
- 2 Electronic test Instruments, Analog and digital measurements, Robert A.Wittie, Pearson Education, 2nd Edition, ISBN: 817758748X.
- 3 Electronic test Instruments, Analog and digital measurements, Robert A.Wittie, Pearson Education, 2nd Edition, ISBN: 817758748X.

Web Links:

- 1 <https://www.allaboutcircuits.com/textbook/alternating-current/chpt-12/ac-bridge-circuits/>
- 2 <https://www.science-ebooks.com/bridge-circuit.html>

Introduction to Embedded Systems

Course Code: 2501EC84

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Summarize the building blocks of an Embedded system.
- CO2:** Interpret the hardware modules required to design an Embedded system.
- CO3:** Infer the firmware design approaches for an Embedded system.
- CO4:** Examine to integrate hardware and firmware for an Embedded system.
- CO5:** Design and program Embedded systems based on their applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	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.

Textbooks

- 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: 032385494

Web Links:

- 1 http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf
- 2 <http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>
- 3 <http://www.vtt.fi/inf/pdf/publications/2004/P526.pdf>

Fundamentals of Image Processing

Course Code: 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 colour 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.

Textbooks

- 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/.](http://www.imageprocessingplace.com/)
- 2 <http://nptel.ac.in/courses/117105079/>
- 3 <https://sisu.ut.ee/imageprocessing/avaleht>
- 4 <https://www.coursera.org/learn/digital#ratings>
- 5 <https://www.coursera.org/courses?languages=en&query=image+processing>

Sensors & Transducers

Course Code: 2501EC77

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Illustrate the fundamental concepts of energy transformation in Sensors.
- CO2:** Infer the thin film physics, deposition techniques and Photolithography.
- CO3:** Summarize the design and fabrication process of Micro sensors.
- CO4:** Outline the Characteristics of Transducers.
- CO5:** Summarize the Basic Knowledge different types of Transducers.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Basics of Energy Transformation: Transducers, Sensors, Understanding of thin film physics: Application in MOSFET and its variants. Thin Film Deposition Techniques: Chemical Vapor Deposition (PECVD, MOCVD), Physical Vapor Deposition (Thermal Deposition, Sputtering, Pulsed Laser Deposition).

UNIT – II

Basic understanding of Photolithography for patterning layer. Detailed overview of Etching methods. Understanding various gas sensors: Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor.

UNIT – III

Micro sensors: Force Sensors, Pressure Sensors, Strain gauges and practical applications. Working principles of Actuators. Piezoelectric, Piezo resistive actuators.

UNIT – IV

Characteristics Of Transducers: Static characteristics, dynamic characteristics, mathematical model of transducer, zero, first order and second order transducers – response to step, ramp and sinusoidal inputs.

UNIT – V

Resistive, Inductive and Capacitance Transducers- Potentiometer, Strain gauge, LVDT, variable reluctance transducers, Proximity transducers, capacitive transducer, Capacitor microphone.

Text Books:

1. Sensors and Signal Conditioning , Ramon Pallàs – Areny and John G. Webster, Wiley-Blackwell, 2nd Edition, ISBN: 9780471332329.
2. Sensors and Transducers, D. Patranabis , 2nd Edition, ISBN: 9788120321984.

Reference Books:

1. Sensors and Signal Conditioning , Ramon Pallàs – Areny and John G. Webster, Wiley-Blackwell, 2nd Edition, ISBN: 9780471332329.
2. Instrument transducers, H.K.P. Neubert, Oxford University press. 2nd Edition, ISBN: 9780195629972.

Web Links:

1. <https://nptel.ac.in/courses/108108147>
2. <https://nptel.ac.in/courses/108102191>

Data Structures

Course Code: 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 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
Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan
2. 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

Course Code: 2501CS65

L	T	P	C
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: 978-1259005275
2. Computer System Architecture, M. M. Mano, Prentice Hall of India,3rd Edition, ISBN-13. 978-8131700709.
3. Computer Organization and Architecture Designing for Performance, Wiiliam Stallings, Pearson Education, 8th Edition, ISBN-13. 978-0136073734.

Reference Books:

1. Computer Architecture and Organization, John P Hayes, McGraw-Hill, 3rd revised Edition, ISBN-13. 978-1259028564.
2. Computer Organization and Architecture, Ghosh T. K., Tata McGraw-Hill, Third Edition, ISBN: 9780071329071.

Web Links:

1. <https://www.classcentral.com/course/swayam-computer-organization-andarchitecture-a-pedagogical-aspect-9824>
2. <https://www.udemy.com/course/introduction-to-computer-organization/>
3. <https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials>
4. <http://vlabs.iitkgp.ac.in/coa/#>

Operating Systems

Course Code: 2501CS13

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 operating system and their structures.
- CO2:** Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
- CO3:** Interpret the issues and challenges of memory management.
- CO4:** Synthesize the concepts of Disk management and file system implementation.
- CO5:** Explain the issues related to protection and security mechanisms.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

UNIT – II

Process Concept: Process scheduling, Operations on processes, Inter-process communication.

Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.

Multithreaded Programming: Multithreading models, Thread libraries, Threading issues

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the following CPU scheduling algorithms: FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

UNIT – III

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

UNIT – IV

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.

Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.

File Systems: Files, Directories, File system implementation, management and optimization.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm
4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

UNIT – V

Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.

System Security: Introduction, Program threats, System and network threats.

Practice:

1. The above topics are discussed as case study in Windows/ Unix OS

Text Books:

1. Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12th Edition. ISBN: 978-0470128725
2. William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall, 7th Edition. ISBN: 978-9332518803

Reference Books:

1. Modern Operating Systems, Tanenbaum A S, Pearson Education, 3rd Edition. ISBN: 978-0136006633
2. Operating Systems A Concept Based Approach, Dhamdhare D M, Tata McGraw-Hill, 3rd Edition. ISBN: 978-1259005589
3. Operating Systems, Nutt G, Pearson Education, 3rd Edition,. ISBN: 978-8131723593

Web Links:

1. <https://archive.nptel.ac.in/courses/106/106/106106144/>
2. <https://archive.nptel.ac.in/courses/106/105/106105214/>
3. <https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems>
4. <http://www.geeksforgeeks.org/operating-systems/>
5. <https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923>

Database Management Systems

Course Code: 2501IT05

L	T	P	C
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: 978-1260091195.

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

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Capstone Project:

Students shall choose a real-time software application (e.g., e-commerce backend, SMS, food delivery app) and apply Agile design principles, perform refactoring, implement TDD, and use version control and CI tools. This project should be implemented as a Capstone project and submitted at the end of the course.

Text Books:

- 1 Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
- 2 Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

- 1 Software Engineering, Lan Sommerville, Pearson, Tenth Edition, ISBN: 978-9332582699.
- 2 Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, David J. Anderson; Eli Schragenheim, ISBN: 978-0131424609

Web Links:

- 1 https://www.tutorialspoint.com/software_engineering/
- 2 <https://www.sciencedirect.com/science/article/pii/S0950584916303329>

Computer Networks

Course Code: 2501CS07

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Describe network topologies, reference models and media for data transmission
- CO2:** Analyze error and flow control issues in data link layer
- CO3:** Classify MAC protocols and channelization techniques
- CO4:** Apply routing algorithms and congestion control techniques for effective data transmission
- CO5:** Analyze protocols Transport and Application Layers

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Network Overview: interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

Practice:

- 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:

- 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:

- Write a Program to implement Sliding window protocols

UNIT – IV

Routing Algorithms: The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical

Congestion Control algorithms: General principles of congestion control, Congestion prevention policies, Approaches to Congestion Control, Traffic Aware Routing, Admission **Control, Traffic Throttling:** Load Shedding Traffic Control Algorithm: Leaky bucket & Token bucket.

Practice:

1. Programs to implement routing protocols like shortest path.

UNIT – V

IP Protocols: IP Addressing, IP & ICMP.

Transmission Control Protocol: UDP & TCP.

Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP

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, Atul Kahate, McGraw-Hill Education (India) Pvt Limited, 2nd Edition. ISBN: 978-0-07-123110-7
- 2 Computer Networks, Mayank Dave, CENGAGE India, 6th Edition ISBN: 978-8131509869

Web Links:

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>

Java Programming

Course Code: 2501IT06

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1:** Apply Java features for problem solving.
- CO2:** Build applications using principles of OOPs, interfaces and Packages.
- CO3:** Develop programs using Exception Handling to handle run-time errors.
- CO4:** Develop applications using multithreading for inter thread communication.
- CO5:** Build JDBC applications for performing CRUD operations using MySQL.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Java: History of Java, Features of Java Language, JVM Architecture, Java source file structure. Building Blocks of Java, Control Statements, Operators, Type Conversion, Command Line Arguments, Arrays.

Practice:

1. Control Statements

- a. Select all the prime numbers within the range of 1 to 100.
- b. Find the sum of all even terms in the Fibonacci sequence up to the given range N.
- c. Check whether a given number is Armstrong or not.

2. Arrays

- a. Sort an array of integers in ascending order.
- b. Find the maximum and minimum element in an array.
- c. Remove duplicate elements from an array.

UNIT – II

Concepts of Class: Class, Object, Method, Constructor, Overloading- Method and Constructor Keywords: this, static and final, String Class and its Methods, StringTokenizer, StringBuffer and StringBuilder.

Practice:

1. Class Mechanism

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

2.Strings

- a. Check if a given string is a pangram (contains every letter of the alphabet at least once).
- b. Find the most frequently occurring character in a string.
- c. Find all permutations of a given string.
- d. Check if a given string is a anagram (Ex: CAT and ACT).

UNIT – III

Inheritance: Inheritance, Types of Inheritance, super and super(), Method Overriding, Using final with inheritance, abstract with Class and Method, Dynamic Method Dispatch. Interfaces: Introduction to interface, Multiple inheritance.

Practice:

1. Inheritance & interface

- a. Implement multi level Inheritance.
- b. Implement multiple Inheritance.
- c. Find the areas of different shapes using abstract classes.

UNIT – IV

Packages: Introduction, Importing Packages and Classes, path and classpath, Access Specifiers, java.util: Collection Framework (related interfaces and classes), java.io: FileReader, FileWriter, FileInputStream, FileOutputStream, BufferedReader and BufferedWriter, Wrapper Classes.

Practice:

1. Packages & java.io

- a. Import and use user defined package.
- b. Illustrate the use of protected members in a package.
- c. Copy Even numbers into Even.txt file and Odd Numbers into Odd.txt file.

2. Collection Framework

- a. ArrayList and LinkedList
- b. Iterator and Iterable
- c. Comparator and Comparable
- d. HashMap and TreeMap
- e. HashSet and TreeSet
- f. f. HashTable

UNIT – V

Exception Handling: Introduction, Keywords: try, catch, throw, throws and finally, Multiple Catch Clauses, Checked and Unchecked Exceptions, User Defined Exceptions.

Multithreading: Introduction, Thread Life Cycle, Creation, Priorities, Synchronization, ITC.

Java Database Connectivity: Introduction, JDBC Architecture, Types of Drivers, JDBC Environment Setup, JDBC Steps, CRUD Operations.

Practice:

1. Exception Handling

- a. Illustrate exception handling mechanism using multiple catch clauses.
- b. Make use of Built-in and user-defined Exceptions in handling a run time exception.

2. Multithreading

- a. Creates threads by extending Thread class. First thread display “Good Morning “every 1 sec, the second thread displays “Hello “every 2 seconds and the third display “Welcome” every 3 seconds, (Repeat the same by implementing Runnable).
- b. Solve Producer-Consumer problem using synchronization.

3. JDBC

- a. CRUD operations.

Additional Practice:

1. Student Management
2. Inventory Management
3. Phone book Management

Capstone Project:

Develop a console-based quiz application in Java where questions are fetched from a database. The app should handle user login, score calculation, timer using threads, exception handling, and store results in both files and database

*** 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: 2501CS68

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Apply basic and advanced Linux commands to install RHEL, manage files, and edit text using the command line.
- CO2:** Explain how to manage users, processes, services, and network settings in a Linux environment.
- CO3:** Describe how file permissions work and how software packages are managed in a Linux system.
- CO4:** Analyze system performance and configure basic network services in a Linux environment.
- CO5:** Implement remote administration and system maintenance tasks to ensure security and stability in a Linux environment.

Mapping of Course Outcomes with Program Outcomes:

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

Practice:

- 1. Installation and Basic Commands**
 - a. Install RHEL: Set up RHEL on your system, configure installation options, and create user accounts.
 - b. Execute Basic Commands: commands like `ls`, `cd`, `pwd`, and `man`
- 2. File Management and Text Editing**
 - a. File and Directory Management: Explore `mkdir`, `cp`, `mv`, and `rm`.
 - b. Text Editing: Use `nano` or `vim` to create and modify text files.
- 3. Advanced Command Line Operations**
 - a. Redirection and Pipes: Understand `>`, `>>`, `|`.
 - b. Wildcards: Learn about `\*`, `?`.
- 4. User and Group Management**
 - a. User Accounts: Create, modify, and delete users.
 - b. Groups and Permissions: Understand ownership and permissions.
- 5. Process and Service Management**
 - a. Process Management: Explore `ps`, `top`, and `kill`.
 - b. Services: Start, stop, and manage services (daemons).
- 6. Network Configuration and Security**
 - a. Network Interfaces: Configure network settings (`ifconfig`, `ip`).
 - b. Firewalls and Security: Learn about `firewalld` and network services.
- 7. File System Permissions**
 - a. File Permissions: Master `chmod`, `chown`.
 - b. Access Control Lists (ACLs): Understand extended permissions.

8. **Software Packages and Updates**
 - a. Package Management: Use `yum` or `dnf` to install, update, and remove software.
 - b. Repositories and Dependencies: Explore package sources.
9. **Server Analysis and Support**
 - a. Performance Analysis: Use tools like `top`, `htop`, and system logs.
 - b. Seeking Support: Understand how to get help from Red Hat or the community.
10. **Network Services Configuration**
 - a. Static IP Addresses: Configure networking.
11. **Remote Administration with SSH**
 - a. SSH: Secure remote access using key-based authentication.
 - b. Secure Communication: Understand encryption.
12. **System Maintenance and Security**
 - a. Maintenance Tasks: Perform backups, log rotation, and routine maintenance.
 - b. Security Updates: Regularly apply patches and keep the system secure.

Additional Practice:

1. **Basic Shell Commands Practice**

Objective: Familiarize yourself with basic shell commands by performing file operations, navigating directories, and manipulating text files.

Skills: Command-line proficiency, file management, text processing.
2. **User and Group Management**

Objective: Learn to manage users and groups on a Linux system by adding, modifying, and removing users, and setting permissions.

Skills: User account management, permission setting, group policies.
3. **Package Management**

Objective: Learn to use the package manager of your Linux distribution to install, update, and remove software packages.

Skills: Familiarity with apt, yum, or pacman, software lifecycle management.

Text Books:

- 1 Redhat Enterprise Linux 9, Vishesh kumar, Gitanjali Mehra

Reference Books:

- 1 The Linux Command Line: A complete Introduction 1st Edition by William E. Shotts
- 2 Linux command Line and Shell Scripting Bible 4th Edition by Richard Blum, Christine Bresnahan
- 3 Linux Administration: A Beginner's Guide, Eighth Edition by Wale Soyinka
- 4 Red Hat System Administration I (RH 124) by Red Hat Press

Web Links:

- 1 <https://www.redhat.com/en/topics/linux>
- 2 <https://www.freecodecamp.org/news/manage-users-and-groups-in-rhel/>
- 3 https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/9/html-single/configuring_and_managing_networking/index
- 4 https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/9/html/configuring_basic_system_settings/managing-file-system-permissions_configuring-basic-system-settings
- 5 <https://www.cyberciti.biz/faq/redhat-network-interface-configuration/>
- 6 <https://www.koenig-solutions.com/red-hat-enterprise-linux-diagnostics-troubleshooting-training-certification>

AWS Cloud Foundations

Course Code: 2501CS67

L T P C
0 0 3 3

Course Outcomes:

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

- CO1:** Apply cloud cost estimation, user management, and security concepts using AWS tools and services.
- CO2:** Explain the components and configuration of Virtual Private Cloud (VPC) and its security features in AWS.
- CO3:** Describe how network access control, EC2 instances, and VPC peering are used to manage and secure cloud networks
- CO4:** Implement serverless functions, website deployment, and storage services using AWS tools.
- CO5:** Apply AWS services like EC2 snapshots, autoscaling, load balancing, and CloudFormation to manage cloud infrastructure.

Mapping of Course Outcomes with Program Outcomes:

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

Practice:

1.
 - a. Calculate Total Cost of Ownership
 - b. Use AWS Pricing calculator to estimate multiple pricing models.
2.
 - a. Differentiate between AWS and customer responsibilities using Shared Responsibility Model
 - b. User Management using Identity and Access Management
3.
 - a. Securing IAM user accounts.
 - b. IPv4 and IPv6 implementation in cloud
4.
 - a. Design Virtual Private Cloud
 - b. Configure NAT gateway.
5.
 - a. Implementing Internet Gateway in AWS Cloud
 - b. Working with bastion host.
6.
 - a. Create and manage Private & Public subnets.
 - b. Secure VPC using Security Groups
7.
 - a. Implement Network Access Control lists to control traffic.
 - b. Build VPC and launch a web server.
8.
 - a. Launch EC2 instances in two different regions and connect.
 - b. Create multiple VPCs and peer them using VPC peering.

9.
 - a. Create and trigger AWS Lambda functions.
 - b. Use AWS lambda to automate EC2 instance behavior.
10.
 - a. Website deployment using AWS Elastic Beanstalk
 - b. Working with Elastic Block Storage
11.
 - a. Creating and working with EC2 snapshots.
 - b. Configure autoscaling for application deployed in AWS Cloud
12.
 - a. Load balance application deployed in AWS Cloud
 - b. Basic implementation of Infrastructure as Code using AWS CloudFormation

Additional Practice:

1. Working with Elastic File System
2. Working with S3 Buckets and Objects
3. Build a database server

Textbooks:

- 1 AWS Certified Cloud Practitioner study guide, Ben Piper & David Clinton

Reference Books:

- 1 AWS Certified Cloud Practitioner cert guide, Anthony J Sequeira, by Pearson Education

Web Links:

- 1 <https://skillbuilder.aws/>
- 2 <https://aws.amazon.com/training/awsacademy/>

AWS Cloud Development

Course Code: 2501CS66

L T P C
0 0 3 3

Course Outcomes:

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

- CO1:** Explain the fundamentals of AWS CLI, SDKs, IAM, and core services like S3 and DynamoDB.
- CO2:** Apply IAM policies, user/group management, and SDK tools to configure secure AWS environments.
- CO3:** Develop RESTful APIs using API Gateway and Lambda functions in AWS.
- CO4:** Deploy containerized applications using Docker and AWS managed services.
- CO5:** Implement caching and content delivery solutions using ElastiCache and CloudFront.

Mapping of Course Outcomes with Program Outcomes:

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

Practice:

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

Additional Practice:

1. Implementing a Messaging System Using Amazon SNS and Amazon SQS
2. Orchestrating Serverless Functions with Step Functions
3. Implementing Application Authentication Using Amazon Cognito
4. Automating Application Deployment Using a CI/CD Pipeline

Reference Books:

- 1 Mastering DynamoDB, Tanmay Deshpande, Packt Publishing, ISBN: 9781783551958
- 2 Serverless Programming Cookbook, Heartin Kanikathottu, Packt Publishing, ISBN: 9781789133801

Web Links:

1. <https://docs.aws.amazon.com/cli/latest/userguide/getting-started-install.html>
2. https://docs.aws.amazon.com/IAM/latest/UserGuide/id_groups_create.html

Continuous Integration & Delivery using DevOps

Course Code: 2501CS70

L	T	P	C
0	0	3	3

Course Outcomes:

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

- CO1:** Recall basic concepts of Git workflows, Jenkins pipelines, and Docker image creation.
- CO2:** Explain Docker and Kubernetes networking, storage, and orchestration of multi-container applications.
- CO3:** Describe Helm, monitoring, and Ansible tools used in Kubernetes deployment and automation.
- CO4:** Apply DevOps practices using Ansible, CI/CD pipelines, and Infrastructure as Code tools like Terraform.
- CO5:** Implement centralized logging with ELK stack, visualize data using Grafana, and manage blue-green and canary deployments.

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	3	-	-	-	-	-	2
CO3	3	2	2	-	3	-	-	-	-	-	2
CO4	3	3	3	2	3	-	-	-	2	2	2
CO5	3	3	3	2	3	-	-	-	2	2	2

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: 2501IT24

L	T	P	C
0	0	2	2

Course 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

- Create a Formula field, to Calculate the 7% of Service Tax based on the Annual Revenue.
- 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)
- Create a Validation Rule on the Account object, to make sure the Annual Revenue should be more than 400000.
- 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

- Configure the Lookup Relationship between "Hiring Manager" and "Position" objects and list out all the observations / features.
- 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

- 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.
- 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

- Configure a flow to display the Message on the home page screen.
- Configure a flow to display the Current User Name on the home page screen.
- Configure a flow that populate the Shipping address with billing address while creating an account record.

6. Flow Builder

- Configure a flow to send the Email notification to the Hiring Manger upon creating a new HR Manager Record.

7. Data Management

- 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

- 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:
 - Development User (with Salesforce License)
 - Testing User (with Salesforce Platform License)
 - Manager User (with Salesforce Platform License)
 - Customer User (with Salesforce Platform License)
- 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 Administrator]

| ---> 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

- Create an Account Record inside the object by using "Development User" account, and Share the Record to "Manager User" with "ReadOnly" access.
- Create a Permission Set to grant the "Edit and Delete" permissions on the Account Object to the Manager User.
- 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.

- Account: Rating == 'Hot'
- Account: Industry == 'Finance'
- Account: Active == 'Yes'
- 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:

- 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.
- Importing New Records**
Objective: Import new Hiring Manager records into Salesforce.
Description:
 - You have a CSV file with a list of new Hiring Managers that needs to be imported into Salesforce.
 - The CSV file contains fields: Name, Email, Phone Number, Department, Location, Number of Open Positions.
- Creating a Hiring Managers Report**
Objective: Create a detailed report on Hiring Managers and their activity.

Description: You need to generate a report that shows all Hiring Managers along with the number of job applications they have processed in the last month. The report should include fields such as Hiring Manager Name, Email, Department, and Number of Job Applications

Text Books:

1. Salesforce CRM Administration Handbook: A comprehensive guide to administering, configuring, and customizing Salesforce CRM by Krzysztof Nowacki and Mateusz Twarożek, Packt Publishing Ltd, April 2024.
2. Salesforce CRM - The Definitive Admin Handbook by Paul Goodey, Packt Publishing Ltd., 5th Edition, April 2019.

Reference Books:

1. Salesforce for Beginners, Sharif Shaalan, Timothy Royer, Packt Publishing Ltd, 2nd Edition.

Web Links:

1. <https://trailhead.salesforce.com/help?article=Salesforce-Certified-Administrator-Exam-Guide>
2. https://developer.salesforce.com/docs/atlas.enus.salesforce1appadmin.meta/salesforce1appadmin/s1_admin_guide_actions_intro.html
3. https://help.salesforce.com/s/articleView?id=sf.printabledoc_admin.htm&type=5
4. <https://trailhead.salesforce.com/search/learning?keywords=journey+2+salesforce>
5. <https://www.salesforcetutorial.com/>
6. <https://www.tutorialspoint.com/salesforce/index.html>
7. https://api.pageplace.de/preview/DT0400.9781782170532_A24166039/preview-9781782170532_A24166039.pdf
8. <https://www.youtube.com/watch?v=mc5cQ1vHcr0&list=PLgW8Fj5TGrqr9oCcfX1MWcoh2oluUHI9>
9. <https://www.youtube.com/watch?v=THbIw8hgW0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn>

Advanced Salesforce Administration

Course Code: 2501IT34

L	T	P	C
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
 - a. 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
 - a. 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.
 - b. 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
 - a. Paul, an employee has forgotten his Salesforce password and cannot log in. As the Salesforce administrator, how can you reset his password.

- b. 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:
 - i. Minimum length of 12 characters
 - ii. At least one uppercase letter
 - iii. At least one lowercase letter
 - iv. At least one number
 - v. At least one special character
 - vi. Passwords must expire every 90 days
 - vii. Users must not reuse their last 3 passwords
4. Role Hierarchy
 - 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]
5. Profile Management
 - a. 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
 - b. 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
 - a. Create a Permission Set to grant the "Edit and Delete" permissions on the Account Object to the Manager User.
 - b. Login into the Development User Account, and share the above Account record to the Testing User with "Read/Write" access.
7. Public Groups
 - a. 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
 - a. 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.
 - i. Account: Rating == 'Hot'

- ii. Account: Industry == 'Finance'
- iii. Account: Active == 'Yes'
- iv. Account: Customer Priority == 'High'

9. Web to Lead

- a. Implement the use of Web to Lead in a Salesforce Org with suitable example.

10. Web to Case

- a. Create a Web to case form for raising a ticket in your organization.

11. Case Escalation Rule

- a. 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

- a. 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=THblw8hg-W0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn>

Principles of Pega Systems

Course Code: 2501IT23

L	T	P	C
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

Course Code: 2501IT26

L	T	P	C
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.

Reference Books:

- 1 Pega Infinity '23 Essential Constellation: Practical Constellation Development with App Studio, Dev Studio and DevOps, François Dobson, 1st Edition, 2023 ISBN: 979-8878686921
- 2 Production Level in Pega, E. Karthick, Eliva Press, 2024, ISBN: 978-9999318938

Web Links:

1. <https://academy.pega.com/>
2. <https://academy.pega.com/challenge/skimming-ruleset/v1>
3. <https://academy.pega.com/module/application-development/v2>
4. <https://www.pega.com/case-management>
5. <https://academy.pega.com/topic/reports/v3>
6. <https://academy.pega.com/topic/understanding-security-basics/v1>
7. <https://www.pega.com/technology/generative-ai>
8. <https://www.pega.com/retail-banking-solutions>
9. <https://www.pega.com/insurance-software>
10. <https://www.pega.com/healthcare-management>

Entrepreneurship Development and Incubation

Course Code: 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/107/101/107101092/>
2. <https://www.tutorialspoint.com>

Business Ethics & Corporate Governance

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 and Business Management

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: 9788189757007
2. Principles of Management by Tripathi P C & Reddy P N, Tata McGraw Hill, ISBN-13: 9780071333334.

Web Links:

1. <https://archive.nptel.ac.in/courses/110/106/110106141/>
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/03_lec/

SoC Design

Course Code: 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
2501EE01	Basic Electrical & Electronics Engineering	FC	2		2	4	50	50	100	-
2501MB02	Engineering Economics	IC	3			3	50	50	100	-
2501MB03	Management Science	AC	2			2	50	50	100	-
	Total		7		2	9				

Basic Electrical & Electronics Engineering

Course Code 2501EE01

L	T	P	C
2	0	2	4

Course Outcomes:

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

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

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:

DC and AC Circuits:

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

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

PRACTICE:

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

UNIT-II:**Machines and Measuring Instruments:**

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

PRACTICE:

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

UNIT-III:**Energy Resources, Electricity Bill and Safety Measures**

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

PRACTICE:

1. Calculation of Electrical Energy for Domestic Premises

UNIT-IV:**SEMICONDUCTOR DEVICES**

Intrinsic semiconductors – Extrinsic semiconductors - P type and N type - P-N junction characteristics of P N Junction Diode — Zener Effect — Zener Diode and its Characteristics. working of simple zener voltage regulator and amplifier- Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics.

PRACTICE:

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

UNIT-V:**BASIC ELECTRONIC CIRCUITS**

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

DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, gray code, Hamming code. Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adders

PRACTICE:

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

Text Books:

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

Reference Books:

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

Web Links:

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

Engineering Economics
(Common to ECE, PT & Min.E)

Course Code: 2501MB02

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the Managerial Economic concepts and Illustrate the law of demand forecasting methods.
- CO2:** Identify the production , cost behavior for managerial decision making and Break Even Point (BEP) of an enterprise.
- CO3:** Differentiate types of market structures, business organizations along with basic knowledge on business cycle.
- CO4:** Make use of the process & principles of accounting for the preparation of basic accounts.
- CO5:** Utilize various techniques on investment project proposals with the help of capital budgeting techniques for decision making.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Managerial Economics and demand Analysis: Definition and Scope of Managerial Economics, Concept and determinants of demand, Demand curve, Law of Demand and its limitations, Elasticity of demand and its types, Demand forecasting and its Methods.

UNIT – II

Production and Cost Analyses: Concept of production function – Law of variable proportions-Isoquants and Iso costs- cost concepts: opportunity costs, explicit and implicit costs- Fixed costs, Variable costs and total costs – Cost –Volume-Profit analysis-Determination of breakeven point (simple problems)- Managerial significance and limitations of breakeven point.

UNIT – III

Introduction to Markets, Pricing Policies & Types of Business Organization and Business Cycles.

Market structures: Perfect competition, monopoly, monopolistic competition and oligopoly –Features – Methods of pricing: Average cost pricing, Limit pricing, Market skimming pricing. Features and evaluation of Sole Trader, Partnership, Joint Stock Company – Business cycles : Phases of business cycles.

UNIT – IV

Introduction to Accounting & Financing Analysis: Introduction to double entry systems – Journal entries – Ledger – Trail balance – Trading and Profit and Loss account-simple problem.

UNIT – V

Capital and Capital Budgeting:Capital Budgeting: Meaning of Capital- Methods of Capital Budgeting-Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value. method, Internal Rate of Return Method and ProfitAbility Enhancement Courses Index)- Simple Problems.

Text Books:

1. Managerial Economics and Financial Analysis, A.R. Aryasri , McGrawHill Education. ISBN: 978-0070078031
2. Managerial Economics and Financial Analysis, N.Appa Rao, P.Vijay Kumar, Cengage Publications. ISBN: 978-8131515952

Reference Books:

1. Managerial Economics , V. Maheswari , Sultan Chand Publications. ISBN: 81-8054-914-4
2. Managerial Economics, Suma Damodaran : Oxford University Press. ISBN: 978-0198061113

Web Links:

1. <https://www.udemy.com/course/introduction-to-managerial-economics/?couponCode=LETSLEARNNOWPP>
2. <https://archive.nptel.ac.in/courses/110/101/110101149/>

Management Science
(Common to ECE & PT)

Course Code: 2501MB03

L T P C
2 0 0 2

Course Outcomes:

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

- CO1:** Apply management and motivation theories to renovate the practice of management.
- CO2:** Explain concepts of quality management and use process control charts, concepts and tools of quality engineering in the design of products and process controls.
- CO3:** Appraise the functional management challenges associated with high levels of change in the organizations.
- CO4:** Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM.
- CO5:** Develop global vision and management skills both at strategic level and interpersonal level.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Management: Concept nature and importance of management, Generic functions, Principles and Types of Management, Theories of motivation, Decision making process, Designing organization structure.

UNIT – II

Operations Management: Work study, Statistical quality control, Control charts (P-chart, R-chart, and C-chart), Need for inventory control, EOQ, ABC analysis, and Types of ABC analysis (HML, SDE, VED, and FSN analysis).

UNIT – III

Functional Management: Concept of HRM, HRD and PMIR, Functions of HR Manager, Job evaluation and merit rating, Marketing management, functions of marketing, channels of distributions.

UNIT – IV

Project Management: Development of Network, Difference between PERT and CPM, Identifying critical path, (Simple Problems).

UNIT – V

Strategic Management: Vision, Mission, Goals, Strategy, Elements of corporate planning process, SWOT analysis, Steps in strategy formulation and implementation.

Text Books:

1. Management Science, Aryasri, Tata McGraw Hill. ISBN: 9780070090279
2. Management, James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R, Pearson Education/Prentice Hall, 6th Edition. ISBN: 9788131707043

Reference Books:

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

Web Links:

1. <https://archive.nptel.ac.in/courses/122/106/122106031/>
2. https://www.google.com/search?sca_esv=680b12c94771f77f&sca_upv=1&rlz=1C1VDKB_enGBIN1079IN1079&tbm=vid&sxsrf=ADLYWIKvg0FuUABCxWsswlpWlfSE3hFy0A:1716531957118&q=management+science+online+video+lectures&sa=X&ved=2ahUKEwissbLs06WGAXVX2.wGHYpkDOMQ8ccDegQIExAF

Ability Enhancement Courses (AEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EN01	Essential Cognitive Skills for Engineers	FC			1	1	100	-	100	-
2501EN02/ 2501UC05/ 2501UC04/ 2501UC03/ 2501UC06	Advanced Cognitive Skills for Engineers (or) Proficiency in Foreign Language ((Japanese/ German/ French/ Spanish)	FC			1	1	100	-	100	-
2501UC07	Design Thinking using AI	FC			1	1	100	-	100	-
2501UC08	Universal Human Values	FC	2			2	100	-	100	-
2501UC09	Technical Paper Publication	AC			2	2	100	-	100	-
2501PT52	Student Activity Based Learning	AC			2	2	100	-	100	-
Total			2		7	9				

Essential Cognitive Skills for Engineers

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

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 – 1 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: Protector of the sea and the woman who reinvented children's TV, Interviews: 30-day challenge, Article: Tech free!
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 – 2 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: How to survive...an animal attack, Leaflet: Be wise and survive
Writing	Guidelines, organizing guidelines in a leaflet
Grammar	Narrative tenses, Future time clauses and conditionals
Vocabulary	Expressions with get, Animals and the environment
Pronunciation	Sound and Spelling: g, Intonation in question tags

Unit – 3 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 – 4 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 – 5 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. ISBN: 978-1107468726

Suggested Software:

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

Reference Books:

1. M Ashraf Rizvi: Effective Technical Communication ISBN: 9352605780
2. Raymond Murphy: English Grammar in Use, Cambridge University Press. Fifth Edition ISBN: 978-3125354241
3. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, 2013 ISBN: 9788120314955

Web links:

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

Advanced Cognitive Skills for Engineers
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

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 – 1

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 – 2

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>
	Email: Complaining about an important issue.
Writing	Email of complaint, Using formal language

Grammar	<i>Too/enough; so/such, Causative have/get</i>
Vocabulary	Describing life in cities, Film and TV; Houses
Pronunciation	Sound and spelling: o, Stress in compound nouns

Unit – 3	Dilemmas A/B/C/D
Listening	Radio programme: person finance, Three monologues about honesty, Going to the bank, Conversation about a TV programme
Speaking	Giving opinions on financial matters, Discussing moral dilemmas, Talking about hopes and worries Discussing programmes about crime
Reading	Article: <i>Is it time to give up on cash?</i> , Newspaper article: <i>The honesty experiment</i> , Review: <i>Crime with a smile</i>
Writing	Review, Organising a review
Grammar	First and second conditionals, Third conditional; <i>should have+past participle</i>
Vocabulary	Money and finance, Crime
Pronunciation	Stressed and unstressed words; Sound and spelling: <i>l</i> , Word groups

Unit – 4	Discoveries A/B/C/D
Listening	Conversation about inventions, Conversation about an email hoax, Finding the perfect flat, Four monologues about alternative medicine
Speaking	Talking about inventions, Describing a hoax or a scam or a case of fraud, Giving and receiving surprises
Reading	Article: <i>Too good to be true?</i> , Article: <i>The rise and fall of Barry Minkow</i> , Essay: <i>The Value of alternative medicine</i>
Writing	Opinion essay, Presenting a series of arguments
Grammar	Relative clauses, Reported speech; Reporting verbs
Vocabulary	Health, Verbs describing thought and knowledge
Pronunciation	Sound and spelling : <i>ui</i> , Linking and intrusion

Unit – 5	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. ISBN: 978-1107468726

Suggested Software:

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

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press.2018. ISBN: 9789354972256
2. Michael Swan- Practical English Usage ISBN: 9780194202466
3. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India,2016 ISBN: 978-0070996038

Web links:

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

Design Thinking using AI

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

Course Code:2501UC07

L	T	P	C
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>

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT19	MATLAB For Petroleum Engineers Lab	IC			2	2	50	50	100	-
2501PT51	Well Control and Pressure Control Lab	IC			1	1	100	-	100	-
2501PT20	Petroleum Equipment Design and Simulation Lab	IC			2	2	50	50	100	SPO
2501PT18	Drilling Simulation Lab	AC			2	2	50	50	100	-
2501PT21	Unit Operations Using SCI Lab	AC			2	2	50	50	100	FMPE & HTPO
Total					9	9				

MATLAB for Petroleum Engineers Lab

Course Code: 2501PT19

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Develop a program to create geological model using simple matlab code.
- CO2:** Make use of different homogeneous models for geological layers.
- CO3:** Apply the concepts of flow models in porous media.
- CO4:** Build grids of structured, unstructured and complex grids.
- CO5:** Develop GUI for the Grids Generated using the MRST

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Practices

1. Data representation, error analysis, introduction to MATLAB; Applied MATLAB programming
2. Structured programming and looping
3. Numerical solution of algebraic and transcendental equations.
4. Create a geological model is a grid describing the geometry of the reservoir rock, here chosen as a regular $1 \times 1 \times 30$ Cartesian grid.
5. Curve fitting: Straight line fit, polynomial curve fit and exponential curve Fit.
6. Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule,
7. Solution of simultaneous algebraic equations: Gauss elimination method.

8. Numerical solution of ordinary differential equation: Taylor's method, Euler's method, Runge- Kutta method, modified Euler's method; Predictor corrector method: Adam's method and Milne's method.
9. consider a reservoir consisting of a homogeneous $500 \times 500 \times 25$ m³ sand box with an isotropic permeability of 100 mD, represented on a regular $20 \times 20 \times 5$ Cartesian grid.
10. Optimization algorithms and introduction to Simulink.

Additional Practices:

1. Consider a homogeneous reservoir in the form of a 2D rectangle $[0,4] \times [0,1]$. Flow is driven from the north to the south side of the reservoir by a fluid source with unit rate located at (2,0.975)
2. Construct a Radial symmetric grids graded towards the origin are commonly used to increase resolution near wells.
3. Construct an areal Voronoi grid from a set of generating points obtained by perturbing the vertices of a regular Cartesian grid and then use the function makeLayeredGrid to extrude this Voronoi grid to 3D along vertical pillars in the z-direction.

Textbooks:

- 1 Knut-Andreas Lie ,An introduction to reservoir simulation using matlabgnu and Octave, User Guide for the MATLAB Reservoir Simulation Toolbox (MRST),Cambridge press, 2019 eISBN: 9781108492430
- 2 Chapra, S., "Applied Numerical Methods with MATLAB for Engineers and Scientists", Edition: 4, McGraw-Hill Education (2017). eISBN: 9780077144883

Reference Books:

- 1 Pratap, R. "Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers", Ox- ford University Press, (2010). eISBN: 9780199731244
- 2 Ahuja, P. "Introduction to Numerical Methods in Chemical Engineering", PHI Learning Pvt., Edi- tion: 2 (2019). eISBN: 9789389347173

Web Links:

- 1 <https://www.mathworks.com/academia/books/an-introduction-to-reservoir-simulation-using-matlab-gnu-octave-lie.html>
- 2 <https://www.sintef.no/contentassets/8af8db2e42614f7fb94fb0c68f5bc256/mrst-book-2016.pdf>
- 3 <https://www.cambridge.org/core/books/an-introduction-to-reservoir-simulation-using-matlabgnu-octave/modeling-reservoir-rocks/D54C1FD08E64FDD810436E0651E40650>

Well Control & Pressure Control Lab

Course Code: 2501PT51

L	T	P	C
0	0	1	1

Course Outcomes:

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

- CO 1: Make use of excel to solve the area and volume calculations.
- CO 2: Calculate the examples related to volume, capacities and displacements
- CO 3: Explain the well control risk and borehole geometry
- CO 4: Study and solve the gas laws and its characteristics
- CO 5: Study the concept of circulating system.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

List of Experiments:

1. Introductory Concepts: Areas and Volumes

- I. Perimeter and area
- II. Units of area
- III. Angles
- IV. Areas of regular shapes
- V. Conservation of area

2. Volumes, Capacities and Displacements

- I. Calculating mud pit volumes and capacity
- II. Calculating the volume of a cylinder
- III. Calculating the capacity of a cylinder in bbl/ft
- IV. Calculating annular volumes
- V. Calculating annular capacities
- VI. Calculating drill pipe, casing and tubing capacities
- VII. Calculating metal displacement
- VIII. Calculating closed end displacements

3. **Well Control Risks When Tripping**
 - I. Tripping 'dry' and tripping 'wet'
 - II. Tripping into the well
 - III. Tripping out of the well
 - IV. Trip tanks
 - V. Trip sheets
4. **Borehole Geometry**
 - I. Drill string capacity and annular volumes
 - II. Surface and subsea well geometry
 - III. Calculating drill string capacity and annular volumes for a surface well
 - IV. Calculating drill string capacity and annular volumes for a subsea well
5. **Gas and its characteristics**
 - I. Gas and gas characteristics
 - II. Gas mass
 - III. Gas density
 - IV. Pressure gradient
6. **Gas Laws**
 - I. How gas changes with pressure
 - II. Gas density changes with pressure
 - III. High pressure gases
 - IV. Ideal gas law
7. **Accumulator bottles**
 - I. Accumulator capacity calculations
 - II. Accumulator pre-charge
 - III. Accumulator minimum operating pressure
 - IV. Accumulator maximum operating pressure
 - V. Useable hydraulic fluid volume
8. **The Circulating System**
 - I. Understanding pump pressure
 - II. Combining several pipe sections into a system
 - III. The drilling circulating system
 - IV. Mud pump pressure in a circulating system
 - V. Changes in pump rate
 - VI. Changes in drilling fluid density
9. **Effect of Circulation on Bottomhole Pressure**
 - I. The effect of circulating pressures on bottomhole pressure (BHP)
 - II. The effect of annular pressure loss on BHP
 - III. Equivalent circulating density (ECD)
10. **Pump outputs, Strokes and Circulating time**
 - I. Pump output and pump strokes
 - II. Calculating the required number of strokes
 - III. Calculating the time required to pump a volume of fluid
 - IV. Using both formulas with given well data

Reference Books:

1. Drilling Engineering" by J.J. Azar and G. Robello Samuel ISBN: 978-0750678613
2. Applied Drilling Engineering" by Adam T. Bourgoyne Jr., et al. ISBN: 978-0884152585

Web Links:

- I. <https://iwcf.org/well-control-pressure-calculations/#/>

Petroleum Equipment Design & Simulation Lab

Course Code: 2501PT20

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1: Design and simulation of the two-phase, three phase separators and compressors
- CO2: Design and simulation of absorber-stripper unit for removal of CO₂ and H₂S from natural gas
- CO3: Size /rate the pipeline & pumping systems for liquid pumping & simulate water hammer conditions
- CO4: Design and simulation of flash vaporization units
- CO5: Generating sized equipment data sheets as per the industry standards with required information for detailed design / manufacture

Mapping of Course Outcomes with Program Outcomes:

CO/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	1
CO3	-	-	-	-	2	-	-	-	2	2	1
CO4	-	-	-	-	2	-	-	-	2	2	1
CO5	-	-	-	-	2	-	-	-	2	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Practices:

1. Study Oil- Water separator
2. Study Gas- Oil-Water separator
3. Study Lean / rich amine heat exchanger
4. Study Air-cooled heat exchanger.
5. Study CO₂ and H₂S absorber unit using, MEA/DEA amine solution.
6. Study Stripping unit
7. Study Single stage flash vaporization unit

8. Study three stage flash vaporization unit.
9. Study Liquid pumping system & simulation of water-hammer phenomena
10. Study Gas Compressor unit

List of Additional Practices:

1. Study Expander
2. Study Conversion Reaction
3. Study Equilibrium Reaction

Reference Books:

1. Process Modeling, Simulation and Control for Chemical Engineering, Luyben, McGraw Hill Education; 2 editions, 2013. eISBN: 9780070391598
2. Optimization of Chemical Processes, Thomas F. Edgar, David M. Himmelblau, Thomas E. Casson, 2nd Edition, 2001. eISBN: 9780071189774
3. Elements of Chemical Reaction Engineering, Fogler H.S, Prentice Hall India Learning Private Limited; 4 edition, 2008. eISBN: 9780131278394

Web Links:

1. https://petrowiki.org/Oil_and_gas_separators
2. <http://www.thermopedia.com/content/551/>
3. https://en.wikipedia.org/wiki/Amine_gas_treating
4. www.chemprosys.com/products/evaporators/multi-stage-flash/
5. <https://worldwidescience.org/topicpages/w/water+hammer+phenomena.html>

Drilling Simulation Lab

Course Code: 2501PT18

L T P C
0 0 2 2

Course Outcomes:

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

- CO1:** Evaluate the suitability of drilling Simulator by performing different laboratory tests
- CO2:** Analyse the effect of adding different drilling parameters with simulation
- CO3:** Analyse the effect of adding different kick parameters with simulation
- CO4:** Estimate the kick by using methods.
- CO5:** Function effectively as an individual, and as a member or leader while performing lab experiments.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Practices:

- Drilling a vertical well up to a certain depth using the various drilling systems such as the hoisting system and the rotary system.
- Calculation and monitoring of all the drilling parameters such as the drilling rate (rate of penetration, ROP), rotary speed, drill pipe pressure, casing pressure, mud weight etc.
- Setting up of a situation where a kick is induced into a well and fixing it using the driller's method (two circulation method). Preparation of a kill sheet.
- Resolving a kick using the wait of weight method (Engineer's method, one circulation method). Preparation of a kill sheet.
- Resolving a kick using the volumetric method. Preparation of a kill sheet.
- Resolving a kick using the concurrent method. Preparation of a kill sheet.
- Resolving the drilling problem when a choke is plugged.
- Resolving a drilling problem when a choke is washout out.

9. Resolving a drilling problem when a bit nozzle is plugged.
10. Evaluate the effect of differential sticking on drilling.

Additional Practices:

1. Resolving a drilling problem when the well is packed-off.
2. Evaluate the effect of surge and swabbing on drilling.

Text Books:

- 1 Lab Manual For Drilling Simulator

Reference Books:

- 1 Well Control Problems Solutions : Neal A J.dams 1983 eISBN: 9780878141241

Unit Operations Using SCI Lab

Course Code: 2501PT21

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Develop simulation to optimize column performance with Distillation Column.
- CO2:** Make use of various methods to determine heat transfer coefficients.
- CO3:** Apply hydrodynamics and reaction kinetics within fluidized bed systems
- CO4:** Develop empirical models to predict pump performance under varying conditions
- CO5:** Simulate the evaporation of a liquid in a single-effect or multi-effect evaporator

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Practices:

1. Distillation Column Simulation:
Simulate the operation of a distillation column to separate a binary mixture using the McCabe-Thiele method or other equilibrium-based approaches.
2. Heat Exchanger Performance Analysis:
Analyze the heat transfer characteristics of a shell-and-tube heat exchanger under various operating conditions.
3. Fluidized Bed Reactor Simulation:
Simulate the behavior of a fluidized bed reactor for gas-solid reactions and investigate the effects of different parameters on reactor performance.
4. Pump Performance Curve Estimation:
Estimate the performance curve of a centrifugal pump by analyzing its head-flow characteristics using experimental data.
5. Mixer-Settler Design and Optimization:
Design and optimize a mixer-settler unit for liquid-liquid extraction processes, considering factors such as residence time and phase distribution.

6. Fluid Flow in Pipes:
Analyze the pressure drop and flow characteristics of fluids in pipes of different diameters and lengths using SCILAB's fluid dynamics simulation capabilities.
7. Solid-Liquid Filtration Experiment:
Simulate the filtration process in a filter press or filter medium to determine the filtration rate, cake formation, and pressure drop.
8. Crystallization Process Modelling:
Model the crystallization process in a batch or continuous crystallizer to predict crystal size distribution and yield under varying conditions.
9. Evaporation Process Simulation:
Simulate the evaporation of a liquid in a single-effect or multi-effect evaporator to determine heat transfer coefficients and evaporation rates.
10. Absorption Tower Design:
Design and analyze the performance of a packed or tray absorption tower for gas-liquid mass transfer processes, such as CO₂ removal from flue gases.

Additional Practices:

1. Centrifugation Experiment:
Analyze the separation efficiency of a centrifuge for solid-liquid or liquid-liquid separation processes and optimize operating parameters.
2. Fluid Mixing Analysis:
Investigate the mixing efficiency and time required to achieve homogeneity in a stirred tank reactor or mixing vessel under different agitation speeds.
3. Gas-Liquid Mass Transfer Experiment:
Study the mass transfer characteristics of a gas-liquid contactor, such as a bubble column or stirred tank, for absorption or stripping processes.

Text Books:

- 1 Scilab Code for Unit Operations of Chemical Engineering, Warren L. McCabe, Julian C. Smith, Peter Harriott, McGraw Hill, 2010. eISBN: 0-07-112738-0
- 2 Introduction to Scilab: For Engineers and Scientists, Sandeep Nagar, APress; 1st ed. Edition, 2017. eISBN: 978-1484231959

Reference Books:

- 1 Introduction to Scilab, Rachna Verma, Arvind Verma, independently published, 2018. eISBN: 9789353008390
- 2 Scilab: from Theory to Practice - I. Fundamentals, Philippe Roux, Éditions D-BookeR, 2016 eISBN: 9782822702928

Web Links:

- 1 <https://www.opensourceforu.com/2015/05/using-scilab-with-the-mccabe-thiele-method/>
- 2 <https://www.colan.org/process-modeling-component/scilab-unit-operation/>
- 3 <https://kpriet.ac.in/stories/898/dynamic-simulation-of-a-distillation-column-in-dwsim>
- 4 <http://surl.li/tvqos>
- 5 <http://surl.li/tvqok>

Value Added Courses (VAC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS02	Data Analysis Using Python	IC			2	2	50	50	100	PPSC
2501CS04	Internet of Things	FC			1	1	50	50	100	-
2501UC11	Employability Skills-I	FC			3	0	100	-	100	-
2501UC13	Employability Skills-II	FC			3	0	100	-	100	ES-I
2501UC14	Employability Skills-III	IC			3	0	100	-	100	ES-II
2501UC15	Employability Skills-IV	IC			3	0	100	-	100	ES-III
2501UC16	Employability Skills-V	AC			3	1	100	-	100	ES-IV
Total					18	4				

Data Analysis using Python

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

Course Code: 2501CS02

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Make use of control statements and data structures to solve problems
- CO2:** Apply OOPs concepts and files to develop applications.
- CO3:** Explain the data collection, management and storage for processing using Numpy
- CO4:** Make use of Pandas to create and manipulate data structures like Series and Data Frames.
- 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 develop a GUI based Calculator application.
3. Write a Python program to develop a GUI based to do list application for adding, deleting and updating tasks.

Reference Books:

1. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, SueBlumenberg. ISBN:978-1530051120
2. Code with Python: Suresh Sundaradasu, S.Rama Sree ISBN: 978-9355017574
3. Python Programming, Dr.Maganti Venkatesh, Monelli Ayyavaraiah, Niveditha Ravindra Pandey, NeethumolSabu, Charulatha Publications ISBN:978-93-5577-695-6
4. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Wes McKinney, O'Reilly Media, ISBN: 978-1491957660

Web Links:

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>

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:

1. Study of Arduino UNO and Raspberry Pi boards including architecture, pin configuration, power supply, communication interfaces and development environments.
2. 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.
3. Design and implement basic digital input–output operations using Arduino by controlling LED/buzzer.
4. Interface an analog sensor (LDR) with Arduino and display sensor values on Serial Monitor.
5. Interface a digital sensor (Ultrasonic sensor) with Arduino and display measured values on Serial Monitor.
6. Develop conditional logic using Arduino to control LED or buzzer based on sensor threshold values.

7. 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

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

Course Code: 2501UC11

L	T	P	C
0	0	3	0

Course Outcomes:

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

- CO1** Apply fundamental arithmetic concepts such as number systems, LCM & HCF, ratio & proportion, and averages to solve quantitative problems efficiently.
- CO2** Analyze number and letter series to identify logical patterns and predict subsequent elements.
- CO3** Select the option by evaluating relationships in analogy-based problems and detecting inconsistencies in logical sequences
- CO4** Demonstrate effective verbal communication skills by using appropriate parts of speech and tone in various interpersonal and professional contexts.

Mapping with Program Outcomes:

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

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.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications.
2. Analytical Reasoning – Jaikishan and Premkishan Arihant Publications.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- II

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

	L	T	P	C
Course Code: 2501UC13	0	0	3	0

Course Outcomes:

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

- CO1** Apply percentage, profit & loss, and partnership concepts to solve real-world quantitative problems.
- CO2** Analyze age-related problems to develop logical problem-solving strategies.
- CO3** Evaluate logical reasoning questions including ranking, directions, and alphabet tests for accurate decision-making.
- CO4** Solve pattern-based problems in coding and decoding to enhance analytical skills.
- CO5** Demonstrate effective written communication using correct grammar and structured presentation techniques

Mapping with Program Outcomes:

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

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.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications.
2. Analytical Reasoning – Jaikishan and Premkishan Arihant Publications.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- III

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

	L	T	P	C
Course Code: 2501UC14	0	0	3	0

Course Outcomes:

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

- CO1** Solve financial and quantitative aptitude problems using concepts of simple and compound interest.
- CO2** Apply logical time-work frameworks to solve real-time problems related to work efficiency and pipe systems .
- CO3** Analyze and interpret problems related to blood relations, clocks, calendars, and coded inequalities.
- CO4** Evaluate spatial and logical reasoning through cubes, dice, and symbolic interpretation problems.
- CO5** Demonstrate effective communication using correct grammar, and participate actively in discussions and comprehension activities.

Mapping with Program Outcomes :

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

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.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications.
2. Analytical Reasoning – Jaikishan and Premkishan Arihant Publications.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- IV

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

L T P C

Course Code: 2501UC15

0 0 3 0

Course Outcomes:

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

- CO1** Apply concepts of time, speed, distance, trains, boats and streams to solve motion-related aptitude problems.
- CO2** Solve mensuration problems involving surface area and volume in real-world contexts.
- CO3** Analyze logical reasoning questions involving Venn diagrams and syllogisms to make valid conclusions.
- CO4** Interpret seating arrangements and solve non-verbal reasoning questions involving patterns and spatial reasoning.
- CO5** Demonstrate effective communication through structured self-introduction, emails, letters, reports, and grammar usage.

Mapping with Program Outcomes:

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

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.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications.
2. Analytical Reasoning – Jaikishan and Premkishan Arihant Publications.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications.

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)

	L	T	P	C
Course Code: 2501UC16	0	0	3	1

Course Outcomes:

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

- CO1** Apply principles of permutations, combinations, probability, and logarithms to solve quantitative aptitude problems.
- CO2** Interpret and analyze data from charts, graphs, and statistical tables for decision-making and accuracy.
- CO3** Evaluate logical reasoning statements involving arguments, assumptions, conclusions, and data sufficiency.
- CO4** Solve puzzle and eligibility test problems using analytical and critical thinking skills.
- CO5** Demonstrate effective interpersonal, communication, and time management skills for successful personal and professional interactions.

Mapping with Program Outcomes:

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

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.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications.
2. Analytical Reasoning – Jaikishan and Premkishan Arihant Publications.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Mandatory Courses (MC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
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
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, 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: 978-8170087380.

Web Links:

1. <https://archive.nptel.ac.in/courses/127/105/127105018/>
2. https://onlinecourses.swayam2.ac.in/cec24_ge05/preview

Constitution of India

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

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/101104065/

Research Methodology
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, 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: 9788122415223.
2. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press. ISBN: 9780367135720.

Reference Books:

1. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd. ISBN: 978-8126530755.
2. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi. ISBN: 9788120349469.
3. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi. ISBN: 978-8180545283.

Web Links:

1. <https://nptel.ac.in/courses/127106227>
2. <https://archive.nptel.ac.in/courses/121/106/121106007/>

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

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: 9788178002774.
2. Intellectual Property -Deborah E.Bouchoux, Third Edition, Cengage Learning, New Delhi. ISBN: 0 340 67786 4.

Reference Books:

1. Intellectual property rights- Prabuddha Ganuli, Tata Mcgraw hill. ISBN: 978-0070077171.
2. Intellectual property rights M.Ashok kumar and Mohd.Iqbal Ali:, Serials Publications. ISBN: 9788183871648.
3. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi. ISBN: 979-8886848229.
4. Intellectual Property- Richard Stim, Cengage Learning, New Delhi. ISBN: 978-0766826656.

Web Links:

1. <http://www.wipo.int/portal/en/index.html>
2. <https://indiankanoon.org/>
3. <http://www.ipindia.nic.in/patents.htm>
4. <http://www.ipindia.nic.in/trade-marks.htm>
5. <http://copyright.gov.in>

Indian Knowledge Systems (IKS)
(CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min. E)

Course Code: 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 Petroleum Technology (offered to other branches students)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT27	Introduction to Petroleum Engineering	FC	3			3	50	50	100	-
2501PT35	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
2501PT47	Fundamentals of Geology & Reservoir Engineering	IC	3			3	50	50	100	-
2501PT48	Fundamentals of Drilling & Production Engineering (or)	IC	2			2	50	50	100	-
2501PT16	Unconventional Hydrocarbon Resources		1	1		2				
2501PT49	Natural Gas Hydrates (or)	AC	3			3	50	50	100	-
2501PT5	Fundamentals of Liquefied Natural Gas		3			3				
2501PT50	Artificial Lift Techniques (or)	AC	3			3	50	50	100	-
2501PT03	Enhanced Oil Recovery		2	1		3				
2501PT12	Petroleum Refinery Engineering	AC	3			3	50	50	100	-
Total			18	2		20				

Introduction to Petroleum Engineering

Course Code: 2501PT27

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1:** Identify the various streams in the petroleum industry.
- CO 2:** Outline the onshore and offshore reservoirs.
- CO 3:** List out the various artificial lift techniques.
- CO 4:** Illustrate various attributes in mid-stream processing and storage.
- CO 5:** Describe the crude oil products and their specifications.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	3	-
CO2	2	-
CO3	2	-
CO4	3	-
CO5	3	-

UNIT-I

What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector- Midstream Processing-Downstream Processing-Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II

Exploration & Production-Indian and World Scenario of Petroleum and Natural Gas Resources- The Reservoir-Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs - Reservoir Drives. Exploration and Drilling Rigs- Rig Components- Drill and drill bits- Drilling fluids.

UNIT III

Well Completions Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.
Artificial Lift: Principles and operation of Rod Pumps Down Hole Pumps - Gas Lift - Plunger Lift- Electrical submersible pumps.

UNIT IV

Separation of Reservoir Fluids- Manifolds and Gathering - Production Separators - Gas Treatment and Compression - Oil & Gas Storage.

Midstream processing: Transportation of Crude Oil & its Products and Natural Gas- - World and Indian pipeline scenario- Design of Oil and Gas pipelines Safety aspects of pipelines- Environmental issues.

UNIT V

Crude Oil Refining: Classification and Composition - Constituents - Products and their specifications- Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Text Books:

1. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, ABB ATPA Oil and Gas. eISBN: 978-1329783454
2. John R. Fanchi and Christiansen, R.L. Introduction to Petroleum Engineering, John Wiley & Sons. eISBN:9781119193463

Reference Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; Elsevier publications, 2nd Edition. eISBN: 0-444-99564-1
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier eISBN: 978-1-85617-689-7

Web Links:

1. <https://www.studentenergy.org>
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Pipeline_transport
4. https://petrowiki.org/Production_system

Unit Operations in Petroleum Industry

Course Code: 2501PT35

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Understand the Heat and Mass Transfer Principles
- CO2: Prioritize Proficiency in Conduction Mechanisms
- CO3: Explain Mastery of Convective Heat Transfer
- CO4: Apply Knowledge of Heat Exchange Equipment and Evaporation
- CO5: Distinguish Mass Transfer and Distillation Techniques

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction: Objective, scope and outcome of the course.

Conduction: Introduction to unit operation and its application in petroleum engineering. Heat Transfer and its application, Modes of heat transfer one dimensional and two-dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

UNIT – II

Convection: Convective heat transfer, natural and forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, Fouling factor, Heat transfer with and without phase change conditions.

UNIT – III

Heat Exchange equipment: Introduction to double pipe, shell and tube exchangers, condensers, extended surface equipment.

Evaporation- Type of evaporators and their applications single and multiple effect evaporators, operation of forward– backward and mixed feed operations.

UNIT – IV

Mass transfer and its application: Analogies in transfer process, basic concept of diffusion and interphase mass transfer. Mass transfer theory film theory Penetration and surface renewal theory.

UNIT – V

Distillation: Rectification, reflux ratio, calculation of numbers of plates by McCabe Thiele method, optimum reflux ratio

Basic introduction to absorption, liquid liquid extraction, leaching

Drying: Equilibrium mechanism theory of drying, drying rate curve

Text Books:

1. Heat and Mass Transfer: Fundamentals and Applications by Yunus A. Çengel and Afshin J. Ghajar. eISBN: 978-9339223199
2. Introduction to Chemical Engineering Thermodynamics" by J.M. Smith, H.C. Van Ness, and M.M. Abbott. eISBN: 978-0070145870

Reference Books:

1. Transport Processes and Separation Process Principles" by Christie John Geankoplis. eISBN: 9789332549432
2. Process Heat Transfer" by Donald Q. Kern. eISBN: 978-0074632178

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc22_me139/preview
2. https://www.engineeringtoolbox.com/convective-heat-transfer-d_430.html
3. <https://www.thomasnet.com/articles/process-equipment/double-pipe-heat-exchangers/>
4. <https://pages.mtu.edu/~fmorriso/cm3120/lectures/2020%20CM3120%20First%20Diffusion%20Lecture%209.pdf>
5. <http://www.dempt.co.za/mso2015/handout4.pdf>

Fundamentals of Geology & Reservoir Engineering

Course Code:2501PT47

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1: Explain the general facts of the earth.
- CO 2: Compare and classify various kinds of rocks.
- CO 3: Explain how basins are formed.
- CO 4: Understand the basic concepts in petroleum reservoir engineering.
- CO 5: Acquire the knowledge on drive mechanisms and how to apply the material balance to oil reservoirs.

Mapping of Course Outcomes with Program Outcomes:

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

Origin and Evolution of Earth:

Dimensions, origin, internal structure of the earth -- crust, mantle, core. Internal dynamic process- Plate tectonics, Continental drift, Earthquake and Volcanoes. External dynamic process – weathering-erosion-deposition. Principles of stratigraphy.

UNIT-II:

Petrology:

Origin of igneous, sedimentary and metamorphic rocks. Sedimentology -Sedimentary structures- petrographic characters of conglomerate, sandstone, shale, and limestone.

UNIT-III:

Sedimentary Basins:

Introduction to sedimentary basins and deltaic systems; Topographic maps, Thematic maps, and their profiles

UNIT-IV:

Some basic concepts in reservoir engineering: Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor-Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor- Hydrocarbon phase behaviour, Basic concepts in PVT analysis.

UNIT-V:

Material balance applied to oil reservoirs: General form -The material balance expressed as a linear equation- Reservoir drive mechanism- Solution gas drive- Gas cap drive- Natural water drive- compaction drive under related pore compressibility phenomena.

Darcy's law and applications: Darcy's law and field potential- Sign convention

Textbooks:

1. Engineering Geology, Bell, F.G., 2nd Edition, Butter worth Heimann. eISBN: 978-0750680776
2. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science eISBN: 978-0444418302

Reference Books:

1. Text book of Geology, Mukherjee, P.K., The World Press Pvt. Ltd., eISBN: 9786039657736.
2. Principles of Engineering Geology, Bangar, K.M., 2nd Edition, Standard Publishers eISBN: 9788180141157.
3. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing eISBN: 9780080480688

Web Links:

1. web.crc.losrios.edu/~jacksoh/classes/earthscience/Chapter1.pdf
2. <https://ocw.mit.edu/courses/earth-atmospheric-and-astronomical-engineering/12-00-sedimentary-geology/ch11.pdf>
3. www.ucmp.berkeley.edu/fosrec/ONeill.html
4. <https://wiki.seg.org/wiki/Volumetrics>
5. https://petrowiki.spe.org/Material_balance_in_oil_reservoirs

Fundamentals of Drilling & Production Engineering

Course Code:2501PT48

L	T	P	C
2	0	0	2

Course Outcomes:

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

CO 1: Explain the Overview of GTO

CO 2: Design of the drill string, drilling hydraulics.

CO 3: Determine the well head pressure, down-hole pressure and operating oil/ gas flow rates of the reservoir.

CO 4: Illustrate the concepts of artificial lift methods

CO 5: Determination of stimulation methods in production operations

Mapping of Course Outcomes with Program Outcomes:

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

Overview of drilling: Drilling plan - GTO -Types of drilling, Hydrostatic pressure, Pore pressure, causes of abnormal pore pressure, abnormal pore pressure evaluation - Measurement while drilling & logging while drilling data -Direct measurements of pore pressure – Drilling fluid properties - Drilling fluid hydraulics calculations - Bit Hydraulics Formation integrity tests – Fracture gradient determination – Theory of wellbore – FIT procedural Guidelines – Predicting fracture gradient.

UNIT-II

Wellbore stability – e in-situ stress - Determination of rock properties, Failure criteria – Stress distribution around a wellbore - safe mud weights to prevent hole collapse, Kick tolerance Use of kick tolerance to calculate wellbore pressures. Casing: Functions of casing – Types of casing – Casing properties and specifications – Casing connections – Factors influencing casing design – Combination strings – Tension criterion - Compression loads – Biaxial effects – Triaxial analysis. Cementation: Introduction to cement slurries - Cementing nomenclature - Cement additives.

UNIT-III

Petroleum production system over all view, Production from various types of reservoirs based on drive mechanisms, field development method, Safety control system. Properties of oil and natural gas: Solution Gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-IV

Basic concepts on artificial lift methods: Sucker rod pumping system, electrical submersible pumps, hydraulic piston pumping, progressive cavity pumping, plunger lift, hydraulic jet pumping, and Gas lift system.

UNIT-V

Production Stimulation: Well problem identification, Matrix acidizing, Fundamentals of Hydraulic fracturing.

Textbooks:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc. eISBN: 978-0136621553
2. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books. eISBN: 9780080479958.

Reference Books:

1. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman eISBN: 978-0860107149
2. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.

Web Links:

1. <https://www.slb.com/resource-library/oilfield-review/defining-series/defining-drilling>
2. <https://onepetro.org/JPT/article/36/06/889/73274/Wellbore-Stability>
3. https://petrowiki.spe.org/Production_system
4. https://wiki.aapg.org/Artificial_lift
5. <https://www.petrosync.com/blog/what-is-well-stimulation/>

Unconventional Hydrocarbon Resources

Course Code: 2501PT16

L	T	P	C
1	1	0	2

Course Outcomes:

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

- CO1:** Explain the present global energy scenario
- CO2:** Determine the Characteristics of a Tight Reservoir and Oil
- CO3:** Illustrate the origin and characterize shale gas
- CO4:** Demonstrate the Characteristics of Coal Bed Methane and Gas Hydrates
- CO5:** Explain the heavy oil reservoirs and their challenges

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction

Introduction to Unconventional Hydrocarbon resources, Coal Bed Methane: Geological controls in CBM plays, Resource estimation, Drilling, completion and production performance of a CBM well, Indian Scenario

UNIT – II

Tight Gas and Oil

Characteristics of a Tight Reservoir; What makes them Tight; The Permeability Jail; Where to find Tight Reservoirs; Drilling practices for Tight reservoirs; Formation Evaluation; Hydraulic Fracturing, Post Fracture Reservoir evaluation; New Technologies

UNIT – III

Shale Gas/ Oil

Introduction, geology, important occurrences, petrophysical properties, hydro fracturing, horizontal wells, production profiles.

UNIT –IV

Coal Bed Methane and Gas Hydrates

Characteristics of Coal Bed Methane Gas; Drilling practices for Coal Beds; Workflow for Coal Bed Formation Evaluation, Cleat, Gas Content; Hydraulic Fracturing, Depressuring and Dewatering issues Success and Lessons learnt so far; Gas Hydrates: Mineralogy, Chemistry and physical properties, stability, challenges and pitfalls

UNIT – V

Non-Conventional Oil

Introduction to Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales; origin and occurrence worldwide, resources, reservoir characteristics, new production technologies

Textbooks:

- 1 Unconventional Gas Reservoirs: Evaluation, Appraisal, and Development, Islam M.R., Gulf Professional Publishing, 2014 eISBN: 978-0128017682.
- 2 Coal Bed Methane: From Prospects to Pipeline, Thakur P., Aminian K., Schatzel S., Elsevier Science Publishing, 2015. eISBN: 978-0128002138

Reference Books:

- 1 Geophysical Characterization of Gas Hydrates: 14 (Geophysical Developments), Michael Riedel, Satinder Chopra, Society of Exploration Geophysicists; 1st edition, 2010 eISBN: 978-1560802454
- 2 Shale Gas: Exploration and Environmental and Economic, Anurodh Mohan Dayal, Devleena Mani, Elsevier Science Publishing, 2017. eISBN: 978-0128041519.

Web Links:

- 1 <https://link.springer.com/article/10.1007/s13202-021-01404-x>
- 2 https://spgindia.org/10_biennial_form/P260.pdf
- 3 <https://www.iogp.org/wp-content/uploads/2016/10/An-introduction-to-shale-oil-and-gas-Jul2015-1.pdf>https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
- 4 https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
- 5 <https://www.open.edu/openlearn/science-maths-technology/living-without-oil/content-section-1>.

Natural Gas Hydrates

Course Code: 2501PT49

L T P C
3 0 0 3

Course Outcomes:

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

- CO 1: Explain the necessity of natural gas hydrates, different hydrate types and formers.
- CO 2: Apply different hand calculation methods and computer methods for rapid estimation of hydrate formation conditions.
- CO 3: Outline the design information for battling hydrates using chemicals and the reasons responsible for dehydration of gas.
- CO 4: Identify the regions of pressure and temperature for combating hydrate formation and the importance of physical properties of design processes.
- CO 5: Examine the relationship between fluid phase equilibria and hydrate formation and water content of natural gas.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	2
CO5	2	2	-	-	-	-	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT-I:

Introduction: Overview of Natural Gas Hydrates; Natural Gas; The Water Molecule; Hydrates; Water and Natural Gas; Heavy Water.

Hydrate Types and Formers: Type I Hydrates; Type II Hydrates; Type H Hydrates; Size of the Guest Molecule; N-Butane; Other Hydrocarbons; Cyclopropane; 2-Butane; Hydrogen and Helium; Chemical Properties of potential Guests; Liquid Hydrate Formers; Hydrate Forming Conditions; L_A+L_N+H Correlations; Quadruple Points; Other Hydrate Formers; Hydrate Formation at ^0C ; Mixtures.

UNIT-II:

Hand Calculation Methods: Gas Gravity Method; K-Factor Method; Baillie-Wichert Method; Other Correlations; Comments on all of these methods; Local Models.

Computer Methods: Phase Equilibrium; Van der Waals and Platteeuw; Parrish and Prausnitz; NG and Robinson Methods; Calculations; Dehydration.

UNIT-III:

Inhibiting Hydrate Formation with Chemicals: Freezing Point Depression; Hammer-Schmidt Equation; Nielsen-Bucklin Equation; New method; Brine Solutions; Comment on the Simple Methods; Advanced Calculation Methods; Inhibitor Vaporization; Comment on the Injection Rates; Safety Considerations; Low Dosage Hydrate Inhibitors.
Dehydration of Natural Gas: Water Content Specification; Glycol Dehydration; Mole Sieves; Refrigeration.

UNIT-IV:

Combating Hydrates using Heat and Pressure: Plugs; Use of heat; Depressurization; Melting a Plug with Heat; Hydrate Plug Location.

Physical Properties of Hydrates: Molar Mass; Density; Enthalpy of Fusion; Heat Capacity; Thermal conductivity; Mechanical Properties; Volume of Gas in Hydrate.

UNIT-V:

Phase Diagrams: Phase Rule; Comments about Phases; Single Component Systems; Binary Systems; Phase behavior below 0°C; Multi component Systems.

Water Content of Natural Gas: Dew Point; Equilibrium with Liquid Water; Equilibrium with Solids.

Text Books:

1. Natural Gas Hydrates: A Guide for Engineers, John Carroll, Elsevier Publications, 3rd Edition, 2014. eISBN: 9780128000748
2. Clathrate Hydrates of Natural Gas, E Dendy Sloan, Jr., C Koh, CRC Publications, 3rd Edition, 2007. eISBN: 978-0849390784

Reference Books:

1. Natural Gas Hydrates in Flow Assurance, E Dendy Sloan, Jr., C Koh, Amadeu K Sum, Elsevier Publications, 2011. eISBN: 9781856179454
2. Exploration of Gas Hydrates; Geophysical Techniques, Naresh Kumar Thakur, Sanjeev Rajput, Springer Publications, 2011. eISBN: 978-36625019578

Web Links:

1. https://www.researchgate.net/publication/300953314_Hydrate_Types_and_Formers
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Glycol_dehydration
4. <https://www.hindawi.com/journals/jther/2010/271291/>
5. <https://www.ogj.com/articles/print/volume-91/issue-13/in-this-issue/gas-processing/chart-estimates-water-content-of-sour-natural-gas.html>

Fundamentals of Liquefied Natural Gas

Course Code: 2501PT5

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the LNG value chain
- CO2:** Classify the different liquefaction technologies of LNG
- CO3:** Explain the components of LNG receiving terminals
- CO4:** Summarize LNG storage and transportation facilities
- CO5:** Identify major equipment and safety aspects of LNG industry

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Introduction: Overview of LNG industry -History of LNG industry – Base load LNG – Development of an LNG Project – World and Indian Scenario– Properties of LNG.

UNIT – II

Propane precooled mixed refrigerant process – Description of Air products C3MR LNG process–. Description of Conoco Phillips optimized cascade (COPOC) process – Liquefaction– LNG flash and storage.

Other Liquefaction Processes: Description of Linde MFC LNG process- Precooling and Liquefied Petroleum Gas (LPG) recovery – Liquefaction and sub cooling- Trends in LNG train capacity –strategy for grassroots plant- offshore LNG production.

UNIT – III

Gas pre-treatment: Slug catcher– NGL stabilization column – Acid gas removal unit – Molecular sieve dehydrating unit Receiving terminals in India – Main components and description of marine facilities – LNG tanks– Process descriptions. –Mercury and sulphur removal unit–NGL recovery–Nitrogen rejection–Helium recovery.

UNIT – IV

LNG Shipping Industry: LNG fleet – Types of LNG ships – Moss – Membrane – prismatic; Cargo measurement and calculations, Cryogenic heat exchangers: Spiral– Wound heat exchangers – Plate & fin heat exchangers – Cold boxes; Centrifugal compressors –Axial compressors – Reciprocating compressors; LNG pumps and liquid expanders –Loading Arms and gas turbines, Description of Regasification.

UNIT – V

Submerged combustion vaporizers- Open rack vaporizers–Shell and tube vaporizers: direct heating with seawater, and indirect heating with seawater. Safety design of LNG facilities – Security issues for the LNG industry – Environmental issues– Risk-based analysis of an LNG plant.

Ambient air vaporizers: Direct heating with ambient air – Indirect heating with ambient air.

Textbooks:

- 1 LNG: Basics of Liquefied Natural Gas, Stanley Huang, Hwa Chiu and Doug Elliot, 1st Edition, PETEX. eISBN: 978-0886982171
- 2 Marine Transportation of LNG (Liquefied) and related products, Richard G. Wooler, Gornell Marine Press. eISBN: 9780608024646

Reference Books:

- 1 Natural Gas by Sea: The Development of a new technology, Roger Rooks, With by Publishers eISBN: 9780856140549
- 2 Marine Transportation of Liquefied Natural Gas, Robert P Curt, Timothy D. Delaney, National Maritime Research Centre. eISBN:

Web Links:

- 1 <http://folk.ntnu.no/skoge/prost/proceedings/aiche2008/data/papers/P139095.pdf>
- 2 https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook_demos/lng/html/index.Htm
- 3 [http://petrowiki.org/Liquified_natural_gas_\(LNG](http://petrowiki.org/Liquified_natural_gas_(LNG)
- 4 <http://www.chebeague.org/fairwinds/risks.htm>
- 5 http://www.beg.utexas.edu/energyecon/LNG_Safety_and_Security_Update_2012.pdf

Artificial Lift Techniques

Course Code: 2501PT50

L T P C
3 0 0 3

Course Outcomes:

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

- CO 1: Explain the fundamental concepts of artificial lift techniques such as reservoir pressure, well productivity and reservoir fluids.
- CO 2: Apply sucker rod lift system, polished rod motion, FRP sucker rods, criteria for rod string design with advantages and limitations.
- CO 3: Apply gas lift, gas compression requirements sonic flow, subsonic flow, volumetric efficiency advantages and limitations.
- CO 4: Explain electrical submersible pumps, principle hydraulic piston pumping advantages and limitations.
- CO 5: Explain hydraulic jet pumping advantages and disadvantages.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes

CO / PSO	PSO 1	PSO 2
CO1	2	-
CO2	3	-
CO3	3	-
CO4	-	1
CO5	-	-

UNIT-I:

Introduction of artificial lift:

Definition and Purpose of artificial lift selection-Reservoir pressure and well productivity-reservoir fluids-Types of artificial lift.

UNIT-II:

Sucker Rod lift:

Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods-Non-API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift installation.

UNIT –III:**Gas lift:**

Gas lift system-gas compression requirements sonic flow-subsonic flow- volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve-continuous and intermittent gas lift advantages and limitations

UNIT-IV:**Electrical submersible pumps, Progressive cavity pumping:**

Electrical submersible Pumps (ESP)-principle-hydraulic piston pumping-ESP design-ESP advantages and limitations.

Progressive cavity pumping: Plunger lift-working principle-design-plunger lift models-progressive cavity pumping (PCP) advantages and limitations

UNIT-V:**Hydraulic Jet pumping:**

Hydraulic Jet pumping-selection of jet pump-advantages and disadvantages.

Selection of artificial lift method: Artificial lift method selection-gas lift vs pump assisted lift-installation and replacement of artificial lift-maintenance of artificial lift.

Text Books:

1. Petroleum Production engineering: A computer-assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books. eISBN: 978-0123838469
2. Petroleum Engineering Handbook-Production Operations Engineering, volume 4 by Joe Dunn Clegg and Larry W. Lake, SPE. eISBN: 978-1555631147

Reference Books:

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488. eISBN: 978-0136586832
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn WellBooks, Tulsa, Oklahoma. eISBN: 978-0878141545

Web Links:

1. http://petrowiki.org/Sucker-rod_lift
2. http://petrowiki.org/Gas_lift
3. http://petrowiki.org/Electrical_submersible_pumps
4. http://petrowiki.org/Hydraulic_pumping
5. https://en.wikipedia.org/wiki/Progressive_cavity_pump

Enhanced Oil Recovery

Course Code: 2501PT03

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Explain the basic features and technical foundations of the most common EOR methods
- CO2:** Explain the basic geological factors for flooding of reservoirs
- CO3:** Apply screening criteria to a given reservoir to select a displacement method both technically and economically
- CO4:** Make Use of rock, fluid, and reservoir data for the Displacement of fluids in the reservoir
- CO5:** Apply screening criteria to a given reservoir to select a chemical method for flooding

Mapping of Course Outcomes with Program Outcomes:

CO/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	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	2
CO5	2	-	-	-	-	-	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Principles of enhanced oil and gas recovery methods. IOR, EOR& EGR. Screening criteria for EOR methods.

UNIT – II

Geological Factors in Enhanced Oil Recovery

Reservoir heterogeneities, Examples of geological factors in enhanced recovery projects
Natural fractures,

Determination of Residual Oil Saturation based on

Geophysical Well logging techniques, Determination of residual saturation, Well-log-derived oil saturation determination in open hole, Residual oil saturation determination in cased wellbore

UNIT – III

Immiscible displacement: Injection well location, production well completion, surface installation. Miscible drive: Miscible slug flooding, thermodynamic miscibility, ternary diagrams, methods of miscible drive. Benham's correlations, physical and mathematical modelling.

UNIT – IV

Displacement of fluids in reservoir: capillary force; viscous force; phase trapping; mobilization of trapped phases, and alteration of viscous/capillary force ratio.

UNIT – V

Design aspects of chemical flooding. Case studies of surfactant, alkali, polymer, ASP flooding. WAG process, SWAG process, and Chemical augmented WAG process. Foam flooding.

Textbooks:

- 1 Enhanced Oil Recovery: Mechanisms, Technology, and Feasibility" by Ajay Mandal and Keka Oja. eISBN: 978-0128200810.
- 2 Applied Enhanced Oil Recovery, Aural Carcoane, Prentice Hall eISBN: 9780130442727

Reference Books:

- 1 Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, eISBN: 9781851666171
- 2 Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier eISBN: 978-3-319-31421-1
- 3 Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, eISBN: 9780132816014

Web Links:

- 1 <https://www.ogj.com/oil-drilling-and-production/production-operations/ior-eor.html>
- 2 http://www.ccop.or.th/ppm/document/INWS4/INWS4DOC03c_Norway_GUNNA_R.pdf
- 3 https://petrowiki.org/Polymer_waterflooding
- 4 https://www.glossary.oilfield.slb.com/en/Terms/a/alkaline_flooding.aspx
- 5 https://petrowiki.org/Conformance_improvement

Petroleum Refinery Engineering

Course Code: 2501PT12

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify the types of petroleum feed stocks and products by their properties
- CO2:** Make use of process knowledge to solve operational problems and increase the efficiency
- CO3:** Apply the knowledge of crucial processes to meet the end product demands
- CO4:** Prioritize the demand of various petrochemicals to optimize the processes
- CO5:** Classify various petrochemical products and their uses

Mapping of Course Outcomes with Program Outcomes:

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

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 of Petroleum:

Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as True Boiling (TBP), American Society for Testing Materials (ASTM).

UNIT – II

Properties of Crude and Petroleum Products:

Various types of Average Boiling Points of Crude Oil & Petroleum Fractions.

Types of Gases & their Composition, Types of Gasoline & it's Important Properties and tests such as ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content etc, Various Types of Naphtha and their Important Properties & Applications.

Important Tests & Properties of Kerosene such as Flash& Fire Point, Smoke Point, Aniline Point etc.,

Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc.

Heavy Fractions like Lube Oil, Bitumen, Asphalt etc & their Important Properties such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.

UNIT – III

Processing of Petroleum:

Pretreatment of Crude (Dehydration & Desalting), Pumping of Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux, ADU & VDU.

UNIT – IV

Thermal & Catalytic Cracking:

Thermal cracking – Processes, operating parameters, feed stock selection and product yields, Advantages –Types and functions of secondary processing – Visbreaking – Processes, operating parameters and advantages–Coking –Operating parameters and advantages. Fluid catalytic cracking –processes, operating parameters, feed stock selection and product yields –Advantages.

UNIT – V

Treatment Techniques:

Physical Impurities found in Crude& their Removal, Sweetening Techniques, Production and Treatment of LPG & their Methods, Dehydration and Sweetening of Gases, Gasoline Treatment such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Treatment of kerosene.

Textbooks:

- 1 Petroleum Refining: Technology and Economics ,J.H.Gary and G.E.Handwerk, 5th Edition, Marcel Dekkar, Inc. eISBN: 9780203907924
- 2 Elements of Petroleum Processing, D S Jones, Wiley–Blackwell. eISBN: 9780471964896

Reference Books:

- 1 Petroleum Refining Engineering, WL Nelson, 4th Edition, McGraw Hill Company eISBN: 9780070462687
- 2 Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers eISBN: 9780846404385
- 3 Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company eISBN: 9782710810650

Web Links:

- 1 <https://www.scribd.com/doc/.../Surface-Production-Operations-Volume-1-Oil-System>
- 2 www.academia.edu/.../Ken_Arnold-Surface_Production_Operations_Volume_1_3rdE
- 3 <https://byjus.com/chemistry/petroleum/>
- 4 <https://www.slideshare.net/.../surface-production-operations-volume-iv-pumps-compr...>
- 5 https://www.researchgate.net/publication/359449933_Petroleum_sludge_treatment_and_disposal_techniques_a_review

Minor Degree in Civil Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CE25	Repair & Rehabilitation of Structures	FC	3			3	50	50	100	-
2501CE43	Building Planning & Computer-Aided Drawing	FC			2	2	50	50	100	-
2501CE27	Green Buildings	FC	3			3	50	50	100	-
2501CE40	Fundamentals of Soil Behaviour	FC	2	1		3	50	50	100	-
2501CE54	Railway Engineering (or)	FC	3			3	50	50	100	-
2501CE47	Docks & Harbour Engineering									
2501CE36	Environmental Impact & Risk Management (or)	IC	3			3	50	50	100	-
2501CE37	Environmental Management									
2501CE56	Urban Transportation Planning (or)	IC	3			3	50	50	100	-
2501CE49	Intelligent Transportation Systems									
Total			17	1	2	20				

Repair & Rehabilitation of Structures

Course Code: 2501CE25

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Describe the concept of repair and its need.
- CO2:** Classify various causes of deterioration of concrete structure and Distresses monitoring techniques.
- CO3:** Identify the effect of corrosion on structures.
- CO4:** Assessing the techniques for repairing.
- CO5:** Apply the NDT techniques to assess the condition of the structures& explain seismic retrofitting and maintenance of heritage structures.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction:

Maintenance and Repair strategies - Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure.

UNIT – II

Deterioration of Structures:

Introduction, Basic terminology – Causes of deterioration, physically induced deterioration, chemically induced deterioration, Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking

UNIT – III

Corrosion of structures:

Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Coatings - Cathodic protection for reinforcements-design and construction errors - Effects of cover thickness and cracking.

UNIT – IV

Rehabilitation and retrofitting methods:

Repair: Gunning, Shotcreting, Epoxy – Cement mortar injection, Crack ceiling
Rehabilitation Methods: Grouting, Imbalance of structural stability, Strengthening & Stabilization techniques, Design consideration – Beam shear capacity strengthening – Shear transfer strengthening – Stress reduction techniques – Column strengthening, Flexural strengthening – Connection stabilization & strengthening.

UNIT – V

Damage Assessment:

Repairs to Structures - Repair of structures distressed due to earthquake – Strengthening using FRP Strengthening and stabilization techniques for repair Non – Destructive testing methods – Rebound hammer, Ultrasonic pulse velocity, Rebar locator, Corrosion meter, Penetration resistance & Pullout tests. Seismic Retrofitting and Maintenance of Heritage Structures: Earthquake damages of buildings, their retrofitting and restoration. Effects of earthquakes. Methods of seismic retrofitting, restoration of buildings, Special care in repair and rehabilitation of heritage structures.

Text Books:

1. Maintenance Repair Rehabilitation & Minor works of Buildings- P.C. Varghese, PHI Publications. (ISBN: 978-81-203-4945-2)
2. Repair and Rehabilitation of Concrete Structures – P.I. Modi, C.N. Patel, PHI Publications. (ISBN : 9788120352148).

Reference Books:

2. Rehabilitation of Concrete Structures - B. Vidivelli, Standard Publishers Distributors (ISBN : 9788180141102).
3. Concrete Repair and Maintenance illustrated - Peter H.Emmons (ISBN-13: 978-0876292860).

Web Links:

1. https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures
2. <https://nptel.ac.in/courses/105/106/105106202/>

Building Planning & Computer Aided Drawing

Course Code: 2501CE43

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Study the CAD software and basic functions.
- CO2:** Plan different types of buildings as per NBC regulations and building laws
- CO3:** Sketch the various building components
- CO4:** Evaluate plans of Single storied building & multistoried buildings
- CO5:** Develop different sections at different elevations
- CO6:** Detailing of building components like doors, windows and roof trusses etc.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	3	3	2	2	2	2	2
CO2	3	-	-	-	2	3	2	2	2	2	1
CO3	3	-	-	-	2	2	2	2	2	2	2
CO4	2	-	-	-	3	3	2	2	2	2	2
CO5	2	-	-	-	3	3	2	2	2	2	2
CO6	2	-	-	-	3	3	2	2	2	2	2

Practice:

1. Introduction to various CAD commands with simple examples
2. To understand about Principles of building planning and building bye-laws.
3. To draw the foundation details for the buildings.
4. To draw the stretcher and header bond.
5. To draw the English and Flemish bond.
6. To draw the plan section and elevation of different types of staircases
7. To draw the plan section & elevation of buildings using software a) Single storeyed b) Multi storeyed residential buildings
8. To draw the developed plan, elevation, section and site plan of public buildings (Hospital & or School buildings).
9. Detailing of building components like doors and windows.
10. To draw the elevation of roof structures like king post and queen post truss.

Additional Practice:

1. To draw the plan, elevation, section and site plan of Industrial buildings
2. To draw the plan and elevation of different types staircases.
3. To draw the plan, elevation, and section of two storied building.

Text Books:

- Building Planning and Drawing, Dr. N. Kumara Swamy, A. Kameswara Rao,
1. Charotar Publishing House Pvt. Ltd. 2019, 9th edition. (ISBN: 13. 978-9385039386).
2. Building Planning and Drawing by S.S. Bhavikatti, Dreamtech Press India Pvt. Ltd, 1 Edition 2019. (ISBN: 13. 978-9389307085)

Reference Books:

1. Building, Planning and Drawing - Tech Knowledge Publications by Nishant A. Upadhye (ISBN: 978-93-89684-17-9)
2. Model Building Bye-laws 2016, Young Global Publications (ISBN-13:978-8188274475)
3. Planning, Designing and scheduling, Girescharan Singh & Jagadish Singh, Published by Standard Publishers Distributors. (ISBN: 13. 978-8180140051)
Repair & Rehabilitation of Structures

Web Links:

1. <http://www.bsiet.org/notes/BPD%20Theory.pdf>
2. <https://sites.google.com/a/mitr.iitm.ac.in/iitmcivil/ce2050>
3. <http://www.cadmatesoftware.com/>

Green Buildings

Course Code: 2501CE27

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1: Define sustainability and a green building, along with its features and benefits.
- CO 2: Describe the methods used to maintain indoor environmental quality.
- CO 3: Describe the water efficiency methods
- CO 4: Design sustainable and energy efficient civil engineering projects.
- CO 5: Select materials for sustainable built environment & adopt waste management methods.

Mapping of course outcomes with program outcomes:

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

UNIT I

Green Building Concept:

Overview of green building movement; Concept of Green building and sustainable development; Issues and strategies of Green building and sustainable development; Objectives Principals and Benefits of Green building design; Introduction to High-performance building; integrated design process of high-performance building; Green project requirements and strategies; Overview of various green rating systems worldwide.

UNIT-II:

Green Building Materials and Indoor Environment Quality

Introduction; Low emitting materials; Building and material reuse; Construction waste management; Regional materials; Life cycle cost assessment of building materials and products; Factors affecting indoor environment quality; Ventilation and filtration; Building materials and finishes- Emittance level; Indoor Environment quality best practice.

UNIT-III:

Water:

Reduce, Reuse and Recycle: Introduction; Wastewater strategy and water reuse/recycling; Water fixtures and water use reduction strategies.

UNIT-IV:**Energy Efficiency:**

Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy:

Energy efficient building envelopes, Solar Heat Gain Coefficient, U-Values for facade materials, efficient lighting technologies, energy efficient and BEE rated appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of NET ZERO buildings.

UNIT-V:**Building materials:**

Methods to reduce embodied energy in building materials: (a) Local building materials. (b) Natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks. (c) Materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) Reuse of waste and salvaged materials.

Waste Management:

Handling of construction & demolition waste materials, separation of household waste, handling e-waste, on-site and off-site organic waste management.

Text Books:

1. Alternative Building Materials and Technologies, K.S. Jagadeesh, B.V. Venkata Rama Reddy, and K.S. Nanjunda Rao, New Age International Publishers. (ISBN: 9788122433110)
2. Green Building Fundamentals, Mike Montoya, Pearson in the USA. (ISBN: 9780135066403)

Reference Books:

1. Green Buildings, Peter Gevorkian, published by McGraw-Hill. (ISBN: 9780071473590)
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison, and Rob Harrison, E & FN Spon (an imprint of Thomson Science & Professional). (ISBN: 9780419236900)

Web Links:

1. <https://www.igbc.in/>
2. <http://www.sbtmanual.in/>
3. <https://www.grihaindia.org/>

Fundamentals of Soil Behaviour

Course Code: 2501CE40

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Identify the probable soil formation history
- CO2:** Evaluate the soil fabric by indirect and direct methods
- CO3:** Identify and solve soil water interaction problems
- CO4:** Evaluate the soil compressibility aspects and estimate probable settlements.
- CO5:** Asses the shear strength characteristics by conducting the most appropriate tests

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Soil Formation and Composition :

Origin, nature and distribution of soil, description of individual particle, clay mineralogy, clay-water electrolytes, soil fabric and structure

UNIT – II

Effective Stress and Soil Permeability:

Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination of coefficient of permeability.

UNIT – III

Soil Consolidation :

Consolidation in one, two, three and radial direction, variation of effective stress during consolidation, consolidation tests and determination of consolidation parameters.

UNIT – IV

Shear Strength of Soils:

Stress path analysis, tri-axial and direct shear tests, shear behaviour of granular soils and Fine-Grained Soils, factors affecting shear behaviour, determination of shear strength parameters, pore pressure parameters, UU,CU, CD tests, total and effective shear strength parameters, factors affecting shear strength- determination of in situ undrained strength.

UNIT – V

Critical State Model :

Introduction models and soil mechanics, use of models in engineering, elasticity, soil elasticity, plasticity and yielding, yielding of metal tubes in combined tension and torsion, elastic-plastic model for soil, elastic volumetric strains, a particular elastic-plastic model.

Text Books:

1. Soil Mechanics and Foundation Engineering ,Arora K.R., Standard publisher, 2020. (ISBN: 13- 978-8180141126).
2. Soil Mechanics and Foundations , Punmia, B.C., Laxmi Publications Pvt. Ltd. New Delhi. (ISBN: 13- 978-8170087915).

Reference Books:

1. Text book in Fundamentals of Soil Behaviour , Mitchell, J. K., , John Wiley & Sons, New York, 2Ed. (ISBN: 13- 978-0471856405).
2. Soil Behaviour and critical State Soil Mechanics , Muir Wood , Cambridge University Press. (ISBN: 13- 978-0521337823).

Web Links:

1. <https://nptel.ac.in/courses/105101084>
2. <https://archive.nptel.ac.in/courses/105/101/105101201/>

Railway Engineering

Course Code: 2501CE54

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain different components of railway track.
- CO2:** Design track gradients as per given requirements.
- CO3:** Discuss various types of tracks turnouts and crossings.
- CO4:** Explain interlocking and signaling systems.
- CO5:** Describe purposes and facilities at Railway Stations.
- CO6:** Explain track maintenance.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	2	2	3	-	-	-	-	-	-	-	-
CO3	-	2	3	-	-	1	-	-	-	-	-
CO4	-	1	3	-	-	2	-	-	-	-	-
CO5	1	-	-	-	-	2	-	-	-	-	-
CO6	1	-	-	-	-	2	-	-	-	-	-

UNIT – I

Components of Railway Engineering:

Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings – Creep of Rails- Theories related to Creep – Adzing of Sleepers- Sleeper density – Rail joints.

UNIT – II

Geometric Design of Railway Track:

Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves.

UNIT – III

Turnouts & Controllers:

Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing – Inspection and maintenance of Points and Crossings.

UNIT – IV

Signalling and Interlocking:

Objectives of Signalling - Classification of Signals – Fixed Signals - Stop Signals Signalling Systems – Mechanical Signalling System - Electrical Signalling System - Systems for Controlling Train Movement – Interlocking - Modern Signalling Installations.

UNIT – V

Railway Stations and Yards:

Purpose of a Railway Station - Selection of Site for a Railway Station - Facilities Required at Railway Stations – Requirements of a Passenger Station Yard - Classification of Railway Stations - Station Platforms - Types of Yards.

Text Books:

1. Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi, 2020. (ISBN: 9780195687798).
2. Railway Engineering, Rangwala, Charotar Publishing House. (ISBN: 9788177643260).

Reference Books:

1. Roads, Railways, Bridges & Tunnel Engineering, T.D.Ahuja & G.S.Birdie. (ISBN: 9788189401337).

Web Links:

1. <https://nptel.ac.in/courses/105/107/105107123/>
2. <http://www.nptelvideos.in/2012/11/transportation-engineering-ii.html>
3. <https://lecturenotes.in/subject/458>

Docks & Harbour Engineering

Course Code: 2501CE47

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Introduce history and classifications of harbors
- CO2:** Explain the fundamentals of Harbor planning
- CO3:** Explain the natural forces affecting ports and general design aspects of marine structures
- CO4:** Describe various navigational aids and dock & repair facilities
- CO5:** Describe maintenance and protection of port facilities

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Harbor Planning:

Types of water transportation, water transportation in India, requirements of ports and harbors, classification of harbors, selection of site and planning of harbors, location of harbor, traffic estimation, master plan, ship characteristics, harbor design, turning basin, harbor entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

UNIT – II

Harbor Works:

Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, the necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

UNIT – III

Docks and Repair Facilities:

Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of the lock, lock gates, types of gates.

UNIT – IV

Port facilities:

Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.

UNIT – V

Dredging, Coastal Protection and Inland navigation:

Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone, and beach profile. Inland waterways, Inland water transportation in India, classification of waterways, the economics of inland waterways transportation, national waterways.

Text Books:

1. Dock and Tunnel Engineering, Srinivasan and S. C. Rangwala, Harbour, Charotar Pub House, Anan. (ISBN: 9788192869261).
2. Docks and Harbour Engineering, Bindra S.P. - Dhanpat Rai & Sons, New Delhi.(ISBN: 9788189928858).

Reference Books:

1. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad,2020. (ISBN: 9789389211160).
2. Port Design - Guidelines and recommendations, C. A. Thoresen, Tapir Publications,2018. (ISBN: 97882501908399).
3. Highway, Railway, Airport and Harbor Engineering, Subramanian K. P, Scitech Publications (India) Pvt Limited, Chenna. (ISBN:13- 9788195330591).

Web Links:

1. <https://nptel.ac.in/courses/114106025>
2. <https://lecturenotes.in/s/1892-dock-harbour-and-airport-engineering/videos>

Environmental Impact & Risk Assessment

Course Code: 2501CE36

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Apply basic principles of EIA
- CO2:** Illustrate the necessity to study the impacts
- CO3:** Interpret different risks that will be caused by projects or industries
- CO4:** Identify methods to overcome these impacts
- CO5:** Demonstrate the concepts of the legal requirements of Environmental and Risk Assessment for projects.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction :

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA – EIA process – screening – scoping – setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA.

UNIT – II

Impact Identification and Prediction:

Matrices – Networks – Checklists – Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological – Cumulative Impact Assessment.

UNIT – III

Social Impact Assessment and Eia Documentation:

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

UNIT – IV

Environmental Management Plan :

Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post

project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies.

UNIT – V

Environmental Risk Assessment and Management:

Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modelling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.

Text Books:

1. Environmental Impact Assessment , Canter, L.W., McGraw Hill, New York. (ISBN: 0070097674).
2. Environmental Impact Assessment – Practical solutions to recurrent problems, Lawrence, D.P., Wiley-Interscience, New Jersey. (ISBN: 978-0-471-72202-1).

Reference Books:

1. Environmental Risk and Hazards, Cutter, S.L., Prentice-Hall of India Pvt. Ltd., New Delhi, (ISBN: 0137538561)
2. Risk Assessment and Management Handbook, Kolluru Rao, Bartell Steven, Pitblado R and Stricoff , McGraw Hill Inc., New York. (ISBN: 13978-0070359871)
3. Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control Sam Mannan, Lees, 4th Edition, Butterworth Heineman. (ISBN: 978-0-7506-7555-0)

Web Links:

1. <https://nptel.ac.in/courses/120108004>
2. <https://www.witpress.com/journals>
3. <https://www.researchgate.net/publication/235859306>

Environmental Management

Course Code: 2501CE37

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the physical and chemical treatment processes
- CO2:** Knowledge on various unit operations e.g, sedimentation tank, coagulation and filtration tank.
- CO3:** Knowledge on biological treatment significance
- CO4:** Know the aerobic treatment of wastewater
- CO5:** Understand the anaerobic treatment of wastewater

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Principles of Environmental Management

Definition of Environmental Management - Principles of Environmental Management - Nature, Scope and Components of Environmental Management - Policies and Legal Aspect of Environmental Management.

UNIT – II

Sustainable Environmental solutions

Public Private Participation Model - ISO Certification - Environment Health & Safety (EHS) - Environment & Disaster Management (EDM) - Environmental organizations for planning and implementation of sustainable development.

UNIT – III

Environmental Management Plan

Preventive and reactive strategies for environmental pollution control - Life Cycle Assessment as Environmental Management Tool - Environmental Management Plan (EMP) - Components of EMP - Preparation of EMP - Case Study

UNIT – IV

Environmental Impact Assessment

Environmental Impact Assessment (EIA) - Need and Importance - Steps involved - Methods of EIA - Ad-hoc, checklist, network, matrix etc - Typical case studies of environmental impact assessment - Environmental impact statement and risk assessment

UNIT – V

Environmental Legislations

Environmental Legislation - Air, Water and Environmental acts - Preventive and reactive strategies for environmental pollution control - Environmental Audit.

Text Books:

1. Assessment and analysis of Environmental management, Shukla S. S., Shrivastva P. R, commonwealth publishers New Delhi (ISBN: 8171692192).
An introduction to Environmental Management, Dr, Anand Bal, Himalaya Publishing House, (ISBN-13 978-8183183758).
- 2.

Reference Books:

1. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International editions (ISBN-13 978-0070097643).
Environmental Management 2013, Vikas Khanna, D. R. & Chopra, A. K. & Matta,
2. Gagan & Bhutiani, R. & Singh (ISBN-13 978-8170358220).

Web Links:

1. <https://enviromicro-journals.onlinelibrary.wiley.com/journal/14622920>.
2. <https://link.springer.com/book/10.1007/978-94-017-9118-2>

Urban Transportation Planning

Course Code: 2501CE56

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Design, conduct and administer surveys to provide the data required for transportation planning.
- CO2:** Explain the process of data collection about travel behavior and analyze the data for use in transport planning
- CO3:** Develop and calibrate modal split, trip generation rates for specific types of land use developments
- CO4:** Apply the mode choice behaviour and mode split models.
- CO5:** Adopt the steps that are necessary to complete a long-term transportation plan.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction:

Urbanization, urban class groups, transportation problems and identification, impacts of transportation, urban transport system planning process, modeling techniques in planning. Urban mass transportation systems: urban transit problems, travel demand, types of transit systems

UNIT – II

Data Collection:

Types and Sources of Data Trip generation models - Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models.

UNIT – III

Trip Generation:

UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates; Trip Distribution by Growth Factor Methods. Problems on above.

UNIT – IV

Trip Distribution:

Gravity Models, Opportunity Models, Time Function Iteration Models. Travel demand modeling: gravity model, opportunity models, Desire line diagram. Modal split analysis. Problems on above.

UNIT – V

Traffic Assignment:

Land use transportation models – Urban forms and structures - Location models - Accessibility – Land use models - Lowry derivative models Diversion Curves; Basic Elements of Transport Networks, Coding, Route Properties, Path Building- Preparation of alternative plans - Evaluation technique.

Text Books:

1. Principles of Urban Transportation System Planning , Hutchinson B.G., McGraw Hill. (ISBN : 13. 978-0070315396).
2. Introduction to Transportation Planning , J. Hutchinson, London. (ISBN: 13: 9780090986200).

Reference Books:

1. Transportation Engineering , Kent Lall, Prentice Hall of India (ISBN-13: 978-9332569706).
2. Transportation Engineering and Planning, C.S. Papacostas and P.D. Prevedouros, Prentice Hall of India Pvt. Ltd (ISBN-13: 978-0130814197)
3. Highway Engineering, S.K. Khanna& C.E.G. Justo, Nemchand & Bros., 10th edition (ISBN-13: 978-8185240930)

Web Links:

1. <http://nptel.ac.in/courses/105101087/29>
2. <https://novalynx.com/store/pc/What-Is-a-Wind-Rose-d55.htm>
3. <https://ircep.gov.in/>

Intelligent Transportation Systems

Course Code: 2501CE49

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify and differentiate ITS user services and their components.
- CO2:** Study the telecommunications in ITS.
- CO3:** Interpret ITS functional areas.
- CO4:** Implement suitable ITS and services for effective transportation.
- CO5:** Applications of Automated Highway Systems.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction:

Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT – II

Telecommunications in ITS:

Importance of telecommunications in the ITS system, Information Management, Traffic Management Centers (TMC). Vehicle – Roadside communication – Vehicle Positioning System.

UNIT – III

ITS functional areas:

Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

UNIT – IV

ITS User Needs and Services:

Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

UNIT – V

Automated Highway Systems:

Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

Text Books:

1. Fundamentals of Intelligent Transportation Systems Planning, M.A. Chowdhury and A. Sadek, Artech House, First Edition. (ISBN: 9781580534702).
2. Intelligent Transport Systems, Sarkar, Pradip Kumar, and Amit Kumar Jain, PHI Learning, 2018, First Edition. (ISBN: 9788120353001).

Reference Books:

1. Economic Impacts of Intelligent Transportation Systems: Innovations and Case Studies, Bekiaris and Y.J. Nakanishi, Elsevier/JAI. (ISBN: 9780762310320).
2. Intelligent Transport Systems Standards, Bob Williams, Artech House Publishers. (ISBN: 9781607839324)
3. Intelligent Transport Systems: Cases and Policies, Roger Stough, Edward Elgar. (ISBN: 3. 978-1840644470).

Web Links:

1. https://www.civil.iitb.ac.in/tvm/nptel/591_ITS_1/web/web.html
2. https://www.civil.iitb.ac.in/tvm/nptel/592_ITS_2/web/web.html
3. <https://archive.nptel.ac.in/courses/105/101/105101008/>
4. <http://digital-library.theiet.org/content/journals/iet-its>

Minor Degree in Electrical and Electronics Engineering

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 and 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/ OCEM
2501EE35	Special Electric machines									
2501EE43	Electrical Safety (or)	AC	3			3	50	50	100	EPGDS/PSA
2501EE30	Methods & Algorithms for Intelligent Control									
	Total		18	1	1	20				

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: 9780070699670).
2. Electrical Machinery by Abijith Chakrabarthi & Sudhipta Debnath, McGraw Hill, 1st edition (ISBN: 9781259006456).

Web Links:

1. <http://nptel.ac.in/courses/108106071>
2. http://www.ncert.nic.in/html/learning_basket/electricity/electricity/machine/machine_content.htm
3. <https://lecturenotes.in/subject/41/electrical-machine-1>

Fundamentals of Power Electronics

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: 9780074633694.

Web Links:

1. <https://nptel.ac.in/courses/108/101/108101038/>
2. <https://nptel.ac.in/courses/108/102/108102145/>
3. <https://nptel.ac.in/courses/108/102/108102145/>

Electrical Measurements & Instrumentation

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 lissajous patterns.

Additional practice:

1. Measurement of resistance using Wheatstone bridge.
2. Dielectric oil testing using H.T test Kit.
3. Measurement of Choke coil parameters & single-phase power using three voltmeter & three ammeter method.

Text Books:

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

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications, ISBN: 9786009578337.
2. Electrical & Electronic Measurements & instrumentation by R.K.Rajput, ISBN: 9788121929899.

Web Links:

1. Electrical Measurements by Buckingham & Price - Prentice – Hall
2. <https://archive.nptel.ac.in/courses/108/105/108105153/>
3. <https://electricalbaba.com/different-types-of-transducers/>

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: 9788177000207).
2. Generation, Distribution & Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers (ISBN: 9789393159175).

Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 9780070151413).

Web Links:

1. <https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant>
2. <https://www.euronuclear.org/1-information/energy-uses.html>
3. <https://www.slideshare.net/9anku/electrical-distribution-system>

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: 9789380027845.
2. Utilization of Electric power & Electric Traction -by J.B.Gupta S.K.Kataria & Sons ISBN: 9789350142585.

Web Links:

- 1 <https://nptel.ac.in/courses/108105060>
- 2 https://onlinecourses.nptel.ac.in/noc23_ag06/preview

Hybrid Electric Vehicles

Course Code: 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	-	-	-	-	-	-	-	-

UNIT-I

Introduction: History of hybrid vehicles, architectures of HEVs, series & parallel HEVs, complex HEVs.

UNIT-II

Hybridization of Automobile: Fundamentals of vehicle, components of conventional vehicle & propulsion load; Drive cycles & drive terrain; Concept of electric vehicle & hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV & PHEV; Fuel Cell vehicles & its constituents.

UNIT-III

Plug-in Hybrid Electric Vehicle: PHEVs & EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, PHEV battery charging.

UNIT-IV

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV & PHEV battery chargers.

UNIT-V

Battery & Storage Systems: Energy Storage Parameters; Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource.

Text Books:

1. Advanced Electric Drive Vehicles by Ali Emadi, CRC Press , ISBN: 9781138072855.
2. Electric & Hybrid Vehicles: Design Fundamentals by Iqbal Hussein, CRC Press, ISBN: 9780367693930.

Reference Books:

1. Introduction to Hybrid Vehicle System Modeling & Control by Wei Liu, Wiley ,ISBN: 9788126556205.
2. Electric & Hybrid Vehicles Technologies, Modelling & Control: A Mechatronic Approach by Amir Khajepour, Saber Fallah& Avesta Goodarzi, John Wiley & Sons Ltd , ISBN: 9781118341513.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/108103009/>
2. https://ndl.iitkgp.ac.in/he_document/nptel/nptel/

Special Electrical Machines

Course Code: 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: 9780071745130.
2. Electric Safety Practice & Standards, Khaled Ismail, CRC Press, Taylor & Francis, ISBN: 9781138073999.

Reference Books

1. Electrical Safety- a guide to the causes & prevention of electric hazards, Maxwell Adams.J, The Institution of Electric Engineers, IET, ISBN: 9780852968062.
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning, ISBN: 9780877655800.

Web Links:

1. <http://nptel.ac.in/courses/103106071/5>
2. <https://www.electricalsafetyfirst.org.uk>

Methods & Algorithms for Intelligent Control

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: 9780023527616.
2. Genetic Algorithm in Search Optimization & Machine Learning, David E. Goldberg, Pearson Education, ISBN: 9780201157673.

Reference Books:

1. Fuzzy logic (intelligence control and information), J. Yen and R. Langari, Pearson, first Edition, ISBN: 9780135258170.
2. Methods and Applications of Intelligent Control, Spyros G. Tzafestas, Kluware academic publisher (ISBN: 9780792346241).

Web Links:

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

Minor Degree in Mechanical Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501ME74	Basic Mechanical Engineering	FC	2			2	50	50	100	-
2501ME04	Engineering Thermodynamics	IC	2	1		3	50	50	100	SSP/ MP
2501ME77	Introduction to Automobile Engineering (or)	IC	3			3	50	50	100	SSP/ MP
2501ME78	Mechanics of Solids									
2501ME12	Heat Power Engineering (or)	IC	2	1		3	50	50	100	ETD
2501ME40	Refrigeration & Air Conditioning									
2501ME75	Production Technology	IC	3			3	50	50	100	EW
2501ME76	Metallurgy & Material Science	IC	3			3	50	50	100	SSP/ MP
2501ME79	Theory of Machines (or)	AC	3			3	50	50	100	SSP/ MP
2501ME80	Advanced Engineering Metrology									
Total			18	2		20				

Basic Mechanical Engineering

Course Code: 2501ME74

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Explain the basic concepts of thermodynamics and fluid mechanics
- CO2:** Explain the engineering design principles and process
- CO3:** Draw the velocity and acceleration diagrams analyzing machines and mechanisms
- CO4:** Explain the different manufacturing techniques
- CO5:** Explain the fundamentals of vibrations in mechanical systems

Mapping of Course Outcomes with Program Outcomes:

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

Unit - I

Thermodynamics: Basic concepts and definitions (system, surroundings, state, process, cycle) Zeroth, First, and Second Laws of Thermodynamics, Properties of pure substances, Energy analysis of closed systems and Control volumes, Applications

Fluid Mechanics: Properties of fluids, Pressure variation in a static fluid, Manometry, Bernoulli's equation, Continuity equation, Venturi meter, Orifice meter, Pitot tube, Laminar and Turbulent flow, Reynolds number

Unit – II

Engineering Design:

Definition and importance of engineering design, The role of design in engineering, Historical perspectives and case studies, Steps of the engineering design process, Principles of design thinking, Introduction to computer-aided design (CAD)

Unit – III

Machines & Mechanisms:

Machines: Definition and significance of machines and mechanisms, History and evolution of mechanical systems, Applications

Mechanisms: Types of mechanisms (linkages, cams, gears), Kinematic analysis of mechanisms, Velocity and acceleration diagrams, Gears and gear trains and applications.

Unit – IV

Manufacturing Processes:

Introduction to manufacturing techniques, Casting, Forging, Forming, Machining, Welding, Joining, Powder metallurgy, Plastic and Composite manufacturing, Introduction to Computer Numerical Control (CNC) machines, Additive manufacturing. Introduction to Robotics - Joints & Links, Configurations and Applications of Robotics

Unit – V

Vibrations:

Fundamentals of Vibration: Introduction to Free vibration of single-degree-of-freedom systems, Damped vibration, Forced vibration, Vibration isolation and transmissibility.

Vibration Measurement: Vibration measuring instruments, Basic concepts of vibration control.

Text Books:

1. Basic Mechanical Engineering, P.K. Nag, Tata McGraw Hill Education, 3rd Edition, ISBN : 9780070708389.
2. Manufacturing Engineering and Technology, Serope Kalpakjian and Steven Schmid, Pearson Education; 7th Edition, ISBN-13. 978-9332587908.

Reference Books:

1. Theory of Machines, S.S. Ratan, McGraw Hill Education India Private Limited, 4th Edition, ISBN-13. 978-9353166281.
2. Engineering Design - A Project-Based Introduction, CL Dym, John Wiley & Sons Inc, 4th Edition, ISBN-13, 978-1118324585.

Web Links:

1. <https://nptel.ac.in/courses/112105123>
2. <https://archive.nptel.ac.in/courses/112/107/112107145/>

Engineering Thermodynamics

Course Code: 2501ME04

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Apply thermodynamic concepts to analysis of energy system.
- CO2:** Apply the first law of thermodynamics for closed and open systems.
- CO3:** Apply the second law of thermodynamics and principle of entropy for the engineering system.
- CO4:** Analyse the properties of pure substances.
- CO5:** Explain the working of various refrigeration system and psychrometric process

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility, Forms of energy, pressure, work and heat transfer, temperature and the Zeroth Law of thermodynamics.

UNIT - II

First Law of Thermodynamics: Energy analysis of closed and open system, energy analysis of steady flow devices – Nozzle, Diffusers, Turbine, Compressor, and Throttle. Limitation of first law of thermodynamics.

UNIT – III

Second Law of Thermodynamics: Heat engine and reversed heat engine, Statements of second law (Kelvin-Planck and Clausius Statement) and their equivalence, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic Temperature Scale, Thermodynamic scale of Temperature, Entropy, Clausius Inequality, The increase in entropy principles – Energy Equation, Reversibility and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

UNIT – IV

Properties of Pure Substances: Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy transfer.

UNIT – V

Introduction to Refrigeration: Properties of the refrigerants Working of Air Refrigeration System, Vapour Compression Refrigeration System, Coefficient of performance (COP), Refrigerants.

Introduction to Air Conditioning: Psychrometric properties & Psychrometric process - adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing.

Text Books:

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill Publishers, 6th Edition, ISBN: 9789352606429.
2. Thermodynamics: An Engineering Approach, Cengel, Y.A and Boles, M.A, McGraw Hill, 5th Edition, ISBN: 0073107689.

Reference Books:

1. Treatises on Heat Engineering, V.P.Vasandhani & D.S Kumar, Metropolitan Book Depot, 4th Edition, ISBN: 9788120003507.
2. Engineering Thermodynamics, Mayhew and Rogers, Longman Green & Co Ltd., 4th Edition, ISBN: 0582045665.

Web Links:

1. <https://archive.nptel.ac.in/courses/112/106/112106310/>
2. <https://archive.nptel.ac.in/courses/112/104/112104113/>
3. <https://ocw.mit.edu/courses/3-00-thermodynamics-of-materials-fall-2002/download/>

Introduction to Automobile Engineering

Course Code: 2501ME77

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Summarize the Vehicle Chassis Layouts of 4-wheelers
- CO2:** Identify the different constructional features and working principles of Un-Sprung components of the given vehicle
- CO3:** Identify the different constructional features and working principles Sprung components of the given vehicle.
- CO4:** Summarize the functionalities of various Electrical systems of typical Automobile
- CO5:** Explain the different Active and Passive Vehicle Safety Systems.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: History of Automobile and introduction to Automobile Industry, Chassis Layouts : Components of four wheeler automobile - power transmission modes, Types and Homologation of Vehicles.

UNIT – II

Transmission: Clutches, Gear Box, Rear Axles and its Types, Differential and its applications. **Steering System:** Steering geometry – Types of steering mechanism steering linkages of Independent and Conventional Suspension.

UNIT – III

Suspension System:

Objectives of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system, Air Suspension, Rubber Suspension.

Braking System:

Mechanical braking system, hydraulic braking system requirement of brake fluid.

UNIT – IV

Wheels and Tyres

Basic Requirements of Wheels and Tyres, Construction of Wheel Assembly, Tyre Construction, Types, Tyre Sizes and Designation, Aspect Ratio, Tyre Tread Pattern, Selection of Tyre under Different Applications.

UNIT – V

Electrical System:

Charging circuit, generator, starting system, lighting, horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator.

Safety Systems:

Introduction, safety systems - seat belt, air bags, anti-lock brake system (ABS), Electronic Brake force Distribution (EBD), Head restraints, seats with anti-submarine effects and fuel cut off switch.

Text Books:

1. Automobile Engineering, Kirpal Singh, Vol- I, Standard Publisher, New Delhi, 2020, ISBN: 9788180142420.
2. Motor Vehicles, Newton Steeds and Garret, Butterworth, 13th Edition, ISBN : 0750637633.

Reference Books:

1. Modern Vehicle Technology, Heinz Hazler, Butterworth, London, 2nd edition, ISBN : 0750651318.
2. Automotive Chassis, Heldt P.M., Chilton Co., New York, 2012, ISBN: 1258386380.

Web Links:

1. <https://archive.nptel.ac.in/courses/107/106/107106088/>
2. <https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/?couponCode=LEADERSALE24A>

Mechanics of Solids

Course Code: 2501ME78

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Calculate stress and strain in bodies of varying cross-section and composite bars, principal stresses and strain energy.
- CO2:** Determine the shear force and bending moment diagrams for beams of various loads.
- CO3:** Analyse the variation of bending and shear stresses across a beam.
- CO4:** Compute the slope and deflection for beams of varying loads and support arrangements and torsional rigidity of a solid and hollow shaft.
- CO5:** Analyze the stresses and stability characteristics of thin, thick cylinders and columns.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Simple Stresses & Strains: Elasticity and plasticity – Types of stresses & strains– Hooke’s law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson’s ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr’s circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT – II

Shear Force and Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed load, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT – III

Flexural Stresses: Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT – IV

Deflection of Beams: Bending into a circular arc – slope, deflection and radius of curvature - Differential equation for the elastic line of a beam – Double integration and Macaulay's methods - Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method - application to simple cases.

Torsion: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT – V

Thin and Thick Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lamé's equation – cylinders subjected to inside & outside pressures – compound cylinders.

Columns: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

Text Books:

1. Strength of materials, GH Ryder, Palgrave Macmillan publishers India Ltd, ISBN-13978-0333109281.
2. Strength of materials, B.C. Punmia, Lakshmi publications Pvt. Ltd, 10th Edition, NewDelhi, ISBN - 978-8131809259.

Reference Books:

1. Mechanics of materials, Gere & Timoshenko, CBS publications, 2nd Edition, ISBN 13 - 978-8123908946
2. Strength of Materials, Andrew Pytel and Ferdinand L. Singer, Longman Publications, 4th edition, ISBN 13 9780060453138.
3. Mechanics of Solids, Popov, New Pearson Education, 2nd edition, ISBN13 - 978-9332550216

Weblinks:

1. <https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204>
2. <https://www.coursera.org/learn/mechanics-1>

Heat Power Engineering

Course Code: 2501ME12

L	T	P	C
2	1	0	3

Course Outcomes:

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

- CO1:** Apply the various techniques to improve the performance of Rankine Cycle
- CO2:** Explain the working principle and performance of boiler and draught system
- CO3:** Analyse the performance of Steam nozzles
- CO4:** Analyse the performance of Impulse and Reaction Turbines
- CO5:** Analyse the performance of Steam Condensers and Gas Turbines.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Steam Power Cycles:

Steam Power plant - Layout, Rankine cycle - Schematic layout, Thermodynamic analysis - Simple Cycle. Methods to improve cycle performance - Regeneration & Reheating cycle.

UNIT – II

Boiler: Classification, Working principles of low-pressure (LP) & high-pressure (HP) boilers with sketches, Boiler mountings and accessories. Performance of boiler - Equivalent evaporation - Efficiency.

Draught System: Classification – Natural and Artificial draught – Induced, Forced & Balanced draught - height of chimney for given draught and discharge - condition for maximum discharge and chimney efficiency

UNIT – III

Steam Nozzles

Function of a nozzle – applications – types, Flow through nozzles and thermodynamic analysis, assumptions, Velocity coefficient and condition for maximum discharge, Critical pressure ratio, Supersaturated flow and its effects, Degree of super saturation and Degree of undercooling, Wilson line.

UNIT – IV

Steam Turbines:

Impulse turbine: Mechanical details - Velocity diagram - Effect of friction power developed, Axial thrust, Blade or diagram efficiency - condition for maximum efficiency.

Reaction Turbine: Mechanical details, principle of operation, Thermodynamic analysis of a stage, Degree of reaction velocity diagram, Parson's reaction turbine, Condition for maximum efficiency, Calculation of blade height. Compounding – Velocity, Pressure and Velocity Pressure compounding

UNIT – V

Steam Condensers:

Classification - working principle, vacuum efficiency and condenser efficiency, air leakage, sources and their effects, air pump, cooling water requirement.

Gas Turbines:

Simple gas turbine plant - Ideal cycle - Essential components - Actual cycle. Regeneration, Inter cooling and Reheating cycle, Merits and demerits.

Text Books:

1. Heat Engineering, V.P Vasandani and D.S Kumar, Metropolitan Book Company, 4th Edition, ISBN 978-8120003507
2. Thermodynamics and Heat Engines, R. Yadav, Central publishing house, 6th Edition, ISBN 978818544403

Reference Books:

1. Thermodynamics: An Engineering Approach, Cengel, Y. A. and Boles, M. A., Tata McGraw-Hill, 7th Edition, ISBN 978-0-07-352932-5.
2. Thermal Engineering, P.L.Ballaney, Khanna publishers, 25th Edition, ISBN 978-81-7409-031-7

Web Links:

1. <https://nptel.ac.in/courses/112/106/112106303/>
2. <https://nptel.ac.in/courses/112103262>.

Refrigeration & Air Conditioning

Course Code: 2501ME40

L	T	P	C
2	1	0	3

Course Outcomes:

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

CO1: Explain the principle and applications of air refrigeration system.

CO2: Describe vapour compression refrigeration system.

CO3: Explain different types of vapour absorption refrigeration system.

CO4: Describe air-conditioning processes using the principles of Psychrometry.

CO5: Calculate loads in air-conditioning system and explain different heat pump circuits.

Mapping of Course Outcomes with Program Outcomes:

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

Unit – I:

Introduction to Refrigeration:

Necessity, application, unit and C.O.P of refrigeration, Reversed Carnot cycle, Bell Coleman cycle with its numerical problem, Air Refrigeration System (ARS), Open & Dense air system, Refrigeration system used in air crafts and its problem. Classification of Refrigerants & its Properties, Nomenclature, Ozone layer Depletion, Global Warming.

Unit – II:

Vapour Compression Refrigeration System (VCRS):

Simple Vapour Compression Refrigeration Cycle, Comparison between ARS & VCRS, Representation of cycle on T-S and P-H charts, Effect of sub cooling & super heating, Actual cycle influence of various parameters on system performance, Brief description about Actual VCRS.

Unit – III:

Vapour Absorption Refrigeration System (VARs):

Working principal of VARs, Comparison between VCRS & VARs, Description & working of principle of Ammonia-Water VARs, Lithium-Bromide water VARs, Principle & operation of three fluid absorption system. Salient features, working principle and basic components of Steam Jet Refrigeration System, Principle & operation of thermoelectric refrigeration system - Vortex tube.

Unit – IV:

Introduction to Air Conditioning:

Psychrometric properties & processes, Ventilation, Infiltration, Comfort conditions, Factors Affecting Human Comfort, Factors Affecting Optimum Effective Temperature, Requirements

of human comfort and concept of effective temperature, comfort chart. Air Conditioning Systems: Working principle of comfort, industrial, winter, summer, year-round, unitary and central air conditioning system.

Unit – V:

Air-conditioning load calculations:

Load concepts of Room Sensible Heat Factor, Grand Sensible Heat Factor and Effective Room Sensible Heat Factor. Classification of equipment used in an air conditioning system, Humidifier, filters, grills, registers, fans, and blowers. Air Handling Units, Heat pump – heat sources, Different types of heat pump circuits.

Text Books:

1. Refrigeration and Air-conditioning, Arora C.P., Tata Mc Graw –Hill, 4th edition, 2021, ISBN : 9789390385843.
2. Refrigeration and Air Conditioning, Khurmi R. S., S Chand, Revised edition, 2019, ISBN : 9788121927819.

Reference Books:

1. Refrigeration and Air Conditioning, Manohar Prasad, New Age International, Pvt Ltd, 3rd edition 2021, ISBN-13 : 978-8122436945
2. A Course in Refrigeration and Air conditioning, S. C. Arora & S. Domkundwar, Dhanpatrai, 2010, ISBN - 9788120339156.

Data Book:

1. Refrigerant and Psychrometric Properties - Tables and Charts [SI Units], Mathur, M. L., and Mehta, F. S., Jain Brothers.

Weblinks:

1. <https://nptel.ac.in/courses/112105128>.
2. <https://www.udemy.com/course/water-cooler-dispenser-working-and-circuit-diagram/?couponCode=NVDPRODIN35>.
3. <https://bharatskills.gov.in/Home/StudyMaterial?var=06nHBys5P85EmOqtjA1wsA==&Default=YES>.

Production Technology

Course Code: 2501ME75

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Elaborate the fundamental principles of casting process.
- CO2:** Classify the various joining process with applications
- CO3:** Discuss the basic concepts of metal forming techniques
- CO4:** Explain the basic concepts of smithy and forging techniques.
- CO5:** Explain the basic concepts of plastic processing techniques and powder metallurgy

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction:

Introduction to manufacturing process, Classification and Overview of Manufacturing Processes. Introduction to Metal Casting, Casting design considerations, Sand casting process, Casting Terminology, Types of Patterns, Pattern Materials and Pattern Allowances, Sand casting, Classifications of Moulds, moulding materials and their properties, Core, Gating system and its Design, Riser and its design, Foundry - furnaces, Melting & Pouring, Fluidity, Solidification of pure metals and alloys, Casting defects, Advanced casting processes, advantages and applications.

UNIT – II

Metal Joining:

Introduction, Classification of Welding Processes, Gas Welding & Cutting, Arc Welding-Theory of heat generation, Power Source Selection, Arc characteristics, Arc blow, ISI classification of coated electrodes, SMAW,GTAW,GMAW-CO₂ 12, SAW,LBW,EBW,UW, Resistance welding, Solid state welding processes, Hybrid Welding Processes, Brazing, Soldering and their applications, HAZ, characteristics of weldment, Welding Defects and Remedies.

UNIT – III

Sheet Metal Work:

Standard Specifications for Sheets, Sheet Metal Operations, Yield criteria, Plastic deformation of metals, Tools and Equipment in SMW, Deep drawing.

Forming : Hot working and Cold working, Rolling, Hubbing, Embossing, Thread rolling, Tube Piercing, Hot spinning, Press Working, Defects in metal working, Wire Drawing, Tube drawing, High Energy rate Forming (HERF) processes.

UNIT – IV

Smithing And Forging:

Forging & Forging dies, Smith Forging operations, Forging Process, Hand Forging, Power Forging, Impression Die Forging, Drop Hammers, Press Forging, Upset forging, Forging Defects and Remedies.

UNIT – V

Plastic Processing:Types of Plastics, Properties, Applications, and their processing methods, Blow molding and Injection molding.

Powder Metallurgy:Powder production methods, compaction, and sintering. Applications of powder metallurgy. Advantage and Disadvantage of Powder Metallurgy in comparison to Conventional Shaping process.

Text Books:

1. Manufacturing Engineering and Technology, Kalpakian S, Schmid S.R., Pearson Education, Delhi, 7th Edition 2018, ISBN 978-9332587908
2. Fundamentals of Modern Manufacturing, Groover Mikell P, John Wiley and Sons Inc, 7th Edition, 2018, ISBN 978-1119722014

Reference Books:

1. Manufacturing Science, A. Ghosh & A.K. Mallik, East West Press Pvt. Ltd Publication, 3rd Edition, ISBN 978-8176710633
2. Manufacturing Processes, H.S. Shan, Cambridge University Publication, 2nd Edition, ISBN 978-1316638583
3. Process and materials of manufacture, Lindberg, PHI Publications, 4th Edition, ISBN 978-8120306639

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_me16/preview
2. https://onlinecourses.nptel.ac.in/noc24_me51/preview
3. <https://archive.nptel.ac.in/courses/113/106/113106098/>

Metallurgy & Material Science

Course Code: 2501ME76

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the concepts of structure of metals and equilibrium diagrams.
- CO2:** Analyse the ferrous and non-ferrous metals and alloys in industrial applications
- CO3:** Analyse the heat treatment on steels.
- CO4:** Explain the methods of making of metal powders and applications of powder metallurgy.
- CO5:** Summarize the properties and applications of ceramic and composite materials.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT– I

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor SC, BCC, FCC & HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries– determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds.

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe₃C.

UNIT–II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT–III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe₃C system, annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT–IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.

UNIT– V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nano materials and smart materials.

Text Books:

1. Introduction to Physical Metallurgy, Sidney H Avner, TMH Publications, 2nd Edition ISBN: 978-0074630068
2. Materials Science and Metallurgy, V.D. Kodgire, Everest Publishing House, 39th Edition ISBN: 978-8176314008.

Reference Books:

1. Materials Science and Engineering, An Introduction, William D. Callister, Wiley Publications, 9th Edition. ISBN: 978-1118324578.
2. Mechanical Metallurgy George Ellwood Dieter, David Bacon. McGraw- Hill Book company. ISBN: 978-0071004060
3. Engineering Materials & Metallurgy, R.K. Rajput, S. Chand Publications, 2nd Edition. ISBN: 978-8121927093.

Weblinks:

1. <https://archive.nptel.ac.in/courses/113/106/113106032/>
2. <https://www.coursera.org/learn/fundamentals-of-materials-science>
3. <https://www.coursera.org/learn/material-behavior>.

Theory of Machines

Course Code: 2501ME79

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Apply the knowledge of mechanisms in real time applications
- CO2:** Construct the velocity and acceleration diagrams using relative velocity method and instantaneous centre method.
- CO3:** Calculate the velocity and acceleration of follower motions and construct the cam profile
- CO4:** Calculate the velocities of different components of a compound and epicyclic gear trains
- CO5:** Construct the turning moment diagram of engine and flywheel.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Elements of Kinematics

Classification of Mechanisms-Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain -Limit positions- Mechanical advantage- Description of common mechanisms- Inversions of 4-bar chain: Crank and Slotted Lever mechanism, Quick Return Motion mechanism, Davis and Ackermann Steering gear mechanisms, Hooke's joint.

UNIT – II

Velocity and Acceleration Analysis

Plane motion of a rigid body: Instantaneous centre of rotation, centrode and axode - Relative motion between two bodies – Kennedy's Theorem – Graphical determination of instantaneous centre for Four bar and Single Slider Crank chain mechanisms, Determination of Angular Velocity of points and links. Motion of a Link in Machine - Determination of Displacement, Velocity and Acceleration for a Four Bar Mechanism, Single Slider Crank chain mechanism, Double Slider Crank chain mechanism.

UNIT – III

Cams and followers

Definition and classification of Cams and Followers - Terminology - Types of follower motion: Uniform velocity, Simple harmonic motion and Uniform Acceleration and Retardation, Cycloidal motion for Knife edge, Flat face and Roller follower and offset follower.

UNIT – IV

Power Transmission:

Introduction –Modes of Power Transmission applications. Gears and Gear Trains- Classification, Terminology, Law of Gearing, Path of contact, Arc of contact. Interference, Methods of avoiding interferences. Simple gear train, Compound gear train, reverted gear train, epicyclic gear train and Differential. Table method to find velocity of components of a gear train.

UNIT – V

Turning Moment Diagrams:

Static and dynamic force analysis of planar mechanisms, Dynamic force analysis of slider crank mechanism, Inertia Torque, Angular Velocity and Acceleration of connecting rod, Crank Effort and Turning Moment Diagrams – Fluctuation of energy – Fly Wheel design.

Text Books:

1. Theory of machines, S.S.Rattan, Tata Mc Graw Hill, 5th Edition, 2019, ISBN: 9789351343479.
2. Theory of machines, Thomas Bevan, CBS Publishers, 3rd Edition, ISBN: 9788123908748.

Reference Books:

1. Theory of machines: Kinematics and Dynamics , Sadhu Singh, 3rd Edition, Pearson Publisher, 2011, ISBN: 9788131760697.
2. Theory of machines, R.K.Bansal, J.S.Brar, Laxmi Publications, 6th Edition, ISBN: 9788131808054.

Web Links:

1. https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_403_Part_3_KINEMATICS_OF_MACHINERY.pdf
2. <https://archive.nptel.ac.in/courses/112/104/112104121/>

Advanced Engineering Metrology

Course Code: 2501ME80

L T P C
3 0 0 3

Course Outcomes:

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

- CO1: Identify the generalized concept of measurement system.
- CO2: Summarize the concepts of DC and AC bridges used in measurement systems.
- CO3: Apply the fundamentals in measurements and calibration of instruments.
- CO4: Describe the working principles and operation of measuring instruments.
- CO5: Explain the basic physics of transducers and their operating principles.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I:

Generalized Configuration of Measuring System: Functional elements of a basic measuring system, different types of measurands, description of functional elements, input-output configuration of a measuring system, linear and angular measurements, comparators, interferometry, form and finish measurement, alignment and testing methods, tolerance analysis in manufacturing and assembly, concepts of coordinate-measuring machine (CMM), mathematical model for generalized configuration of a measurement system.

UNIT II:

Comparative Methods of Measurements: D.C potentiometers, D.C (Wheat stone, and Kelvin bridge) & A.C bridges (Maxwell, Anderson, and Schering bridges), transformer ratio bridges, self-balancing bridges, interference & screening, multiple earth and earth loops, electrostatic and electromagnetic interference, grounding techniques, uncertainty analysis.

UNIT III:

Characteristics of Instruments: Objective of studying the characteristics of the instruments. Static characteristics – accuracy, precision, error, sensitivity, hysteresis, threshold, drift, span, and static stiffness, dynamic characteristics – time domain and frequency domain characteristics terms, concept of mechanical loading.

UNIT IV:

Principles of Instrumentation: Sensor interrogation principles using bridge circuits, signal amplification, signal conditioning (transduction, & linearization), phase measurements, active and passive filters, isolation and shielding, elements of control theory, digital data acquisition.

UNIT V:

Principles of Transduction and Transducers: Description of various types of transduction principles. transducers based on variable resistance, variable inductance, variable capacitance, and piezo-electric effects, displacement transducers - wire wound potentiometers, LVDT, strain gauges, diaphragm type pressure transducers and other pressure measuring techniques, design of accelerometers and their applications, temperature and flow measurement techniques.

Textbooks:

1. Instrumentation for Engineering Measurements, James W. Dally, W.F. Riley and K.G. McConnel, John Wiley & Sons Inc, 2nd Edition, **ISBN-13. 978-0471551928**
2. Mechanical Measurements and Instrumentation & Control, A. K. Sawhney, Dhanpat Rai & Co. (P) Limited, **ISBN-13. 978-8177000238.**

Reference Books:

1. Engineering Metrology, M. Mahajan, Dhanpat Rai Publishers, 1st Edition.
ISBN-13 978-8177000511
2. Mechanical and Industrial Measurements, R. K. Jain, Khanna Publishers, 1st Edition
ISBN-13. 978-8174091918

Web Links:

1. <https://archive.nptel.ac.in/courses/112/106/112106139/>
2. <https://ocw.mit.edu/courses/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/>

Minor in Electronics and Communication Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-Requisite
2501EC87	Fundamentals of Communications	FC	2		1	3	50	50	100	-
2501EC88	Fundamentals of Signal Processing	FC	2		1	3	50	50	100	-
2501EC89	Analog & Digital Circuits	IC	2			2	50	50	100	BEEE
2501EC42	Wireless LAN's & PAN's	IC	2	1		3	50	50	100	-
2501EC90	Linear & Digital IC Applications (or) Sensors & Actuators	IC	3			3	50	50	100	ADC
2501EC91										
2501EC92	Embedded Microcontrollers (or) Digital System Design	IC	2		1	3	50	50	100	ADC, PPSC
2501EC93										
2501EC67	Introduction to Internet of things (or)	AC	2		1	3	50	50	100	EM,WLANs & PAN's
2501EC74	Modern Wireless Communications		3			3	50	50	100	FC
Total			15	1	4	20				

Fundamentals of Communication

Course Code: 2501EC87

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Summarize the functional blocks of a communication system.
- CO2:** Interpret the modulation and demodulation techniques of AM.
- CO3:** Discuss the concepts of Angle modulation and demodulation.
- CO4:** Infer Pulse analog modulation and demodulation Techniques.
- CO5:** Interpret the transmitter and receiver sections.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Communication system, Elements of Communication system, Modulation, Need for Modulation, Electromagnetic Spectrum, Frequency Division Multiplexing(FDM). Introduction to Amplitude Modulation (AM), Generation and detection of AM, Spectrum of AM Signals, Power and Power Efficiency of AM.

Practice:

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

UNIT – II

Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Spectrum of DSB-SC Signals, Coherent Demodulation of DSB-SC signals, Introduction to Single Sideband (SSB) Modulation, Generation, and detection of SSB Modulation, Introduction to VSB modulation.

Practice:

1. Generate AM-DSBSC modulated signal and demodulate the modulated signal.

UNIT – III

Frequency modulation: Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals.

Practice:

1. Generate frequency modulated signal, determine the modulation index and Bandwidth, also demodulate the frequency modulated signal.

UNIT – IV

Digital representation of analog signals: Need for Digitizing Analog information, Time Division Multiplexing, Pulse Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, and Filtering, Introduction to Delta Modulation, Signal Reconstruction in Delta Modulation, Slope Overload Distortion and Granular Noise, Differential Pulse Code Modulation (DPCM).

Practice:

1. Analyse the process of pulse Code modulation.

UNIT – V

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

Practice:

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

Text Books:

1. Introduction to Analog and Digital Communications, Simon Haykin, Wiley, 2nd Edition, ISBN: 0471432229.
2. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, Pearson, 5th Edition, 30 August 2019, ISBN: 978-8131719534.
3. Modern digital and analog communication systems—B.P.Lathi , Zhi Ding,oxford,4th Edition, ISBN: 0195331451.

Reference Books:

1. Principles of Communication Systems - Herbert Taub, Donald L Schilling, Goutam Saha, McGraw-Hill, 4th Edition, ISBN: 1259029859.
2. Analog and Digital Communication – K. Sam Shanmugam, Willey, 2018, ISBN: 9788126536801.

Web Links:

1. <https://archive.nptel.ac.in/courses/117/105/117105143/>
2. https://onlinecourses.nptel.ac.in/noc21_ee74/preview
3. <https://archive.nptel.ac.in/courses/108/102/108102096/>
4. <https://archive.nptel.ac.in/courses/117/101/117101051/>
5. <https://web.stanford.edu/class/ee179/>
6. <https://www.udemy.com/course/analog-communication-e/>

Course Code: 2501EC88

L T P C
2 0 1 3

Course Outcomes:

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

- CO1:** Analyse the characteristics of CT periodic signals using Fourier series.
CO2: Analyse the spectral characteristics of CT aperiodic signals using Fourier Transforms.
CO3: Analyse sampling process and reconstruction of signals.
CO4: Analyze the response of continuous time LTI system.
CO5: Apply Laplace and Z-transform techniques on signals.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Signals: Classification of Signals, Different deterministic signals: impulse, step, ramp, gate, signum, sinc, sinusoidal, exponential, complex exponential, operations on signals. Fourier Series: Representation of Fourier series for continuous time periodic signals, Trigonometric Fourier series and Exponential Fourier series, Convergence of Fourier Series: Dirichlet's conditions, properties of Fourier series.

Practice:

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

UNIT – II

Fourier Transform: Deriving Fourier Transform (FT) from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function.

Practice:

1. Calculate the Fourier Transform and Inverse Fourier Transform of a for Continuous time signal.
2. Calculate the Fourier Transform and Inverse Fourier Transform for the Standard signals.

UNIT – III

Sampling: Sampling, Sampling theorem – Graphical and analytical proof for Band Limited Signals, Nyquist rate, Nyquist duration, Impulse sampling, Natural sampling and Flat top Sampling, Reconstruction of signal from its samples, Effect of undersampling – Aliasing.

Practice:

1. Perform convolution of given continuous time signals.
2. Verify Sampling theorem.

UNIT – IV

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

Z-Transform: Concept of Z- Transform of a Discrete Sequence, Region of convergence in Z-Transform, Properties of Z-Transform, Inverse Z-Transform.

Practice:

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

UNIT – V

Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems, Discrete Fourier transforms.

Practice:

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

Text Books:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2nd Edition, ISBN: 9332550239.
2. Signals and Systems – A. Anand Kumar, PHI, 4th Edition, ISBN: 8120348400.

Reference Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition, ISBN: 0471164747 .
2. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, ISBN: 9780070702219.
3. Digital Signal Processing, P. Ramesh Babu, SciTech Publications, 6th Edition, ISBN: 9395245271.

Web Links:

1. <https://freevideolectures.com/course/3540/signals-and-systems-i> (Signals and Systems I by Prof. K.S. Venkatesh IIT Kanpur)
2. <https://nptel.ac.in/courses/108104100> (Principles of Signals and System by Prof. Aditya K. Jagannatham, IIT Kanpur)
3. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing - by Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi)

Analog & Digital Circuits

Course Code: 2501EC89

L T P C
2 0 0 2

Course Outcomes:

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

CO1: Examine the characteristics of special semiconductor diode.

CO2: Illustrate the performance of FET and MOSFET.

CO3: Realize logic minimization using suitable techniques

CO4: Illustrate various combinational logic circuits.

CO5: Construct different sequential logic circuits.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Semiconductor Devices: Tunnel Diode, Varactor Diode, LED, Photo Diode, Transistor as a switch, Transistor as an Amplifier.

UNIT – II

Transistor Characteristics-FET& MOSFET: Construction and operation of FET, Characteristic of FET, FET as a switch and an amplifier, MOSFET working and Characteristics (Depletion mode & Enhancement mode).

UNIT – III

Boolean Algebra & Minimization Techniques: Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 5 variables.

UNIT – IV

Combinational Logic Circuits: Design of Half adder, full adder, half sub-tractor, full sub-tractor, applications of full adders, 4-bit binary adder-sub-tractor circuit, BCD adder circuit, Design of decoder, de-multiplexer, encoder, multiplexer, Realization of Boolean functions using decoders & multiplexers, priority encoder, 2-bit Magnitude Comparator.

UNIT – V

Sequential Circuits: Classification of sequential circuits (synchronous and asynchronous) basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T-flip-flop, D-flipflop with reset and clear terminals). Ripple counters, Synchronous Counter Johnson counter, ring counter. Registers - shift register, bi-directional shift register, universal shift register.

Text Books:

1. Electronic Devices and Circuits, J. Millman, Christos C. Halkias, Tata Mc-Graw Hill, 4th Edition, ISBN: 9789339219543.
2. Digital Design, Morris Mano, Pearson, 3rd Edition, ISBN: 8178085550.

Reference Books:

1. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 9th Edition, ISBN: 0131189050.
2. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, ISBN: 0070669112.
3. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, John Wiley & Sons Inc., 3rd Edition, ISBN: 8126520310.

Web Links:

1. <https://nptel.ac.in/117103063/11>
2. <http://nptel.ac.in/courses/117/106/117106086/>
3. <https://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html>

Course Code: 2501EC42

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Discuss the concept of Random Access protocols
- CO2:** Understand the Wireless LAN Protocols
- CO3:** Demonstrate the IEEE802.11 Standard for WLAN
- CO4:** Describe the Wireless PAN Protocols
- CO5:** Illustrate the IEEE802.15 Standard for WPAN

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Wireless System & Random-Access Protocols:

Introduction, First and Second-Generation Cellular Systems, Cellular Communications from 1G to 3G, Wireless 4G systems, The Wireless Spectrum; Random Access Methods: Pure ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).

UNIT – II

Wireless LANs:

Introduction, importance of Wireless LANs, WLAN Topologies, Transmission Techniques: Wired Networks, Wireless Networks, comparison of wired and Wireless LANs; WLAN Technologies: Infrared technology, UHF narrowband technology, Spread Spectrum technology.

UNIT – III

The IEEE 802.11 Standard for Wireless LANs:

Network Architecture, Physical layer, The Medium Access Control Layer; MAC Layer issues: Hidden Terminal Problem, Reliability, Collision avoidance, Congestion avoidance, Congestion control, Security, The IEEE 802.11e MAC protocol.

UNIT – IV

Wireless PANs:

Introduction, importance of Wireless PANs, The Bluetooth technology: history and applications, technical overview, the Bluetooth specifications, piconet synchronization and Bluetooth clocks, Master-Slave Switch; Bluetooth security; Enhancements to Bluetooth:

Bluetooth interference issues, Intra and Inter Piconet scheduling, Bridge selection, Traffic Engineering, QoS and Dynamics Slot Assignment, Scatternet formation.

UNIT – V

The IEEE 802.15 working Group for WPANs:

The IEEE 802.15.3, The IEEE 802.15.4, ZigBee Technology, ZigBee components and network topologies, The IEEE 802.15.4 LR-WPAN Device architecture: Physical Layer, Data Link Layer, The Network Layer, Applications; IEEE 802.15.3a Ultra wide band.

Text Books:

1. Ad Hoc and Sensor Networks - Carlos de Moraes Cordeiro and Dharma Prakash Agrawal, World Scientific, ISBN: 978-9814338882.
2. Wireless Communications and Networking - Vijay K.Garg, Morgan Kaufmann Publishers, ISBN: 9780123735805.

Reference Books:

1. Principles of Wireless Networks - Kaveh Pahlaram, Prashant Krishnamurthy, PHI, ISBN: 8120323807.
2. Guide to Wireless Communication- Marks Ciampor, George Olenewa, Cengage Learning, ISBN: 1111307318.

Web Links:

1. <https://archive.nptel.ac.in/courses/106/105/106105183/>
2. <https://archive.nptel.ac.in/courses/108/108/108108179/>

Course Code: 2501EC90

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Construct Op Amps using the differential amplifier and other improvement circuits.
- CO2:** Explain parameters related to measurement of Op-Amp characteristics.
- CO3:** Construct the circuits for different linear and non-linear applications using Op-Amp.
- CO4:** Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
- CO5:** Compare different digital logic families.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Integrated Circuits: Integrated Circuits Types, Classification, Package Types, Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations, circuits for improving CMRR, Necessity of swamping resistors, Cascaded Differential Amplifier Stages and Level translator.

UNIT – II

Characteristics of Op-Amps: Block Diagram of an Op-Amp, Pin diagram, symbolic representation and features of 741IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

UNIT – III

Linear and Non-Linear Applications of Op- Amps: Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti-log Amplifiers, Precision rectifiers.

UNIT – IV

D-A and A-D Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC. Different types of ADCs parallel Comparator type ADC, Counter type ADC, Successive Approximation ADC and dual slope ADC. DAC and ADC Specifications.

UNIT – V

Digital Logic Families and Interfacing: Introduction to logic families, Bipolar logic, transistor-transistor logic, TTL families, Emitter coupled logic, CMOS logic, CMOS logic families, state and dynamic electrical behavior.

Text Books

1. Linear Integrated Circuits–D.RoyChowdhury, New Age International(p)Ltd, 2nd Edition, ISBN: 8122403077.
2. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Edition, ISBN: 8131713660.
3. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, PHI, Pearson Education, 4th Edition, ISBN: 8131713660.

Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits-Sergio Franco McGrawHill, ISBN: 0071157220.
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James M Fiore, Cengage Learning India Ltd, ISBN: 9788131512340.
3. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, ISBN: 1259025977.

Web Links:

1. <http://nptel.ac.in/courses/117108038/Prof.GunashekarM.K/IIScBangalore>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-3-circuits/op-amps>

Sensors & Actuators

Course Code: 2501EC91

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Classify various sensors/transducers based on their applications.
- CO2:** Analyse various approaches, procedures and results related to Thermal sensors.
- CO3:** Examine the radiation sensors based on their characteristics.
- CO4:** Apply Smart Sensors in the field of Communication, Automation and Manufacturing
- CO5:** Classify various Actuators based on their applications

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Sensors/Transducers:

Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP) - Characterization.

Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:- Electrostatic Transducer- Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.

UNIT-II

Thermal Sensors:

Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors –Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermo sensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermo emf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

UNIT-III

Radiation Sensors:

Introduction – Basic Characteristics – Types of Photo sensistors /Photo detectors– X-ray and Nuclear ,Electro analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization— Reference Electrodes - Sensor

Electrodes – Electro ceramics in Gas Media. Radiation Sensors – Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

UNIT-IV

Smart Sensors:

Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation Sensors-Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing –Sensors for environmental Monitoring.

UNIT-V

Actuators:

Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Pressure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical aspects of motor selection Electrical Actuation Systems-Electrical systems -Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors

Text Books:

1. Sensors and Transducers, D. Patranabis, PHI Learning Private Limited, ISBN: 9788120321984.
2. Mechatronics, W. Bolton, Pearson Education Limited, ISBN: 1292250976.

Reference Books:

1. Sensors and Actuators, D. Patranabis, PHI, 2nd Edition, ISBN: 9788120321984..
2. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, ISBN: 978-0123821966.

Web Links:

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. <https://www.hella.com/techworld/ae/Technical/Sensors-and-actuators-204/>
3. <https://www.leanix.net/en/blog/iot-devices-sensors-and-actuators-explained>

Embedded Microcontrollers

Course Code: 2501EC92

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the microprocessor internal architecture and programming.
- CO2:** Discuss Microcontroller internal architecture and its assembly language programming.
- CO3:** Describe the Hardware interfaces with Microcontroller in Assembly Language and C programming.
- CO4:** Describe PIC Microcontroller internal architecture and its assembly language programming.
- CO5:** Illustrate the usage of ATMEGA 328P in their project designs.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Microprocessor: Basics of Microprocessor, 8086 Hardware architecture ,8086 registers and its functions, Min mode and Max mode system configuration ,Instruction set of 8086 and simple Programs, Interrupts, DMA.

Practice:

1. Write an Assembly language program to perform Arithmetic operations on 8 bit data.
2. Write an Assembly language program to perform Multi byte addition and subtraction.

UNIT – II

8051 Microcontroller: Comparisons between Microprocessors and microcontroller, 8051 architecture, Pin functions, Memory organization, Special Function Registers, addressing modes, Instruction set. C Programming- I/O programming, Timer programming, 8051 interrupts Programming.

Practice:

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

UNIT – III

External Peripheral Interface: LCD interfacing, Keyboard interfacing, Interfacing with external ROM, ADC interfacing, DAC interfacing, Stepper motor interfacing, DC motor interfacing.

Practice:

1. Interface Keypad to 8051 using proteus software.
2. Interface LCD to 8051 using proteus software.

UNIT – IV

PIC Microcontrollers: Introduction, characteristics of PIC microcontroller, memory organization, parallel and serial input and output, timers, Interrupts, PIC 16F877 architecture, instruction set of the PIC 16F877.

Practice:

1. Introduction to MPLAB XIDE software.
2. Write a C Program for LED Blinking using PIC16F877.

UNIT – V

Atmega328 Microcontroller: ATMEGA 328P architecture, register file, memory, addressing mode, instruction sets, I/O ports, Case studies: interfacing with LCD, Temperature Sensor DHT11, High-Voltage Device and Relay, Bluetooth Module (HC-05), GSM Module (SIM900A), Using I2C Protocol, Using Zigbee to interface wireless sensors.

Practice:

1. Study of Arduino software.
2. Interfacing of analog sensors with Arduino.
3. Interfacing of DC Motor with Arduino.

Text Books:

1. Advanced Microprocessors and Peripherals with ARM and an introduction to Microcontrollers and Interfacing, K. M. Bhurchandi and A. K. Ray, Tata McGraw Hill, 3rd Edition, ISBN: 1259006131.
2. Micro Controller theory and Application, Ajay .V. Deshmukh, TATA McGraw –Hill, 1st Edition, ISBN: 0070585954.
3. Programming and Interfacing with Arduino, Dr. Yogesh Misra, Taylor and Francis, ISBN: 1032059850.

Reference Books:

1. The 8051 Microcontrollers and Embedded systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2nd Edition, ISBN: 8131758990.
2. Microprocessors and Interfacing, D. V. Hall, 3rd Edition (SIE), ISBN: 9781259006159.
3. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 3rd Edition, ISBN: 9788131502006.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/108103157/> microprocessor and microcontrollers by IIT Gowhati.
2. <https://nptel.ac.in/courses/108108147S> sensors and Actuators, IISc Bangalore Prof. Hardik Jeetendra Pandya.

Digital System Design

Course Code: 2501EC93

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the design process of HDL based digital systems.
- CO2:** Illustrate language constructs in Verilog HDL
- CO3:** Develop Verilog Program for Combinational Logic Circuits using gate primitives.
- CO4:** Develop dataflow modeling Verilog Program for Logic Circuits.
- CO5:** Construct sequential circuits using behavioral Modeling.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

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

Practice:

1. Introduction to Xilinx Software

UNIT – II

LANGUAGE CONSTRUCTS AND CONVENTIONS: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators.

Practice:

1. Write a verilog code with the use of data types as scalars and vectors

UNIT – III

GATE LEVEL MODELING: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples: Adders, Subtractor and Multiplexers. Additional Examples: Design of Flip-flops with Gate Primitives, Delays, Net Types.

Practice:

1. Write a Verilog code for logic gates using gate Primitives
2. Write a Verilog code for FullAdder and subtractor using gate Primitives.
3. Write a Verilog code for Multiplexer using gate Primitives.

UNIT – IV

MODELING AT DATA FLOW LEVEL: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Design Examples- Encoder, Decoder and Comparator

Practice:

1. Write a Verilog code for encoder in dataflow model
2. Write a Verilog code for decoder in dataflow model.
3. Write a Verilog code for Comparator in dataflow model.

UNIT – V

BEHAVIORAL MODELING: Introduction, Operations and Assignments, Initial Construct, Always Construct, The case statement, *if* and *if-else* constructs, repeat construct, for loop Examples, Assignments with Delays, Design Examples-Flip-flops, Registers and Counters.

Practice:

1. Write a Verilog HDL code for the RS and JK flip-Flops using case statement.
2. Write a Verilog HDL code for the 4 bit register using *if-else* statement.
3. Write a Verilog HDL code for the 4 bit register using behavioral Modeling.

Text Books:

1. Fundamentals of Digital Logic with Verilog Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, ISBN: 1259025977.
2. Advanced digital design with the Verilog HDL, Michael D. Ciletti, Eastern economy edition, PHI, ISBN: 0136019285.

Reference Books:

1. A Verilog HDL primer by J.Bhaskar, Star galaxy publishing, 3rd Edition, 2018, ISBN: 0965039161.
2. Design through Verilog HDL by T. R. Padmanabhan, B. Bala Tripura Sundari, A JOHN WILEY & SONS, INC., Publication, ISBN: 0471441481.

Web Links:

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

Introduction to Internet of Things

Course Code: 2501EC67

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Describe M2M and IOT Technologies.
- CO2:** Identify the layers and protocols in IOT.
- CO3:** Describe various communication technologies used in IOT.
- CO4:** Demonstrate various hardware components required for IOT applications
- CO5:** Identify the cloud technologies Explain the applications of IoT

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction from M2M to IoT - An Architectural Overview, building architecture, Main design principles and needed capabilities, An IoT architecture outline, M2M and IoT Technology Fundamentals - Devices and gateways.

Practice:

1. Interfacing of analog sensors with Arduino.
2. Interfacing of Digital sensors with Arduino.

UNIT – II

Functionality of Layers in IoT: Study of protocols - Wireless HART, Z-Wave, 6LoWPAN, RPL, CoAP, MQTT.

Practice:

1. Interfacing of actuators with Arduino/Node-MCU.
2. Control an actuator based on sensor input with Arduino/Node-MCU.

UNIT – III

Communication Technologies in IoT : IoT Connectivity-IEEE 802.15.4, Wi-Fi, Bluetooth, Zigbee, LPWAN, 5G Era.

Practice :

1. Develop an Application to Interface Bluetooth module with Arduino.
2. Develop an Application to Interface Wi-Fi module.

UNIT – IV

System Hardware : Sensors, Actuators, Radio Frequency Identification, Introduction to Embedded Devices for IoT - RASPBERRY PI.

Practice:

1. Interfacing of analog sensors with Raspberry pi.
2. Interfacing of digital sensors with Raspberry pi/Node-MCU.

UNIT – V

Cloud Computing: Data Collection, Storage and Computing Using a Cloud Platform for IoT Applications/ Services. Use Cases - Smart and Connected Cities, Agriculture, and Healthcare.

Practice:

1. Deploy sensor data on a cloud platform.
2. Develop IoT model using soil moisture sensor for Agriculture application.

Text Books:

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, Academic Press,. 1st Edition, ISBN: 012407684X.
2. Internet of Things (A Hands-on- Approach), Vijay Madisetti and Arshdeep Bahga, 1st Edition, VPT, ISBN: 8173719543.
3. Internet of Things - By Raj Kamal, McGraw-Hill Education. Copyright, ISBN: 9352605225.

Reference Books:

1. Internet of Things—From Research and Innovation to Market Deployment, Peter Friess, River Publishers, ISBN: 8793102941.
2. From Internet of Things to Smart Cities: Enabling Technologies - edited by Hongjian Sun, Chao Wang, Bashar I. Ahmad, CRC Press -2018, ISBN: 9781498773782.
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015, Editors Ovidiu Vermesan, ISBN: 1783553537.

Web Links:

1. [NPTEL :: Computer Science and Engineering - NOC: Introduction to internet of things](#) BY IIT Kharagpur.
2. <https://nptel.ac.in/courses/108108147> Sensors and Actuators, IISc Bangalore Prof. Hardik Jeetendra Pandya.

Modern Wireless Communications

Course Code: 2501EC74

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1: Summarize the functioning of basic cellular mobile radio systems
- CO2: Identify the general problems of cellular mobile networks
- CO3: Summarize various mobile propagation models
- CO4: Make use of managerial techniques for efficient use of cellular frequency bands.
- CO5: Compare basic digital cellular networks

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Cellular Mobile Radio Systems: Introduction to Cellular Mobile Systems, Generations-1G, 2G, 3G 4G, Performance criteria, uniqueness of mobile radio environment, operation of cellular systems, Hexagonal shaped cells, Analog and Digital Cellular systems.

Elements of Cellular Radio System Design: General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a Omni directional Antenna system, consideration of the components of Cellularsystem.

UNIT – II

Interference: Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, diversity receiver, non-co channel interference-different types.

UNIT – III

Cell Coverage for Signal and Traffic: Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long distance propagation antenna height gain, form of a point to point model.

UNIT – IV

Frequency Management and Channel Assignment: Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, Sectorization, overlaid cells, non-fixed channel assignment.

Handoff: Handoff, dropped calls and cell splitting, types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting, micro cells, vehicle locating methods, dropped call rates and their evaluation.

UNIT – V

Digital Cellular Networks: GSM architecture, GSM channels, GSM call flow, CDMA(IS-95), Forward and Reverse CDMA Channels, DECT, PACS.

Text Books:

1. Mobile Cellular Tele Communications, W.C.Y. Lee, Tata McGraw Hill, 2nd Edition, ISBN: 978-0070635999.
2. Principles of Mobile Communications, Gordon L. Stuber, Springer International, 2nd Edition, ISBN: 9780792379980.

Reference Books:

1. Wireless Communications, Theodore. S. Rapport, Pearson education, 2nd Edition, ISBN: 978-8131731864.
2. Wireless Communication and Networking, Jon W. Mark and WeihuaZhqung, PHI, 1st Edition, ISBN: 978-0130409058.
3. Wireless Communication Technology, R. Blake, Thompson Asia Pvt. Ltd., 1st Edition, ISBN: 978-8131518403.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_ee61/preview?msclkid=f61e217ec14311ecb1ce5ecbd56CE3d
2. <https://www.electronics-notes.com/articles/connectivity/cellular-mobile-phone/what-is-cellular-communications.php>

Minor Degree in Computer Science and Engineering

Course Code	Course Title	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS13	Operating Systems	IC	2		1	3	50	50	100	-
2501CS07	Computer Networks	IC	2		1	3	50	50	100	-
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
2501AI03	Data Mining	IC	1		2	3	50	50	100	-
2501CS08	Object Oriented Programming through C++ (or) Java Programming	IC	2		2	4	50	50	100	PPSC
2501IT06										
2501CS16	Introduction to MERN Stack Development (or)	IC			2	2	50	50	100	JP
2501CS30	Information Security Analysis & Audit	IC	2			2	50	50	100	-
2501CS18	Advanced MERN Stack Development	AC			2	2	50	50	100	IMSD
2501IT12	(or) Flutter Fundamentals	AC			2	2	50	50	100	-
Total			11		9	20				

Operating Systems

Course Code: 2501CS13

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Describe basic concepts of operating systems and its structure.
- CO2:** Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
- CO3:** Interpret the issues and challenges of memory management.
- CO4:** Illustrate concepts of Disk management and file system implementation.
- CO5:** Explain issues related to protection and security mechanisms.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

UNIT – II

Process Concept: Process scheduling, Operations on processes, Inter-process communication. Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.

Multithreaded Programming: Multithreading models, Thread libraries, Threading issues

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the following CPU scheduling algorithms:FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

UNIT – III

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

UNIT – IV

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.

Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.

File Systems: Files, Directories, File system implementation, management and optimization.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm
4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

UNIT – V

Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.

System Security: Introduction, Program threats, System and network threats.

Practice:

1. The above topics are discussed as case study in Windows/ Unix OS

Text Books:

- 1 Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12th Edition. ISBN: 978-0470128725
- 2 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: 978-0136006633
- 2 Operating Systems A Concept Based Approach, Dhamdhere D M, Tata McGraw-Hill, 3rd Edition. ISBN: 978-1259005589
- 3 Operating Systems, Nutt G, Pearson Education, 3rd Edition,. ISBN: 978-8131723593

Web Links:

- 1 <https://archive.nptel.ac.in/courses/106/106/106106144/>
- 2 <https://archive.nptel.ac.in/courses/106/105/106105214/>
- 3 <https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems>
- 4 <https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923>

Computer Networks

Course Code: 2501CS07

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Describe network topologies, reference models and media for data transmission
- CO2:** Analyze error and flow control issues in data link layer
- CO3:** Classify MAC protocols and channelization techniques
- CO4:** Apply routing algorithms and congestion control techniques for effective data transmission
- CO5:** Analyze protocols Transport and Application Layers

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Network Overview: interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

Practice:

- 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:

- 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:

- Write a Program to implement Sliding window protocols

UNIT – IV

Routing Algorithms: The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical

Congestion Control algorithms: General principles of congestion control, Congestion prevention policies, Approaches to Congestion Control, Traffic Aware Routing, Admission Control, **Traffic Throttling:** Load Shedding

Traffic Control Algorithm: Leaky bucket & Token bucket.

Practice:

1. Programs to implement routing protocols like shortest path.

UNIT – V

IP Protocols: IP Addressing, IP & ICMP.

Transmission Control Protocol: UDP & TCP.

Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP

Text Books:

- 1 Computer Networks — Andrew S Tanenbaum and David J Wetherall, Pearson Education, 5th Edition. ISBN: 978-0132126953
- 2 Data Communications and Networking – Behrouz A. Forouzan, McGraw Hill Education, 5th Edition ISBN: 978-1259064753

Reference Books:

- 1 Data Communications and Networks- Achut S Godbole, Atul Kahate, McGraw-Hill Education (India) Pvt Limited, 2nd Edition. ISBN: 978-0-07-123110-7
- 2 Computer Networks, Mayank Dave, CENGAGE India, 6th Edition ISBN: 978-8131509869

Web Links:

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>

Agile Software Engineering
(Common to CSE, IT AIML & CSE (DS))

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

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Text Books:

- 1 Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.
- 2

Reference Books:

- 1 Software Engineering, Lan Sommerville, Pearson, Tenth Edition, ISBN: 978-9332582699.
Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, David J. Anderson; Eli Schragenheim, ISBN: 978-0131424609
- 2

Web Links:

- 1 https://www.tutorialspoint.com/software_engineering/
- 2 <https://www.sciencedirect.com/science/article/pii/S0950584916303329>

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

Course Code: 2501AI03

L	T	P	C
1	0	2	3

Course Outcomes:

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

- CO1:** Illustrate data warehousing architectures and mining concepts for knowledge discovery.
- CO2:** Apply preprocessing techniques to prepare data for mining algorithms.
- CO3:** Build classification model using Decision tree induction.
- CO4:** Analyze association rule generation using Apriori and FP growth algorithms.
- CO5:** Apply Clustering algorithms on given data to find similarity between classes.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Data Warehousing and Online Analytical Processing:

Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation, Data Generalization by AttributeOriented Induction.

Data Mining: What Is Data Mining, Why Data Mining, Data Mining Functionalities, Technologies Are Used, Major Issues in Data Mining, Architecture Of Data Mining Systems Classification Of Data Mining Systems.

Practice :

1. Illustrate KDD process and explore the Data Mining tool WEKA/KNIME for Data Preprocessing, Classification and Clustering.
2. Explain ETL process important for moving data in the data warehouse.

UNIT-II

Know Your Data : Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity.

Data Preprocessing : An Overview, Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization.

Practice :

1. Apply Statistical Descriptions and Measures of Similarity and Dissimilarity on given data
2. Apply Preprocessing for training data set related to Weather data

UNIT-III

Classification and Prediction: Classification: Basic Concepts, General Approach to Solving a Classification Problem, Decision Tree Induction, Model Overfitting, Evaluating the Performance of a Classifier, Issues Regarding Classification and Prediction

Practice :

1. Demonstrate classification rule process on given data set using id3 algorithm.
2. Demonstrate classification rule process on Student's Academic Performance Data using j48 algorithm.

UNIT-IV

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Association Mining to Correlation Analysis.

Practice :

1. Demonstrate Association rule generation on credit card data using apriori algorithm.
2. Demonstrate Association rule process on contact lenses. arff using FPGrowth Algorithm

UNIT – V

Cluster Analysis: Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Evaluation of Clustering, Mining Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Practice

1. Demonstrate clustering process on given dataset using simple k-means
2. Apply Hierarchical clustering process on dataset.

Additional Practice:

1. Write a program of cluster analysis using DB SCAN algorithm Python programming language
2. Demonstrate Web/Text Mining using WEKA/KNIME Tool

Text Books:

- 1 Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei Third Edition, Elsevier, ISBN: 978-9380931913
- 2 Introduction to Data Mining, PangNing Tan, Michael Steinbach and Vipin Kumar Pearson Education, ISBN: 978-1-292-02615-2

Reference Books:

- 1 Data Mining: Introductory and Advanced Topics, Margaret H. Dunham, 1st Edition Pearson Edn, ISBN: 978-8177587852
- 2 Data Mining Techniques and Applications An Introduction, Hongbo Du, 1st Edition, Cengage India, ISBN: 978-8131519554
- 3 Data Warehousing, Data Mining and OLAP, Alex Berson,.Stephen J. Smith, McGrawHill series, ISBN: 978-0070062726

Web Links:

- 1 <https://nptel.ac.in/courses/106105174/>
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Object Oriented Programming through C++

Course Code: 2501CS08

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1:** Make use of C and C++ programming constructs to demonstrate OOP concepts.
- CO2:** Develop applications using constructor and destructor.
- CO3:** Apply C++ features for problem solving.
- CO4:** Apply inheritance concepts and file I/O to solve a given problem.
- CO5:** Design C++ classes using templates and STL.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to C++: Differences between C and C++, Disadvantages of Conventional Programming, Evolution of C++, Key Concepts of Object Oriented Programming, Structure of C++ program, Advantages of OOP, scope resolution Operator, Namespace.

Practice:

- Find the roots of a quadratic equation.
- Find factorial of a given number using recursion
- Implement scope resolution and namespaces.
- Illustrate the use of default arguments and access specifiers

UNIT – II

Classes and Objects: Declaring Objects- Access Specifiers and their Scope, Defining Member Function, Rules for Inline Functions, static Member Variable, static Member Function, Friend functions, overloading Member Function, Array of Objects, Object as Parameter, Object as return type, Nested class, Introduction to Constructors and Destructor, Characteristics of Constructor and Destructor, Application with Constructor, Constructor with Arguments, Copy Constructor, Anonymous Objects.

Practice:

- Program to illustrate inline functions and function overloading.
- Program to illustrate friend function
- Program to illustrate the use of Constructors and Destructors.
- Program illustrating Constructor overloading.
- Program illustrating Copy Constructor.

UNIT – III

Operator Overloading: Introduction, The Keyword Operator, Rules for Overloading Operators, Overloading Unary Operator, Overloading Binary Operator, Overloading using friend function.

Inheritance: Introduction, Reusability, Types of Inheritance, Virtual Base Classes, Object as a Class Member, Abstract Classes, Advantages and Disadvantages of Inheritance. Pointer to Class- Pointer Object, this Pointer, Pointer to Derived Classes and Base Class.

Binding Polymorphisms and Virtual Functions: Introduction, Binding in C++, Virtual Functions, Rules for Virtual Function, Abstract classes, Virtual Destructor

Practice:

1. Overload Unary, and Binary Operators using member function.
2. Overload Unary, and Binary Operators using friend function.
3. Incorporate various forms of Inheritance i. Single Inheritance ii. Multiple Inheritances iii. Multi-level inheritance iv. Hierarchical Inheritance v. Hybrid inheritance
4. Order of execution of constructors and destructors in inheritance.
5. Illustrate the use of object as a class member, pointer to a class, this pointer and Virtual Base Class.
6. Illustrate virtual functions.
7. Implement pure virtual function and calculate the area of different shapes by using abstract class.

UNIT – IV

Generic Programming with Templates: Introduction, Need for Templates, Definition of class Templates, Normal Function Templates, Overloading of Template Function, Bubble Sort Using Function Templates, Difference between Templates and Macros, Linked list with templates

Practice:

1. Illustrate the use of function template.
2. Implement template class.
3. Implement class templates with multiple parameters.

UNIT – V

Exception Handling: Introduction, Principles of Exception Handling, The Keywords try throw and catch, Multiple Catch Statements.

Files: Stream I/O, Reading and writing to Files.

Overview of Standard Template Library: Introduction, STL Programming Model, Containers, Sequence Containers, Associative Containers, Algorithms, Iterators, Vectors, Lists, Maps

Practice:

1. Implement Exceptions handling.
2. Illustrate the use of multiple catch statements.
3. Implement List, Vector and its Operations.
4. Implement Deque and its Operations.
5. Implement Map and its Operations.

Additional Practice:

1. Develop a C++ program for flight booking system
2. Develop Qt application containing slider and spin box in which a slider responds to changes in the spin box.

3. Develop a Qt application for creating a text pad.
4. Develop a C++ program with maximum of 20 characters, that your user will be guessed and will show only asterisks (*) on the screen. The user will input or enter one character at a time. And for every correct character, the asterisk will be replaced by that character until all the characters or the mystery word/s will reveal. Your program will accept a maximum three (3) errors or mistakes in entering/inputting character otherwise the mystery word/s will be viewed. Sample Output: Output: ***** Enter your character: e
Output: ***e***
Enter your character: a Output: sorry! the character is not existing. you still have 2 chances
Enter your character: s Output: s**e***
Enter your character: c Output: sc*e*ce
Enter your character: i Output: scie*ce
Enter your character: n Output: science

Text Books:

- 1 The Complete Reference C++, Herbert Schildt, Fourth Edition, TMH ISBN-13:978-0070532465, and the ISBN-10 is 007053246X.
- 2 The C++ Programming Language, Bjarne Stroustrup, Fourth Edition, Pearson ISBN 978-0321563842

Reference Books:

- 1 A First Book Of C++, Gary Bronson, Fourth Edition, Cengage Learning ISBN-10. 8131532712 and ISBN-13. 978-8131532713
- 2 C++ Primer Plus By Stephen Prata, Sixth Edition, Pearson ISBN: 978-0321776402
- 3 C++ Programming: From Problem Analysis To Program Design, Ds Malik, Eighth Edition, Cengage Learning ISBN: 9781337102087

Web Links:

- 1 <http://nptel.ac.in/courses/106105151/>
- 2 <http://www.geeksforgeeks.org/c-plus-plus/>
- 3 https://infyspringboard.onwingspan.com/web/en/viewer/html/lex_auth_01350157284861542410101
- 4 <https://www.udemy.com/course/beginning-c-plus-plus-programming/>

Java Programming

Course Code: 2501IT06

L	T	P	C
2	0	2	4

Course Outcomes:

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

- CO1:** Apply Java features for problem solving.
- CO2:** Build applications using principles of OOPs, interfaces and Packages.
- CO3:** Develop programs using Exception Handling to handle run-time errors.
- CO4:** Develop applications using multithreading for inter thread communication.
- CO5:** Build JDBC applications for performing CRUD operations using MySQL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO1	2	1	1	-	1	-	-	-	1	2	1
CO2	2	1	3	-	1	-	-	-	1	2	1
CO3	2	3	2	-	1	-	-	-	1	2	1
CO4	2	2	2	-	1	-	-	-	1	2	1
CO5	2	2	3	-	1	-	-	-	1	2	1

UNIT – I

Introduction to Java: History of Java, Features of Java Language, JVM Architecture, Java source file structure. Building Blocks of Java, Control Statements, Operators, Type Conversion, Command Line Arguments, Arrays.

Practice:

1. Control Statements

- a. Select all the prime numbers within the range of 1 to 100.
- b. Find the sum of all even terms in the Fibonacci sequence up to the given range N.
- c. Check whether a given number is Armstrong or not.

2. Arrays

- a. Sort an array of integers in ascending order.
- b. Find the maximum and minimum element in an array.
- c. Remove duplicate elements from an array.

UNIT – II

Concepts of Class: Class, Object, Method, Constructor, Overloading- Method and Constructor Keywords: this, static and final, String Class and its Methods, StringTokenizer, StringBuffer and StringBuilder.

Practice:

1. Class Mechanism

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

- c. Implement method overloading.

2.Strings

- a. Check if a given string is a pangram (contains every letter of the alphabet at least once).
- b. Find the most frequently occurring character in a string.
- c. Find all permutations of a given string.
- d. Check if a given string is a anagram (Ex: CAT and ACT).

UNIT – III

Inheritance: Inheritance, Types of Inheritance, super and super(), Method Overriding, Using final with inheritance, abstract with Class and Method, Dynamic Method Dispatch.

Interfaces: Introduction to interface, Multiple inheritance.

Practice:

1. Inheritance & interface

- a. Implement multi level Inheritance.
- b. Implement multiple Inheritance.
- c. Find the areas of different shapes using abstract classes.

UNIT – IV

Packages: Introduction, Importing Packages and Classes, path and classpath, Access Specifiers, java.util: Collection Framework (related interfaces and classes), java.io: FileReader, FileWriter, FileInputStream, FileOutputStream, BufferedReader and BufferedWriter, Wrapper Classes.

Practice:

1. Packages & java.io

- a. Import and use user defined package.
- b. Illustrate the use of protected members in a package.
- c. Copy Even numbers into Even.txt file and Odd Numbers into Odd.txt file.

2. Collection Framework

- a. ArrayList and LinkedList
- b. Iterator and Iterable
- c. Comparator and Comparable
- d. HashMap and TreeMap
- e. HashSet and TreeSet
- f. f. HashTable

UNIT – V

Exception Handling: Introduction, Keywords: try, catch, throw, throws and finally, Multiple Catch Clauses, Checked and Unchecked Exceptions, User Defined Exceptions.

Multithreading: Introduction, Thread Life Cycle, Creation, Priorities, Synchronization, ITC.

Java Database Connectivity: Introduction, JDBC Architecture, Types of Drivers, JDBC Environment Setup, JDBC Steps, CRUD Operations.

Practice:

1. Exception Handling

- a. Illustrate exception handling mechanism using multiple catch clauses.
- b. Make use of Built-in and user-defined Exceptions in handling a run time exception.

2. Multithreading

- a. Creates threads by extending Thread class. First thread display “Good Morning” every 1 sec, the second thread displays “Hello” every 2 seconds and the third display “Welcome” every 3 seconds, (Repeat the same by implementing Runnable).
- b. Solve Producer-Consumer problem using synchronization.

3. JDBC

- a. CRUD operations.

Additional Practice:

1. Student Management
2. Inventory Management
3. Phone book Management

*** Note: The student must Complete & Submit a Java Programming Certificate Course offered by Oracle Academy at the end of the Practice Session.**

Text Books:

1. The Complete Reference Java, Herbert Schildt, TMH ,8th Edition, ISBN 978-1260440232.
2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition. ISBN: 9780199459643.

Reference Books:

1. Introduction to java programming, by Y Daniel Liang, Pearson, Seventh Edition. ISBN: 978-8131729588
2. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press. ISBN: 978-9351199250

Web Links:

1. <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf>
2. <https://nptel.ac.in/courses/106/105/106105191/>
3. <http://java.sun.com/docs/books/tutorial/>

Introduction to MERN Stack Development

Course Code: 2501CS16

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Make use of HTML elements and their attributes for designing static web pages.
- CO2:** Build a web page by applying appropriate CSS styles to HTML elements.
- CO3:** Experiment with JavaScript to develop dynamic web pages and validate forms.
- CO4:** Build a basic web server using Node.js and also working with Node Package Manager (NPM)
- CO5:** Make use of Typescript to optimize JavaScript code using strict type checking

Mapping of Course Outcomes with Program Outcomes:

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

Practice:

1. Lists, Links and Images

a. Write a HTML program, to explain the working of lists.

Note: It should have an ordered list, unordered list, nested lists and ordered list in an unordered list and definition lists.

b. Write a HTML program, to explain the working of hyperlinks using <a> tag and href, target Attributes.

Note: Use text to link □ <https://www.aec.edu.in/>

Use image to link □ <https://www.aec.edu.in/?p=Gallery>

c. Create a HTML document that has your image and your friend's image with a specific height and width. Also when clicked on the images it should navigate to their respective profiles.

d. Write a HTML program, in such a way that, rather than placing large images on a page, the preferred technique is to use thumbnails by setting the height and width parameters to something like to 100*100 pixels. Each thumbnail image is also a link to a full sized version of the image. Create an image gallery using this technique.

2. HTML Tables, Forms and Frames

a. Write a HTML program, to explain the working of tables. (use tags: <table>, <tr>, <th>, <td> and attributes: border, rowspan, colspan)

b. Write a HTML program, to explain the working of tables by preparing a timetable. (Note: Use <caption> tag to set the caption to the table & also use cell spacing, cell padding, border, rowspan, colspan etc.).

- c. Write a HTML program, to explain the working of forms by designing Registration form. (Note: Include text field, password field, number field, date of birth field, checkboxes, radio buttons, list boxes using <select> & <option> tags, <text area> and two buttons ie: submit and reset. Use tables to provide a better view).
- d. Write a HTML program, to explain the working of frames, such that page is to be divided into 3 parts on either direction. (Note: first frame ☐ image, second frame ☐ paragraph, third frame ☐ hyperlink. And also make sure of using “no frame” attribute such that frames to be fixed).

3. HTML 5 and Cascading Style Sheets, Types of CSS

- a. Write a HTML program, that makes use of <article>, <aside>, <figure>, <figcaption>, <footer>, <header>, <main>, <nav>, <section>, <div>, tags.
- b. Write a HTML program, to embed audio and video into HTML web page.
- c. Write a program to apply different types (or levels of styles or style specification formats) - inline, internal, external styles to HTML elements. (identify selector, property and value).

4. Selector forms

- a. Write a program to apply different types of selector forms
 - i. Simple selector (element, id, class, group, universal)
 - ii. Combinator selector (descendant, child, adjacent sibling, general sibling)
 - iii. Pseudo-class selector
 - iv. Pseudo-element selector
 - v. Attribute selector

5. CSS with Color, Background, Font, Text and CSS Box Model

- a. Write a program to demonstrate the various ways you can reference a color in CSS.
- b. Write a CSS rule that places a background image halfway down the page, tilting it horizontally. The image should remain in place when the user scrolls up or down.
- c. Write a program using the following terms related to CSS font and text:
 - i. font-size ii. font-weight iii. font-style
 - iv. text-decoration v. text-transformation vi. text-alignment
- d. Write a program, to explain the importance of CSS Box model using
 - i. Content ii. Border iii. Margin iv. Padding

6. Applying JavaScript - internal and external, I/O, Type Conversion

- a. Write a program to embed internal and external JavaScript in a web page.
- b. Write a program to explain the different ways for displaying output.
- c. Write a program to explain the different ways for taking input.
- d. Create a webpage which uses prompt dialogue box to ask a voter for his name and age. Display the information in table format along with either the voter can vote or not.

7. Javascript Pre-defined and User-defined Objects

- a. Write a program using document object properties and methods.
- b. Write a program using window object properties and methods.
- c. Write a program using array object properties and methods.
- d. Write a program using math object properties and methods.
- e. Write a program using string object properties and methods.
- f. Write a program using regex object properties and methods.
- g. Write a program using date object properties and methods.

h. Write a program to explain user-defined object by using properties, methods, accessors, constructors and display

8. Javascript Conditional Statements and Loops

- Write a program which asks the user to enter three integers, obtains the numbers from the user and outputs HTML text that displays the larger number followed by the words “LARGER NUMBER” in an information message dialog. If the numbers are equal, output HTML text as “EQUAL NUMBERS”.
- Write a program to display **week** days using switch case.
- Write a program to print 1 to 10 numbers using for, while and do-while loops.
- Write a program to print data in object using for-in, for-each and for-of loops

9. Javascript Functions and Events

- Design a appropriate function should be called to display
 - Factorial of that number
 - Fibonacci series up to that number
- Design a HTML having a text box and four buttons named Factorial, Fibonacci, When a button is pressed an appropriate function should be called to display
 - Factorial of that number
 - Fibonacci series up to that number
- Write a program to validate the following fields in a registration page
 - Name (start with alphabet and followed by alphanumeric and the length should not be less than 6 characters)
 - Mobile (only numbers and length 10 digits)
 - E-mail (should contain format like xxxxxxxx@xxxxxx.xxx)

10. Node.js

- Write a program to show the workflow of JavaScript code executable by creating web server in Node.js.
- Write a program to transfer data over http protocol using http module.
- Create a text file src.txt and add the following content to it. (HTML, CSS, Javascript, Typescript, MongoDB, Express.js, React.js, Node.js)
- Write a program to parse an URL using URL module.
- Write a program to create an user-defined module and show the workflow of Modularization of application using Node.js

11. Typescript

- Write a program to understand simple and special types.
- Write a program to understand function parameter and return types.
- Write a program to show the importance with Arrow function. Use optional, default and REST parameters.
- Write a program to understand the working of typescript with class, constructor, properties, methods and access specifiers.

Additional Practice:

- Write a CSS program, to apply 2D and 3D transformations in a web page
- Design a Web page with new features of HTML file and CSS3.
- Design a to-do list application using Javascript.

Text Books:

1. Programming the World Wide Web, Robert W. Sebesta, Pearson, 7th Edition. ISBN 13 97893325018827
2. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasanth Subramanian, APress, O'Reilly, 2nd edition. ISBN 9781484226520.

Web Links:

1. <https://www.w3schools.com/html>
2. <https://www.w3schools.com/css>
3. <https://www.w3schools.com/js/>
4. <https://www.w3schools.com/nodejs>
5. <https://www.w3schools.com/typescript>

Information Security Analysis & Audit

Course Code: 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	-	-	-	-	2	-	-	-	2
CO3	1	3	-	1	-	1		1	-	-	2
CO4	1	2	-	-	-	-	1	1	-	1	1
CO5	1	3	-	2	1	-	2	2	-	-	-

UNIT – I

Overview of Information System Auditing: Effect of Computers on Internal Controls, Effects of Computers on Auditing, Foundations of information Systems Auditing, Conducting an Information Systems Audit.

UNIT – II

The management Control Framework-I: Introduction, Evaluating the planning Function, Leading Function, Controlling Function, Systems Development Management Controls, Approaches to Auditing Systems Development, Programming Management Controls, Data Resource Management Controls.

UNIT – III

The Management Control Framework-II: Security Management Controls, Operations management Controls Quality assurance Management Controls, Case Studies

UNIT – IV

Evidence Collection: Audit Software, Code Review, Test Data, and Code Comparison, Concurrent Auditing techniques, Interviews, Questionnaires, and Control Flowcharts. Performance Management tools- Case Studies.

UNIT – V

Evidence Evaluation: Evaluating Asset Safeguarding and Data Integrity, Evaluating System, Effectiveness, Evaluating System Efficiency, Information Systems Audit and Management: Managing the Information Systems Audit Function.

Text Books:

- 1 Information Systems Control and Audit, Ron Weber, Pearson Education, 1st Edition. ISBN : 978-8131704721
- 2 Cryptography Engineering: Design Principles and Practical Applications ,Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons. ISBN: 978-0470474242

Reference Books:

- 1 Information System Audit and Assurance, D P Dube, TMH, New Delhi. ISBN: 978-0070585690
- 2 Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi. ISBN: 978-8170083412

Web Links:

- 1 <https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks>
- 2 <https://computersecurity.stanford.edu/free-online-video> [Free Online Videos]
- 3 CERT-In Guidelines- <http://www.cert-in.org.in/>

Advanced MERN Stack Development

Course Code: 2501CS18

L	T	P	C
0	0	2	2

Course Outcomes:

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

- CO1:** Make use of router, template engine and authentication using sessions to develop application in ExpressJS.
- CO2:** Build a single page application using RESTful APIs in ExpressJS.
- CO3:** Make use of components, props, states and render data in ReactJS.
- CO4:** Apply router and hooks in designing ReactJS application.
- CO5:** Make use of MongoDB queries to perform CRUD operations on document database.

Mapping of Course Outcomes with Program Outcomes:

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

PRACTICE:

1. ExpressJS – Routing, HTTP Methods, Middleware.

- a. Write a program to define a route, Handling Routes, Route Parameters, Query Parameters and URL building.
- b. Write a program to accept data, retrieve data and delete a specified resource using http methods.
- c. Write a program to show the working of middleware.

2. ExpressJS – Templating, Form Data

- a. Write a program using templating engine.
- b. Write a program to work with form data.

3. ExpressJS – Cookies, Sessions, Authentication

- a. Write a program for session management using cookies and sessions.
- b. Write a program for user authentication.

4. ExpressJS – Database, RESTful APIs

- a. Write a program to connect MongoDB database using Mongoose and perform CRUD operations.
- b. Write a program to develop a single page application using RESTful APIs.

5. ReactJS – Render HTML, JSX, Components – function & Class

- a. Write a program to render HTML to a web page.

- b. Write a program for writing markup with JSX.
- c. Write a program for creating and nesting components (function and class).

6. ReactJS – Props and States, Styles, Respond to Events

- a. Write a program to work with props and states.
- b. Write a program to add styles (CSS & Sass Styling) and display data.
- c. Write a program for responding to events.

7. ReactJS – Conditional Rendering, Rendering Lists, React Forms

- a. Write a program for conditional rendering.
- b. Write a program for rendering lists.
- c. Write a program for working with different form fields using react forms.

8. ReactJS – React Router, Updating the Screen

- a. Write a program for routing to different pages using react router.
- b. Write a program for updating the screen.

9. ReactJS – Hooks, Sharing data between Components

- a. Write a program to understand the importance of using hooks.
- b. Write a program for sharing data between components.

10. ReactJS Applications – To-do list and Quiz

- a. Design to-do list application.

11. MongoDB – Installation, Configuration, CRUD operations

- a. Install MongoDB and configure ATLAS
- b. Write MongoDB queries to perform CRUD operations on document using insert(), find(), update(), remove()

12. MongoDB – Databases, Collections and Records

- a. Write MongoDB queries to Create and drop databases and collections.
- b. Write MongoDB queries to work with records using find(), limit(), sort(), createIndex(), aggregate().

Additional Practice:

- 1. Design a to-do list application using NodeJS and ExpressJS.
- 2. Design a Quiz app using ReactJS.
- 3. Complete the MongoDB certification from MongoDB University website.

Note: The student must Complete & Submit a Express Js, React Js & MongoDB Certificate Courses offered by Infosys Spring board at the end of the Practice Session.

Reference Books:

- 1 Programming the World Wide Web, 7th Edition, Robert W. Sebesta, Pearson. ISBN 13 97893325018827
- 2 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasanth Subramanian, Apress, O'Reilly, 2nd edition. ISBN 9781484226520.

Web Links:

- 1 [https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384329019595161635073_shared/overview \(Express Js\)](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384329019595161635073_shared/overview_(Express_Js))
- 2 [https://infyspringboard.onwingspan.com/web/en/app/toc/lex_10648877150323546000_shared/overview\(ReactJs\)](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_10648877150323546000_shared/overview(ReactJs))
- 3 [https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013177169294712832113_shared/overview \(MongoDB\)](https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013177169294712832113_shared/overview_(MongoDB))

Flutter Fundamentals

Course Code: 2501IT12

L	T	P	C
0	0	2	2

Practice:

1.Introduction to Flutter

1. **Setup Environment:** Set up the Flutter development environment on both Windows and Mac OS.
2. **First App:** Create and run your first Flutter application in Android Studio.
3. **Hello World:** Create a simple "Hello World" Flutter application and run it on an Android emulator.
4. **Understanding Structure:** Modify the main Dart file to understand the structure of a Flutter app.
5. **Hot Reload and Restart:** Practice using the hot reload and hot restart features to see how changes reflect instantly.

2. Flutter Basics

1. **Button Widgets:** Create a Flutter app with various button widgets (Flat Button, Elevated Button, Icon Button).
2. **Image Widget:** Create an app that displays an image using the Image widget and customize its properties.
3. **Icon Widgets:** Use Icon widgets to display different icons in a Flutter app.
4. **Counter App:** Build a simple counter app that increases a number each time a button is pressed using set State.
5. **Gesture Detector:** Implement a gesture detector that changes the color of a container when tapped.

3.Flutter Basics Continued

1. **List of Items:** Create an app with a list of items where each item can be clicked to display a toast message.
2. **Input Validation:** Implement form input validation to ensure correct data entry.
3. **Dialogs:** Use Alert Dialog to show a dialog box when a button is pressed.

4.Introduction to Layouts

1. **Basic Layouts:** Create a layout using Column, Row, and Stack widgets.
2. **Responsive Layout:** Implement a responsive layout using the Flex widget.
3. **Single and Multiple Child Widgets:** Build a layout with a combination of single child and multiple child widgets.
4. **Nested Layouts:** Design a complex UI using nested layouts (e.g., rows inside columns).
5. **Gesture Detection:** Use Gesture Detector to detect various gestures (tap, double-tap).

5.Layouts Continued

1. **Navigation:** Implement navigation between two screens using the Navigator widget.
2. **Grid View:** Create a layout using Grid View to display items in a grid.
3. **List View:** Use List View to display a list of dynamic items.

Scrolling: Implement scrolling for a long list of items using List View and Scroll View

6.State Management (Basic)

1. **Stateful and Stateless Widgets:** Create a simple app to toggle between stateful and stateless widgets and observe the behavior.
2. **Form Input and Display:** Build an app with a form that takes user input and displays it on the same screen using set State.
3. **Responsive Layout with Media Query:** Create a responsive layout that adapts to different screen sizes using Media Query.
4. **To-Do List App:** Create a to-do list app where users can add and remove items dynamically.

7.Animation in Flutter

1. **Animated Container:** Create a simple animation using Animated Container.
2. **Fade Transition:** Implement a basic fade transition using Animated Opacity.
3. **Physics-based Animation:** Develop an app that uses a physics-based animation like Draggable.
4. **Hero Animation:** Implement a hero animation for navigating between screens.

8.Advanced Animations

1. **Animated Builder:** Use Animated Builder to create complex animations.
2. **Animation Controller:** Create animations with fine control using Animation Controller.
3. **Staggered Animations:** Implement staggered animations to animate multiple widgets in sequence.
4. **Curved Animations:** Use Curved Animation to create non-linear animations.

9.State Management (Advanced)

1. **Provider Package:** Use the Provider package for state management.
2. **BLoC Pattern:** Use the BLoC (Business Logic Component) pattern for managing state.
3. **River pod:** Explore and use the River pod package for state management.

10.Networking in Flutter

1. **HTTP Requests:** Use the http package to make GET and POST requests.
2. **JSON Parsing:** Parse JSON data received from an API.
3. **Fetching Data:** Fetch and display data from a remote API.
4. **Handling Errors:** Implement error handling for network requests.
5. **REST API:** Create an app that interacts with a REST API

11.Firebase Integration

1. **Firestore Setup:** Set up Firestore for a Flutter project.
 2. **Authentication:** Implement user authentication using Firebase Auth.
 3. **Fire store:** Use Fire store to store and retrieve data.
- Firestore Storage:** Upload and download files using Firestore Storage

12.Project Week

1. **Project Planning:** Plan a small project incorporating concepts learned.

- 2. Project Development:** Develop the project with proper state management, layout, and networking.
- 3. Testing:** Test the project for bugs and ensure all functionalities work as expected.
- 4. Optimization:** Optimize the app for performance and responsiveness

Additional Practice:

1. Create a Flutter app that displays a list of items using List View. builder and allows users to add new items dynamically.
2. Develop a Flutter app that uses a Bottom Navigation Bar to navigate between different screens.
3. Create a Flutter app that implements basic form validation with input fields for name, email, and password.

Reference Books:

- 1 "Beginning Flutter: A Hands-On Guide to App Development" by Marco L. Napoli.ISBN: 978-1119550822
- 2 "Flutter in Action" by Eric Windmill, 2020.ISBN: 978-1617296147
- 3 Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart 2 by Alessandro Biessek.ISBN: 9781800565999

Web Links:

- 1 <https://flutter.dev/docs>
- 2 <https://dart.dev/guides>
- 3 <https://codelabs.developers.google.com/?cat=flutter>

Minor Degree in Data Science

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
2501CS34	Fundamentals of Data Science	IC	2		1	3	50	50	100	PPSC
2501CS12	NoSQL Databases	IC	2			2	50	50	100	-
2501AI03	Data Mining	IC	1		2	3	50	50	100	-
2501CS37	Health Care Data Analytics	IC	2		1	3	50	50	100	PPSC
2501CS36	(or) Business Intelligence & Analytics									
2501AI04	Big Data Analytics (or)	AC	2		1	3	50	50	100	DM
2501AI19	Data Visualization									DAP
2501CS41	Social Network Analysis	AC	2		1	3	50	50	100	-
2501CS40	(or) Social Networks & Semantic Web									
	Total		13		7	20				

Agile Software Engineering
(Common to CSE, IT AIML & CSE (DS))

Course Code: 2501IT07	L 2	T 0	P 1	C 3

Course Outcomes:

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

- CO1:** Apply software engineering practices and evaluate different software development models to design and manage the life cycle of a Student Management System (SMS).
- CO2:** Analyze the principles of Agile methodologies and compare them with traditional models by transitioning a retail software company from Waterfall to Agile.
- CO3:** Evaluate the impact of Agile processes on requirements engineering and manage unstable requirements for a social media platform project.
- CO4:** Design and implement a comprehensive testing strategy using TDD and test automation tools in an Agile project.
- CO5:** Apply Agile design principles and execute refactoring techniques to develop maintainable and scalable software systems.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Text Books:

- 1 Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
- 2 Agile Software Development, Current Research and Future Directions, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

- 1 Software Engineering, Lan Sommerville, Pearson, Tenth Edition, ISBN: 978-9332582699.
- 2 Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, David J. Anderson; Eli Schragenheim, ISBN: 978-0131424609

Web Links:

- 1 https://www.tutorialspoint.com/software_engineering/
- 2 <https://www.sciencedirect.com/science/article/pii/S0950584916303329>

Fundamentals of Data Science

Course Code: 2501CS34

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain fundamental concepts of Data Science.
- CO2:** Implement Data Collection and Preprocessing Techniques.
- CO3:** Demonstrate Proficiency in Data Loading, Storage, and File Handling
- CO4:** Conduct Exploratory Data Analysis (EDA) using Visualization and Statistical Techniques.
- CO5:** Make use of Neo4j, Cypher tools to manage and analyze graph data.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction To Data Science: Definition and Scope of Data Science, History and Evolution of Data Science, Applications of Data Science, Data Science Lifecycle, Data Types and Structures, Tools and Technologies in Data Science.

Practice:

1. Importing and Exploring Datasets - Loading datasets using libraries and performing basic exploration.
2. Basic Data Structures - Working with data structures such as arrays, lists, data frames, and matrices.

UNIT-II

Data Collection and Preprocessing: Data Collection Methods, Data Cleaning and Handling Missing Values, Data Transformation: Normalization and Standardization, Feature Engineering and Feature Scaling, Data Integration and Aggregation.

Practice:

1. Computing summary statistics like mean, median, mode, and standard deviation for a sample dataset.
2. Handling missing values and outliers in a dataset using techniques like imputation and filtering.

UNIT – III

Data Loading, Storage, and File Formats : Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scrapping, Binary Data

Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice:

1. Read data from a JSON file into a DataFrame using Pandas (pd.read_json) or R (jsonlite). Parse nested JSON structures and convert them into a flat table format.
2. Perform web scraping on an HTML page using BeautifulSoup in Python or rvest in R. Extract data from HTML tables and convert it into a DataFrame.

UNIT – IV

Exploratory Data Analysis (EDA): Descriptive Statistics, Data Visualization Techniques, Correlation and Covariance Analysis, Univariate, Bivariate, and Multivariate Analysis, Pattern Detection and Anomaly Identification.

Practice:

1. Plotting histograms and box plots to understand the distribution of a single variable.
2. Creating scatter plots and calculating correlation coefficients to study the relationship between two variables.

UNIT – V

Data Science Tools: Neo4j for dealing with graph databases, graph query language Cypher, libraries like nltk and SQLite for handling Text mining and analytics.

Practice:

1. Get hands-on experience with Neo4j to understand how to manage and query graph databases.
2. Practice writing Cypher queries to interact with graph data in Neo4j.

Text Books:

- 1 Wes McKinney, “Python for Data Analysis”, O’REILLY, ISBN:978-1-449-31979-3, 1st edition, October
- 2 Rachel Schutt & O’neil, “Doing Data Science”, O’REILLY, ISBN:978-1-449-35865-5, 1st edition, October 2013

Reference Books:

- 1 Data Science from Scratch: First Principles with Python, Joel Grus, O’Reilly Media, ISBN: 9781492041139.
- 2 Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, Matt Harrison, O’Reilly, ISBN: 9781787123137

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_cs68/preview
2. https://onlinecourses.nptel.ac.in/noc24_cs133/preview
3. <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>

NoSQL Databases

Course Code: 2501CS12

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Compare the traditional relational databases and NoSQL
- CO2:** Explain the principles and architecture of document store databases
- CO3:** Design and implement keyvalue database solutions.
- CO4:** Illustrate the fundamental concepts and architecture of column family store databases
- CO5:** Optimize graph databases for performance and scalability

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to No SQL: Definition And Introduction, Traditional relational databases vs. NoSQL databases, Types of No SQL databases, Storing and Accessing Data in NoSql databases, Querying in NoSql databases, Evolution and motivation behind NoSQL databases, Characteristics, advantages, and challenges of NoSQL databases Performing Crud Operations, Creating Records, Accessing Data, Updating And Deleting Data

UNIT – II

Document Stores:

Introduction to MongoDB, Importance of NoSQL databases, Data types, Documents, nested Documents, CRUD Operations, Basic cursor methods: map, to Array, pretty, for Each, limit, count, sort, Columnar Databases, Indexing and Aggregation, MongoDB Node JS Drivers and CAP theorem.

UNIT – III

Key Value databases:

What Is a KeyValue Store, KeyValue Store Features, Suitable Use Cases, When Not to Use

Document Databases: What Is a Document Database, Features, Suitable Use Cases, When Not to Use NoSQL Data Bases

UNIT – IV

Column family stores:

What Is a ColumnFamily Data Store, Features, Suitable Use Cases, When Not to Use Graph

Databases: What Is a Graph Database, Features, Suitable Use Cases, When Not to Use

UNIT – V

Graph Database:

Graph Oriented Database Platform: Neo4j Graph Databases – Model relational data – Property graph model – Neo4j Graph Platform –Components – Features – Benefits of Neo4j – Setup Development Environment – Neo4j Sandbox –Neo4j Desktop – Cypher – Match – Graph node retrieval – Graph relations retrieval – Graph properties retrieval – Nodes – Relationships – Merge data into graph – Parameter constraints –Monitor query execution – Indexes – Relational Data.

Text Books:

- 1 NoSQL Distilled, Pramod J. Sadalage, Martin Fowler, Addison Wesley. ISBN: 978-0-321-82662-6
- 2 Making Sense of NoSQL, Dan McCreary and Ann Kelly, Manning Publications. ISBN: 9781617291074

Reference Books:

- 1 Professional NoSQL, Shashank Tiwari, Wrox Press, Wiley. ISBN: 978-0470942246.
- 2 Getting Started with NoSQL, Gaurav Vaish, Packt Publishing. ISBN: 978-1849694988.

Web Links:

- 1 <https://nptel.ac.in/courses/106104135>
- 2 <https://www.geeksforgeeks.org/wheredoesmongodstandinthecaptheorem/>
- 3 <https://www.geeksforgeeks.org/columnardatamodelofnosql/>

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

Course Code: 2501AI03

L	T	P	C
1	0	2	3

Course Outcomes:

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

- CO1:** Illustrate data warehousing architectures and mining concepts for knowledge discovery.
- CO2:** Apply preprocessing techniques to prepare data for mining algorithms.
- CO3:** Build classification model using Decision tree induction.
- CO4:** Analyze association rule generation using Apriori and FP growth algorithms.
- CO5:** Apply Clustering algorithms on given data to find similarity between classes.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Data Warehousing and Online Analytical Processing:

Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation, Data Generalization by AttributeOriented Induction.

Data Mining: What Is Data Mining, Why Data Mining, Data Mining Functionalities, Technologies Are Used, Major Issues in Data Mining, Architecture Of Data Mining Systems Classification Of Data Mining Systems.

Practice :

1. Illustrate KDD process and explore the Data Mining tool WEKA/KNIME for Data Preprocessing, Classification and Clustering.
2. Explain ETL process important for moving data in the data warehouse.

UNIT-II

Know Your Data : Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity.

Data Preprocessing : An Overview, Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization.

Practice :

1. Apply Statistical Descriptions and Measures of Similarity and Dissimilarity on given data
2. Apply Preprocessing for training data set related to Weather data

UNIT-III

Classification and Prediction: Classification: Basic Concepts, General Approach to Solving a Classification Problem, Decision Tree Induction, Model Overfitting, Evaluating the Performance of a Classifier, Issues Regarding Classification and Prediction

Practice :

1. Demonstrate classification rule process on given data set using id3 algorithm.
2. Demonstrate classification rule process on Student's Academic Performance Data using j48 algorithm.

UNIT-IV

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Association Mining to Correlation Analysis.

Practice :

1. Demonstrate Association rule generation on credit card data using apriori algorithm.
2. Demonstrate Association rule process on contact lenses. arff using FPGrowth Algorithm

UNIT – V

Cluster Analysis: Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Evaluation of Clustering, Mining Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Practice

1. Demonstrate clustering process on given dataset using simple k-means
2. Apply Hierarchical clustering process on dataset.

Additional Practice:

1. Write a program of cluster analysis using DB SCAN algorithm Python programming language
2. Demonstrate Web/Text Mining using WEKA/KNIME Tool

Text Books:

- 1 Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei Third Edition, Elsevier, ISBN: 978-9380931913
- 2 Introduction to Data Mining, PangNing Tan, Michael Steinbach and Vipin Kumar Pearson Education, ISBN: 978-1-292-02615-2

Reference Books:

- 1 Data Mining: Introductory and Advanced Topics, Margaret H. Dunham, 1st Edition Pearson Edn, ISBN: 978-8177587852
- 2 Data Mining Techniques and Applications An Introduction, Hongbo Du, 1st Edition, Cengage India, ISBN: 978-8131519554
- 3 Data Warehousing, Data Mining and OLAP, Alex Berson,.Stephen J. Smith, McGrawHill series, ISBN: 978-0070062726

Web Links:

- 1 <https://nptel.ac.in/courses/106105174/>
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Health Care Data Analytics

Course Code: 2501CS37

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain fundamentals of Healthcare Data Analytics.
- CO2:** Demonstrate the technologies for analyzing Biomedical Image
- CO3:** Apply predictive modeling techniques for Clinical Data
- CO4:** Apply predictive analysis techniques for genomic data
- CO5:** Illustrate NLP and Data mining for clinical text.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

An Introduction to Healthcare Data Analytics: ealthcare Data Sources and Basic Analytics Advanced Data Analytics for Healthcare Applications and Practical Systems for Healthcare Resources for Healthcare Data Analytics Electronic Health RecordsComponents of EHR Coding Systems Benefits of EHR Barriers to Adopting EHR Challenges of Using EHR Data.

Practice:

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

Biomedical Image Analysis: Biomedical Imaging Modalities Object Detection Image Segmentation Image Registration Feature Extraction Mining of Sensor Data in Healthcare Mining Sensor Data in Medical Informatics Challenges in Healthcare Data Analysis Sensor Data Mining Applications.

Practice:

1. Build a model to predict if a patient will be readmitted to the hospital within 30 days.Use the Hospital Readmissions Reduction Program (HRRP) dataset.

UNIT – III

Predictive Models for Integrating Clinical and Genomic Data: Introduction Issues and Challenges Different Types of Integration Different Goals of Integrative Studies Validation Information Retrieval for Healthcare KnowledgeBased Information in Healthcare and Biomedicine Content of KnowledgeBased Information Resources Indexing Retrieval Evaluation Research Directions.

Practice:

1. Perform survival analysis on a dataset of cancer patients to estimate survival rates. Use the SEER Cancer Incidence dataset

UNIT – IV

Natural Language Processing and Data Mining for Clinical Text: Natural Language Processing Mining Information from Clinical Text Challenges of Processing Clinical Reports Clinical Applications Social Media Analytics for Healthcare Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks Social Media Analysis for Public Health Research Analysis of Social Media Use in Healthcare.

Practice:

1. Segment patients into different groups based on their health care utilization patterns. Use a dataset containing patient visit records, such as the National Hospital Ambulatory Medical Care Survey (NHAMCS).

UNIT – V

Advanced Data Analytics for Healthcare: Automated Decision Systems The Artificial Intelligence field Basic concepts of Expert Systems Applications of Expert Systems Structure of Expert Systems Knowledge Engineering Development of Expert Systems – Locationbased Analytics Cloud Computing Business Intelligence.

Practice:

1. Analyze health care costs and identify factors driving high costs. Use the Medical Expenditure Panel Survey (MEPS) dataset.

Text Books:

- 1 Chandan K. Reddy, Charu C. Aggarwal "Healthcare Data Analytics", CRC Press, ISBN 9781032527802

Reference Books:

- 1 Analytics in Healthcare A Practical Introduction, Christo El Morr, Hossam Ali Hassan, 2019, ISBN: 9783030045067

Web Links:

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

Business Intelligence & Analytics

Course Code: 2501CS36

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the Business Intelligence, Analytics and Decision Support system
- CO2:** List the technologies for Decision making, Automated decision systems
- CO3:** Explain sentiment analysis techniques
- CO4:** Illustrate Multicriteria Decision making systems, predictive modelling techniques
- CO5:** Evaluate and validate the performance of automated decision systems and expert systems.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

An Overview of Business Intelligence, Analytics, and Decision Support: Information Systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems, A Framework for Business Intelligence, Business Analytics Overview, Brief Introduction to Big Data Analytics.

Practice:

1. Create interactive dashboards to visualize sales data and identify trends.

UNIT – II

Decision Making: Introduction and Definitions, Phases of the Decision, Making Process, The Intelligence Phase, Design Phase, Choice Phase, Implementation Phase, Decision Support Systems Capabilities, Decision Support Systems Classification, Decision Support Systems Components.

Practice:

1. Build a predictive model to forecast future sales.

UNIT – III

Neural Networks and Sentiment Analysis : Basic Concepts of Neural Networks, Developing Neural NetworkBased Systems, Illuminating the Black Box of ANN with Sensitivity, Support Vector Machines, A Process Based Approach to the Use of SVM, Nearest Neighbor Method for Prediction, Sentiment Analysis Overview, Sentiment Analysis Applications, Sentiment Analysis Process,, Sentiment Analysis, Speech Analytics.

Practice:

1. Use a pretrained sentiment analysis model to classify the sentiment of text data.

UNIT – IV

ModelBased Decision Making: Decision Support Systems modeling, Structure of mathematical models for decision support, Certainty, Uncertainty, and Risk, Decision modeling with spreadsheets, Mathematical programming optimization, Decision Analysis with Decision Tables and Decision Trees, MultiCriteria Decision Making With Pairwise Comparisons

Practice:

1. Evaluate different investment options considering potential risks and returns.

UNIT – V

Automated Decision Systems and Expert Systems: Automated Decision Systems, The Artificial Intelligence field, Basic concepts of Expert Systems, Applications of Expert Systems, Structure of Expert Systems, Knowledge Engineering, Development of Expert Systems.

Practice:

1. Develop a system to recommend products to customers based on their purchase history and preferences.

Text Books:

- 1 Ramesh Sharda, Dursun Delen, EfraimTurban, J.E.Aronson, TingPeng Liang, David King, “Business Intelligence and Analytics: System for Decision Support”, 10th Edition, Pearson Global Edition., ISBN: ISBN:9789352866489

Reference Books:

- 1 Data Analytics: The Ultimate Beginner's Guide to Data Analytics Paperback – 12 November 2017 by Edward Mize, ISBN: 9781925997576

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc24_cs65/preview
- 2 <https://www.geeksforgeeks.org/what-is-business-intelligence/>

Big Data Analytics

Course Code: 2501AI04

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Illustrate big data challenges in different domains
- CO2:** Use various techniques for mining data stream.
- CO3:** Demonstrate building blocks of Hadoop
- CO4:** Make use of Pig and Hive to structure big Data
- CO5:** Apply Spark tool to analyze big data.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to big data: Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting.

Practice:

- Hadoop File System Operations: Implement the following file management tasks in Hadoop: a.) Adding files and directories b.) Retrieving files c.) Deleting files

UNIT – II

Stream Processing:

Mining data streams: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics Platform (RTAP) Applications.

Practice:

- Loading DataSet in to HDFS for Spark Analysis.

UNIT – III

Introduction to Hadoop: History of Hadoop, the Hadoop Distributed File System, Components of Hadoop Analyzing the Data with Hadoop, Scaling Out, Hadoop Streaming, Design of HDFS, Java interfaces to HDFS Basics, Developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Failures, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features Hadoop environment.

Practice:

- Map Reduce Word Count Hadoop Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.

UNIT – IV

Pig: Hadoop Programming Made Easier: Admiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Checking out the Pig Script Interfaces, Scripting with Pig Latin. Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works with examples, Querying and Analyzing Data.

Practice:

1. Hive Queries a) Install Hive Framework b) Implement Hive to create, alter, and drop databases, tables
2. Hive Queries Implement hive queries and joins to perform display and retrieve the data

UNIT – V

Spark: Installing Spark, Spark applications, Jobs, stages and Tasks, Resilient Distributed data sets, Shared Variables, Anatomy of a Spark job run.

Practice:

1. Demonstrate Spark SQL on Hive
 - a) Create a SQLContext object and load the Parquet file into DataFrame
 - b) Load the Dataframe into Hive table.
 - c) Verify the created Hive table in Hive environment
 - d) Execute Spark SQL query

Text Books:

- 1 Hadoop: The Definitive Guide, Tom White, O'reilly, 4th Edition, ISBN: 978-1491901632
- 2 Hadoop for Dummies, Dirk deRoos, Paul C.Zikopoulos, Roman B.Melnyk, Bruce Brown, Rafael Coss, John Wiley & Sons, ISBN: 978-1118727128

Reference Books:

- 1 Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Bill Franks, John Wiley & sons, ISBN: 978-1118224912
- 2 Harness the Power of Big Data: The IBM Big Data Platform, Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, Tata McGraw Hill Publications, ISBN: 9780071808187
- 3 Big Data Science & Analytics: A Hands On Approach , Arshdeep Bahga and Vijay Madisetti, VPT, ISBN: 978-0996025577
- 4 Learning Spark: Lightning Fast Big Data Analysis Paperback, Holden Karau, ISBN: 978-1449358624

Web Links:

- 1 Hadoop: <http://hadoop.apache.org/>
- 2 Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
- 3 <https://nptel.ac.in/courses/106106142>
- 4 <https://www.cloudera.com/servicesandsupport/tutorials.html>
- 5 <https://www.databricks.com/spark/gettingstartedwithapachespark>

Data Visualization

Course Code: 2501AI19

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the various types of data and principles of data visualization
- CO2:** Apply visualization techniques to a problem and its associated dataset
- CO3:** Apply structured approach to create effective visualizations
- CO4:** Outline the valuable insights from the massive dataset using visualization.
- CO5:** Build visualization dashboard to support decision making

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Visualization:

Introduction to Data Visualizations and Perception: Introduction to visualization and visual perception, visual representation of data, Gestalt principles, Information overload.

Practice:

1. Introduction to various Data Visualization tools
2. Basic Visualization in Python

UNIT – II

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Practice:

1. Basic Visualization in R
2. Introduction to Tableau and Installation

UNIT – III

Classification of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.

Practice:

1. Connecting to Data and preparing data for visualization in Tableau
2. Data Aggregation and Statistical functions in Tableau

UNIT – IV

Visualization of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization. Various visualization techniques, data structures used in data visualization.

Practice:

1. Data Visualizations in Tableau

UNIT – V

Visualization of Volumetric Data And Evaluation of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations

Practice:

1. Basic Dashboards in Tableau

Text Books:

- 1 Interactive Data Visualization: Foundations, Techniques, and Applications, Ward, Grinstein, Keim, Natick, A K Peters, Ltd, 2nd edition. ISBN: 978-1-4822-5737-3.

Reference Books:

- 1 Visualization Analysis & Design, Tamara Munzner, AK Peters Visualization Series, 1st edition. ISBN: 978-1466508910
- 2 Interactive Data Visualization for the Web, Scott Murray, 2nd Edition. ISBN: 978-1491921289

Web Links:

- 1 <https://elearn.nptel.ac.in/shop/iit-workshops/completed/data-visualization-with-r/?v=c86EEed9d7ed>
- 2 <https://www.geeksforgeeks.org/data-visualization-and-its-importance/>

Social Network Analysis

Course Code: 2501CS41

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the fundamental of semantic web.
- CO2:** Illustrate knowledge representation using ontology.
- CO3:** Analyze various communities in social networks
- CO4:** Illustrate the prediction of human behaviour for social networks.
- CO5:** Design visualization of social networks.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction

Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Webbased networks– Applications of Social Network Analysis.

Practice:

1. Construct a social network object in R

UNIT – II

Modelling, Aggregating And Knowledge Representation

Ontology and their role in the Semantic Web: Ontologybased knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: Stateoftheart in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

Practice:

1. Perform knowledge representation of semantic web.

UNIT – III

Extraction And Mining Communities In Web Social Networks

Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms –

Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – MultiRelational characterization of dynamic social network communities.

Practice:

1. How to visualize a social network

UNIT – IV

Predicting Human Behavior And Privacy Issues

Understanding and predicting human behavior for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and counter measures.

Practice:

1. Calculate node and networklevel summary statistics

UNIT – V

Visualization And Applications Of Social Networks

Graph theory – Centrality – Clustering – NodeEdge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrixbased representations – Matrix and NodeLink Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – CoCitation networks.

Practice:

1. How to incorporate network connectivity in a spatial regression model

Text Books:

- 1 Social Networks and the Semantic Web ,Peter Mika, Springer ,First Edition. ISBN: 978-0-387-71000-6
- 2 Handbook of Social Network Technologies and Applications ,Borko Furht, ISBN: 978-1441971418

Reference Books:

- 1 Web Mining and Social Networking Techniques and applications,Guandong Xu ,Yanchun Zhang and Lin Li, First Edition, Springer. ISBN: 978-1441977342
- 2 Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively ,Dion Goh and Schubert Foo, IGI Global Snippet. ISBN: 978-1599045436
- 3 Max Chevalier, Christine Julien and Chantal SouléDupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet. ISBN: 9781605663074
- 4 The Social Semantic Web ,John G. Breslin, Alexander Passant and Stefan Decker, ,Springer. ISBN: 978-3642424328

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- 2 <https://open.hpi.de/courses/semanticweb>
- 3 <https://crd230.github.io/lab9.html>

Social Networks and Semantic Web

Course Code: 2501CS40

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Summarize the concepts of semantic web and social network analysis.
- CO2:** Describe the knowledge representation on the Semantic web.
- CO3:** Make use of ontology engineering in social networks.
- CO4:** Identify the architectures and challenges in building social networks
- CO5:** Compare various survey methods of social networks.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Web Intelligence: Thinking and Intelligent Web Applications, The Information Age, The World Wide Web, Limitations of Today's Web, The Next Generation Web, Machine Intelligence, Artificial Intelligence, Ontology, Inference engines, Software Agents, BernersLee www, Semantic Road Map, Logic on the semantic Web.

Practice:

1. Plot the trend of Moore's law from 1970 to today. Then project processor performance for the year 2020 based on Moore's law.

UNIT – II

Knowledge Representation for the Semantic Web: Ontologies and their role in the semantic web, Ontologies Languages for the Semantic Web –Resource Description Framework (RDF) / RDF Schema, Ontology Web Language (OWL), UML, XML/XML Schema.

Practice:

1. Why is it necessary to consider less powerful expressive languages for the Semantic Web?

UNIT – III

Ontology Engineering: Ontology Engineering, Constructing Ontology, Ontology Development Tools, Ontology Methods, Ontology Sharing and Merging, Ontology Libraries and Ontology Mapping, Logic, Rule and Inference Engines. Practice:

Describe an ontology with the domain of your university faculty, with teachers, courses, and departments.

Practice:

1. Use an inference engine to validate your ontology and check for inconsistencies.

UNIT – IV

Semantic Web Applications, Services and Technology: Semantic Web applications and services, Semantic Search, elearning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWLS Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Methods

Practice:

1. Why would Semantic Web Services promote open Web standards and a distributed Web?

UNIT – V

Social Network Analysis and semantic web: What is social Networks analysis, development of the social networks analysis, Electronic Sources for Network Analysis – Electronic Discussion networks, Blogs and Online Communities, Web Based Networks, Building Semantic Web Applications with social network features.

Practice:

1. List three potential applications that would benefit from the Semantic Web environment.

Text Books:

- 1 Thinking on the Web – Berners Lee, Godel and Turing, Wiley inter science. ISBN: 978-0471768661
- 2 Social Networks and the Semantic Web, Peter Mika, Springer. ISBN: 978-0-387-71000-6

Reference Books:

- 1 Semantic Web Technologies, Trends and Research in Ontology Based Systems, J. Davies, R. Studer, P. Warren, John Wiley & Sons. ISBN: 9780470030332
- 2 Information sharing on the semantic Web – Heiner Stuckenschmidt; Frank Van Harmelen, Springer Publications. ISBN: 978-3-540-20594-4
- 3 Programming the Semantic Web, T. Segaran, C. Evans, J. Taylor, O'Reilly, SPD. ISBN: 978-0596153816

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_cs78/preview
- 2 <https://tinyurl.com/hhywdjx8>
- 3 <https://open.hpi.de/courses/semanticweb>

Minor Degree in Artificial Intelligence and Machine Learning

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501AI02	Artificial Intelligence	IC	2		1	3	50	50	100	DAP
2501AI05	Machine Learning	IC	2		2	4	50	50	100	DAP
2501AI15	AI Chatbots	IC	2			2	50	50	100	DAP
2501AI14	Soft Computing (or) Fundamentals of Data Science	IC	1		2	3	50	50	100	AI
2501CS34			2		1	3	50	50	100	PPSC
2501AI10	Natural Language Processing (or) Data Visualization	AC	2		1	3	50	50	100	DAP
2501AI19										
2501AI16	Prompt Engineering and GenAI (or) Social Network Analysis	AC	2		1	3	50	50	100	ML
2501CS41										
2501AI17	Federated Machine Learning	AC	2			2	50	50	100	ML
TOTAL			14		6	20				

Artificial Intelligence

Course Code: 2501AI02

L T P C
2 0 1 3

Course Outcomes:

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

- CO1:** Illustrate the historical development of AI, key milestones and contributors.
- CO2:** Apply the basic principles of AI in problem solving
- CO3:** Apply Local Search Algorithms and Optimization Techniques.
- CO4:** Choose the appropriate representation of Knowledge.
- CO5:** Summarise the expert systems and real time applications

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Introduction:

What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Practice :

1. Introduction to LISP :
 - To demonstrate simple recursive functions and list manipulation in LISP
1. Introduction to Prolog :
 - Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

UNIT-II

Problem formulation:

Problem Definition Production systems, Control strategies, Search strategies. Problem characteristics, ProblemSolving 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 tictactoe problem using LISP/PROLOG

UNIT-III

Problem solving methods

Problem graphs, Matching, Indexing and Heuristic functions Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

Practice :

1. Implementation of TSP using heuristic approach using LISP/Prolog
2. Implementation of Hillclimbing to solve 8 Puzzle Problem

UNIT-IV**Knowledge representation**

Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic Structured representation of knowledge Basic plan generation systems – Strips Advanced plan generation systems – K strips Strategic explanations Why, why not and how explanations.

Practice :

1. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.
2. Create a framebased representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

UNIT – V**Expert Learning**

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Practice :

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>

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 Jupiter/Spider notebook and working on basic commands.
2. Loading and apply key preprocessing techniques on the dataset and also analyse the dataset.

UNIT-II

Supervised Learning(Regression/Classification):Basic Methods:

Concept Learning: General-to-Specific Hypotheses Ordering, Find-S and Candidate Elimination Algorithm, Version Space, and Inductive Bias.

Bayesian Learning: Probability Overview, MLE and MAP Estimates, Gaussian Naive Bayes Classifier, Bayesian Networks.

Instance-based Learning: k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN, Distance Metrics and Curse of Dimensionality.

Practice :

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.

3. Exercises to solve the real-world problems using Binary Classifier
4. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

UNIT-III

Linear Models and Regression: Linear Classification, Linear Regression, Non-linear Transformation, Logistic Regression.

Support Vector Machines: Decision Boundary and Support Vector: Optimization and Primal-Dual Problem, Soft Margin and Non-linear Decision Boundary, Kernel Functions and Radial Basis Functions introduction.

Practice :

1. Exercises to solve the real-world problems using Linear Regression
2. Exercises to solve the real-world problems using Logistic Regression
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients.

UNIT-IV

Classifier / Hypothesis Evaluation: Accuracy, Precision, Recall and F-Measures, Scores, Sampling, Bootstrapping and ROC, Hypotheses Testing and Cross-validation.

Unsupervised Learning:

Clustering : Partitional Clustering and Hierarchical Clustering, Cluster Types, Attributes and Salient Features, Hierarchical and Density-based Clustering Algorithms, Inter and Intra Clustering Similarity, Cohesion and Separation. MST and DBSCAN Clustering Algorithms.

Practice :

1. Develop a program for Bias, Variance, Remove duplicates , Cross Validation
2. Write a program to implement One-hot Encoding.
3. Write a program to implement Categorical Encoding.

UNIT – V

Ensemble Learning :

Bagging and Boosting, Adaboost and Random Forest ,

Computational Learning Theory : Error and Noise Formalisms, Training vs. Testing, Theory of Generalization, PAC Learnability and VC Dimensions, Overfitting, Regularization and Validation.

Practice :

1. Write a program to demonstrate the working of Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
2. Use a sentiment analysis dataset from Twitter or other social media platforms, available on platforms like Kaggle and apply bagging and boosting techniques for prediction.

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and

comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

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

Course Code: 2501AI15

L **T** **P** **C**
2 0 0 2

Course Outcomes:

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

- CO1:** Explore the benefits and challenges of deploying chatbots for business use cases.
- CO2:** Evaluate a fully-functional and interactive chatbot using a commercial platform.
- CO3:** Deploy the finished chatbot for public use and interaction.
- CO4:** Distinguish between the NLP and NLU Tools
- CO5:** Demonstrate Microsoft Bot Framework, RASA and Third-Party API's

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I

Introduction: Benefits from Chatbots for a Business, A Customer-Centric Approach in Financial Services, Chatbots in the Insurance Industry, Conversational Chatbot Landscape,

Identifying the Sources of Data: Chatbot Conversations, Training Chatbots for Conversations, Personal Data in Chatbots, Introduction to the General Data Protection Regulation (GDPR)

UNIT II

Chatbot Development Essentials: Customer Service-Centric Chatbots, Chatbot Development Approaches, Rules-Based Approach, AI-Based Approach, Conversational Flow, Key Terms in Chatbots, Utterance, Intent, Entity, Channel, Human Takeover, Use Case: 24x7 Insurance Agent

UNIT III

Building a Chatbot Solution: Business Considerations, Chatbots Vs Apps, Growth of Messenger Applications, Direct Contact Vs Chat, Business Benefits of Chatbots, Success Metrics, Customer Satisfaction Index, Completion Rate, Bounce Rate, Managing Risks in Chatbots Service, Generic Solution Architecture for Private Chatbots

UNIT IV

Natural Language Processing, Understanding, and Generation: Chatbot Architecture, Popular Open Source NLP and NLU Tools, Natural Language Processing, Natural Language Understanding, Natural Language Generation, Applications.

UNIT V

Introduction to Microsoft Bot, RASA, and Google Dialog flow: Microsoft Bot Framework, Introduction to QnA Maker, Introduction to LUIS, Introduction to RASA, RASA Core, RASA NLU, Introduction to Dialog flow

Chatbot Integration Mechanism: Integration with Third-Party APIs, Connecting to an Enterprise Data Store, Integration Module

Text Books:

- 1 Artificial Intelligence Based Chat Bot Design, Nazneen Akhter Shaikh, Khan Samrin Syed Zebanaaz, Saniya Raheen Patel, Lambert Publication, ISBN: 978-6202786713

Reference Books:

- 1 Hands-On Chatbots and Conversational UI Development: Build Chatbots and Voice User Interfaces with Chatfuel, Dialogflow, Microsoft Bot Framework, Twilio, and Alexa Skills, Packt publication, ISBN: 9781788294669

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_ge29/preview
- 2 <https://www.geeksforgeeks.org/nlp-vs-nlu-vs-nlg/>
- 3 <https://dev.botframework.com/>

Course Code: 2501AI17

L **T** **P** **C**
2 **0** **0** **2**

Course Outcomes:

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

- CO1:** Outline the Concepts of Federated Machine Learning
- CO2:** Explore the types of Federated machine Learning.
- CO3:** Apply Optimization techniques for Federated heterogeneous networks.
- CO4:** Apply clustering techniques on high dimensional data to group the similar entities.
- CO5:** Make use of ensemble learning techniques to improve the performance of a model.

Mapping of Course Outcomes with Program Outcomes:

CO/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	3	-	-	-	-	-	-	-	-
CO3	3	2	3	-	2	-	-	-	-	-	2
CO4	3	2	3	-	-	-	-	-	-	-	-
CO5	2	2	2	-	2	-	-	-	-	-	2

UNIT – I

Introduction to Federated learning:

Introduction to Federated learning, Privacy Preserving, Distributed Machine Learning, Threats to Federated Learning, Data Valuation

UNIT – II

Types of the Federated learning

Horizontal Federated learning ,Vertical Federated Learning, Federated Transfer learning

UNIT – III

Federated Optimization for heterogeneous networks:

Deep Networks from Decentralized data, Federated Multitask Learning, Personalized Federated Learning

UNIT – IV

Federated Learning Applications:

Recommendation in health care and Finance, Mobile keyboard prediction, Learning of out of vocabulary words.

UNIT – V

Adaptive personalized Federated learning :

Privacy Preserving Deep Learning, Advances and Open Problems.

Text Books:

- 1 Federated Learning, Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, Han Yu, Morgan & Claypool Publishers, 2019, ISBN: 978-1681736976
- 2 Handbook of Big data Privacy, KimKwang Raymond Choo, Ali Dehghantanha, Springer Nature Switzerland, 2020, ISBN: 978-3030385569

Reference Books:

- 1 Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, ISBN: 9780262018029

Web Links:

- 1 <https://www.deeplearning.ai/machinelearningyearning/>
- 2 https://onlinecourses.nptel.ac.in/noc21_cs24/preview
- 3 <https://www.udemy.com/course/machinelearning/>

Course Code: 2501AI14

L T P C
2 0 1 3

Course Outcomes:

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

- CO1:** Compare intelligent systems and knowledge based systems
- CO2:** Explain fuzzy sets and fuzzy operations
- CO3:** Discuss neuro systems and neural network applications
- CO4:** Apply genetic algorithm and operators
- CO5:** Compare and contrast Swarm Intelligence based algorithms

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to intelligent systems and soft computing: Intelligent systems, Knowledgebased systems, Knowledge representation and processing, Soft computing techniques.

Practice:

1. Text summarization using a simple sequencetosequence model with LSTM (Long ShortTerm Memory) layers.
2. Apply networkx library to represent and process knowledge

UNIT – II

Fundamentals of fuzzy logic systems: Introduction , Background ,Evolution of fuzzy logic, Popular applications, Stages of development of an intelligent product, Use of fuzzy logic in expert systems, Fuzzy sets , Fuzzy logic operations

Practice:

1. Learn the fundamentals of the fuzzy logic ,experiment the basic operations of fuzzy logic (Virtual Labs)
2. Learn about the Fuzzy inference system (FIS) with an example (Virtual Labs)

UNIT – III

Fundamentals of artificial neural networks Introduction Learning and acquisition of knowledge , Symbolic learning , Numerical learning, Features of artificial neural networks , Neural network topologies, Neural network activation functions, Neural network learning algorithms, Fundamentals of connectionist modeling

Practice:

1. Implement Neural Networks and Perceptron with an example (Virtual Labs)
Virtual Labs
2. Study Multilayer Perceptron apply it for image classification

UNIT – IV

Genetic algorithms and evolutionary programming: Introduction, Genetic algorithms, Procedures of genetic algorithms, working of genetic algorithms, genetic algorithm operators, Issues in GAs.

Practice:

1. Implement a genetic algorithm for finding the maximum value of a function.
2. Implement Crossover and Mutation in genetic algorithms

UNIT – V

Swarm Intelligent systems: Introduction, Swarm Intelligence based algorithms – Ant Algorithms; Bee Algorithms; Particle Swarm Optimization, Background of Ant intelligent system, ant colony systems Importance, development, applications, working of ant colony systems, Artificial Bee Colony (ABC) Optimization Behavior of real bees, ABC Algorithm, Variations of ABC: Abcgbest and Abcgbestdist

Practice:

1. Implement Particle Swarm Optimization algorithm
2. Implement ABC with GBest Algorithm: And GBestDist Algorithm

Text Books:

- 1 Soft Computing and Intelligent Systems Design Theory, Tools and Applications, Fakhreddine O. Karray and Clarence de Silva, ISBN: 978-8131723241
- 2 Artificial Intelligence and Intelligent Systems, N. P. Padhy, Oxford University press, ISBN: 9780195671544

Reference Books:

- 1 Fuzzy Logic: A Practical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, ISBN: 978-0124859654
- 2 An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, ISBN: 9780262280013

Web Links:

- 1 <https://nptel.ac.in/courses/106105174/>
- 2 <https://www.kdnuggets.com/>
- 3 <https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/>

Course Code: 2501CS34

L T P C
2 0 1 3

Course Outcomes:

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

- CO1:** Explain fundamental concepts of Data Science.
- CO2:** Implement Data Collection and Preprocessing Techniques.
- CO3:** Demonstrate Proficiency in Data Loading, Storage, and File Handling
- CO4:** Conduct Exploratory Data Analysis (EDA) using Visualization and Statistical Techniques.
- CO5:** Make use of Neo4j, Cypher tools to manage and analyze graph data.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction To Data Science: Definition and Scope of Data Science, History and Evolution of Data Science, Applications of Data Science, Data Science Lifecycle, Data Types and Structures, Tools and Technologies in Data Science.

Practice:

1. Importing and Exploring Datasets - Loading datasets using libraries and performing basic exploration.
2. Basic Data Structures - Working with data structures such as arrays, lists, data frames, and matrices.

UNIT-II

Data Collection and Preprocessing: Data Collection Methods, Data Cleaning and Handling Missing Values, Data Transformation: Normalization and Standardization, Feature Engineering and Feature Scaling, Data Integration and Aggregation.

Practice:

1. Computing summary statistics like mean, median, mode, and standard deviation for a sample dataset.
2. Handling missing values and outliers in a dataset using techniques like imputation and filtering.

UNIT – III

Data Loading, Storage, and File Formats : Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice:

1. Read data from a JSON file into a DataFrame using Pandas (pd.read_json) or R (jsonlite). Parse nested JSON structures and convert them into a flat table format.
2. Perform web scraping on an HTML page using BeautifulSoup in Python or rvest in R. Extract data from HTML tables and convert it into a DataFrame.

UNIT – IV

Exploratory Data Analysis (EDA): Descriptive Statistics, Data Visualization Techniques, Correlation and Covariance Analysis, Univariate, Bivariate, and Multivariate Analysis, Pattern Detection and Anomaly Identification.

Practice:

1. Plotting histograms and box plots to understand the distribution of a single variable.
2. Creating scatter plots and calculating correlation coefficients to study the relationship between two variables.

UNIT – V

Data Science Tools: Neo4j for dealing with graph databases, graph query language Cypher, libraries like nltk and SQLite for handling Text mining and analytics.

Practice:

1. Get hands-on experience with Neo4j to understand how to manage and query graph databases.
2. Practice writing Cypher queries to interact with graph data in Neo4j.

Text Books:

- 1 Wes McKinney, “Python for Data Analysis”, O’REILLY, ISBN:978-1-449-31979-3, 1st edition, October
- 2 Rachel Schutt & O’neil, “Doing Data Science”, O’REILLY, ISBN:978-1-449-35865-5, 1st edition, October 2013

Reference Books:

- 1 Data Science from Scratch: First Principles with Python, Joel Grus, O’Reilly Media, ISBN: 9781492041139.
- 2 Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, Matt Harrison, O’Reilly, ISBN: 9781787123137

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_cs68/preview
2. https://onlinecourses.nptel.ac.in/noc24_cs133/preview
3. <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>

Natural Language Processing

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:

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

UNIT – I

Overview of Natural Language Processing, Natural Language Processing and Python: Understanding Natural language Processing and applications, NLTK, Corpus and Dataset, understanding structure of sentence Defining Context free grammar, Morphological Analysis

Practice:

1. Word Analysis Learn about morphological features of a word by analysing it
2. Word Generation generate word forms from root and suffix information.

UNIT – II

Syntactic Analysis, Semantic analysis, Ambiguity resolution, Discourse integration, Preprocessing tokenization, stemming, lemmatization, Word tokenization and lemmatization

Practice:

1. Implement Porter Stemming Algorithm
2. NGrams learn to calculate bigrams from a given corpus and calculate probability of a sentence

UNIT – III

Feature engineering and NLP algorithms parsers, context free grammars, different types of parsers, POS tagging and different types of POS parsers.

Practice:

1. Morphology understanding the morphology of a word by the use of AddDelete table.
2. POS Tagging – calculate emission and transition matrix which will be helpful for tagging Parts of Speech

UNIT – IV

Basic statistical features of NLP: TFIDF, Vectorization Encoders and Decoders, Normalization, Advanced feature engineering and NLP algorithms Basics of Word2Vec

Practice:

1. Apply term frequency(TFIDF) to Measures the importance of a word to a specific document
2. Implement word embedding using word2vec

UNIT – V

Rule Based system for NLP, Machine Learning for NLP problems, Applications of NLP Text Summarization, Sentiment Analysis

Practice:

1. Chunking understand the concept of chunking and get familiar with the basic chunk tag set.
2. Building Chunker the importance of selecting proper features for training a model and size of training corpus in learning how to do cunking.

Text Books:

- 1 Python Natural Language Processing, Thanaki J, Packt Publishing Ltd, ISBN: 9781787121423
- 2 Springer Handbook of Speech Processing, Jacob Benesty, M. M. Sondhi, Yiteng Huang Springer, ISBN: 978-3-540-49127-9

Reference Books:

- 1 Speech & language processing, Jurafsky D, Pearson Education India, ISBN: 978-93325018414
- 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/ultimateguidetounderstandimplemenntnaturallanguageprocessingcodesinpython/>
- 3 https://datahack.analyticsvidhya.com/contest/linguipediacodefestnaturallanguageprocessing1/?utm_source=ultimateguidetounderstandimplementnaturallanguageprocessingcodesinpython&utm_medium=blog

Data Visualization

Course Code: 2501AI19

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the various types of data and principles of data visualization
- CO2:** Apply visualization techniques to a problem and its associated dataset
- CO3:** Apply structured approach to create effective visualizations
- CO4:** Outline the valuable insights from the massive dataset using visualization.
- CO5:** Build visualization dashboard to support decision making

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Visualization:

Introduction to Data Visualizations and Perception: Introduction to visualization and visual perception, visual representation of data, Gestalt principles, Information overload.

Practice :

1. Introduction to various Data Visualization tools
2. Basic Visualization in Python

UNIT – II

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Practice :

1. Basic Visualization in R
2. Introduction to Tableau and Installation

UNIT – III

Classification of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multidimensional data, text and text documents.

Practice :

1. Connecting to Data and preparing data for visualization in Tableau
2. Data Aggregation and Statistical functions in Tableau

UNIT – IV

Visualization of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization. Various visualization techniques, data structures used in data visualization.

Practice :

1. Data Visualizations in Tableau

UNIT – V

Visualization of Volumetric Data And Evaluation of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations

Practice :

1. Basic Dashboards in Tableau

Text Books:

- 1 Interactive Data Visualization: Foundations, Techniques, and Applications, Ward, Grinstein, Keim, Natick, A K Peters, Ltd, 2nd edition, ISBN: 978-1482257373

Reference Books:

- 1 Visualization Analysis & Design, Tamara Munzner, AK Peters Visualization Series, 1st edition, ISBN: 978-1466508910
- 2 Interactive Data Visualization for the Web, Scott Murray, 2nd Edition, ISBN: 978-1491921289

Web Links:

- 1 <https://elearn.nptel.ac.in/shop/iitworkshops/completed/datavisualizationwithr/?v=c86EEd9d7ed>
- 2 <https://www.geeksforgeeks.org/datavisualizationanditsimportance/>

Prompt Engineering and GenAI

Course Code: 2501AI16

L	T	P	C
2	0	1	3

Course Outcomes:

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

- CO1:** Explain the importance of prompt engineering, distinguish between explicit, implicit, and creative prompts.
- CO2:** Apply prompt engineering to improve NLP tasks, enhance creativity and diversity in AI-generated content.
- CO3:** Evaluate the Finetuning Language Models for Optimal Output Managing Prompt Complexity and Length.
- CO4:** Analyze the data preprocessing Techniques for language models.
- CO5:** Evaluate the ethical considerations and societal impact of generative AI technologies.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Prompt Engineering: What is prompt engineering and why it matters, Prompt types: explicit, implicit, and creative prompts, Best Practices for Crafting Effective Prompts

Practice:

1. Write a python program for Prompt Clarity Evaluation.
2. Write a python program for prompt Relevance Assessment
3. Write a Python Program for Prompt Diversity Experiment

UNIT – II

Practical Applications of Prompt Engineering: Improving NLP Tasks with Custom Prompts, Enhancing Creativity and Diversity in AIGenerated Content, Addressing AI Ethics and Bias through Thoughtful Prompt Engineering, Personalization and Adaptability in AIGenerated Content

Practice:

1. Write a python program for Custom Prompt for NLP Task
2. Write a python program for Enhancing Creativity in AIGenerated Content
3. Write a python program for Addressing Bias in AIGenerated Content

UNIT – III

Advanced Prompt Engineering Techniques

Customising Prompts for Specific Use Cases, Finetuning Language Models for Optimal Output Managing Prompt Complexity and Length, Enhancing Control and Diversity in Generated Text

Practice:

1. Write a python program for Customizing Prompts for Specific Use Cases
2. Finetuning Language Models for Optimal Output using python

UNIT – IV

Foundations of Generative AI

Neural Networks and Their Relevance in AI Language Generation, Deep Learning Architectures for Text Generation and its Implications for Prompt Engineering, Data Preprocessing Techniques for Language Models

Practice:

1. Write a python program for Training a Simple Text Generation Model using LSTM
2. Data Preprocessing Techniques for Language Models using python

UNIT – V

Advanced Topics in Generative AI

Adversarial attacks and defences in generative models, Ethical considerations and societal impact of generative AI, Lang Chain Framework.

Practice:

1. Detecting and Mitigating Adversarial Attacks using python

Text Books:

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville Version: 1st Edition, ISBN: 978-0262035613
- 2 Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit, Steven Bird, Ewan Klein and Edward Loper Version: 1st Edition, ISBN: 978-0596516499

Reference Books:

- 1 Markov Decision Processes: Discrete Stochastic Dynamic Programming, Puterman, Martin L., Germany: Wiley, ISBN: 978-0471727828
- 2 Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, Author: David Foster Version: 1st Editon 2019, ISBN: 978-1492041948
- 3 Interpretable Machine Learning: A Guide for Making Black Box Models Explainable Christoph Molnar Version: 1st Edition 2019, ISBN: 978-1700895466

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc20_cs74/preview

Course Code: 2501CS41

L T P C
2 0 1 3

Course Outcomes:

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

- CO1:** Explain the fundamental of semantic web.
- CO2:** Illustrate knowledge representation using ontology.
- CO3:** Analyze various communities in social networks
- CO4:** Illustrate the prediction of human behaviour for social networks.
- CO5:** Design visualization of social networks.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

INTRODUCTION

Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Webbased networks– Applications of Social Network Analysis.

Practice:

1. Learn how to construct a social network object in R

UNIT – II

MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION

Ontology and their role in the Semantic Web: Ontologybased knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: Stateoftheart in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

Practice:

1. Perform knowledge representation of semantic web.

UNIT – III

EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS

Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – MultiRelational characterization of dynamic social network communities.

Practice:

1. Learn how to visualize a social network

UNIT – IV

PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES

Understanding and predicting human behavior for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and counter measures.

Practice:

1. Learn how to calculate node and network level summary statistics

UNIT – V

VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS

Graph theory – Centrality – Clustering – NodeEdge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrixbased representations – Matrix and NodeLink Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – CoCitation networks.

Practice:

1. Learn how to incorporate network connectivity in a spatial regression model

Text Books:

- 1 Social Networks and the Semantic Web ,Peter Mika, Springer ,First Edition. ISBN: 978-0-387-71000-6
- 2 Handbook of Social Network Technologies and Applications ,Borko Furht, ISBN: 978-1441971418

Reference Books:

- 1 Web Mining and Social Networking Techniques and applications,Guandong Xu ,Yanchun Zhang and Lin Li, First Edition, Springer. ISBN: 978-1441977342
- 2 Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively ,Dion Goh and Schubert Foo, IGI Global Snippet. ISBN: 978-1599045436
- 3 Max Chevalier, Christine Julien and Chantal SouléDupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet. ISBN: 9781605663074
- 4 The Social Semantic Web ,John G. Breslin, Alexander Passant and Stefan Decker, ,Springer. ISBN: 978-3642424328

Web Links:

- 1 https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- 2 <https://open.hpi.de/courses/semanticweb>
- 3 <https://crd230.github.io/lab9.html>

Minor Degree in Mining Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MN03	Development of Mineral Deposits	FC	3			3	50	50	100	-
2501MN41	Green Mining	FC	3			3	50	50	100	-
2501MN06	Surface Mining	IC	3			3	50	50	100	DMD
2501MN24	Drilling & Blasting	IC	3			3	50	50	100	DMD
2501MN07	Underground Coal Mining Technology (or)	IC	3			3	50	50	100	DMD
2501MN08	Underground Metal Mining Technology									
2501MN14	Mine Legislation & General Safety (or)	AC	3			3	50	50	100	UCMT / UMMT
2501MN28	Environmental Pollution & Control									
2501MN45	Industrial Safety Practices (or)	AC	2			2	50	50	100	-
2501MN46	Ground Control									
Total			20			20				

Development of Mineral Deposits

L T P C

Course Code: 2501MN03

3 0 0 3

Course Outcomes:

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

- CO1:** Summarize different stages in the life of a mine
- CO2:** Choose a suitable location for opening to a deposit.
- CO3:** Explain Exploratory and Production Drilling
- CO4:** Categorize the use of explosives and blasting.
- CO5:** Summarize material handling and transportation in mining

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to mining: Mining terminologies, Stages in the life of the mines- Prospecting, Exploration, Development, Exploitation, Reclamation, Brief overview of Surface & Underground Mining Methods.

UNIT – II

Access to mineral Deposits: Adits, shafts, incline - location, shape and size; Drilling, blasting and removal of debris. Methods of shaft sinking –conventional, mechanized and special methods; opening up of surface deposits.

UNIT – III

Exploratory and Production Drilling: Principles of drilling, Types of drill, Drill rods and drill bits – types and applications, Exploratory drilling - Drilling fluid; Production drilling – Rotary, Percussive, Rotary- percussive, pneumatic; Drill patterns.

UNIT – IV

Explosives and Blasting: Types of explosives, Properties of explosives, Detonators. Detonating cords, and detonating fuse and nonel detonator. Storage and transport of explosives, Mechanics of blasting, Primary and secondary blasting, Blast geometry and design, electrical and non electrical methods, delay blasting techniques, handling misfires.

UNIT – V

Material Handling and Transportation in Mines: LHD, SDL, shuttle car, AFC and belt conveyors; Raises, winzes, ore passes, ore chutes; shovels, dumpers, silo, bin, CHP, tippler.

Text Books:

1. Elements of Mining Technology, D.J.Deshmukh, Denett& Co., Nagpur Vol. I. ISBN: 978-8189904333.
2. Surface Mining, Dr T.N.Singh, Lovely Prakashan, Dhanbad , 2nd edition. ISBN: 978-8179561294.

Reference Books:

1. Indian Bureau of Mines, Minerals Year Book & other publications, Latest Edition.
2. Explosives and blasting techniques, G.K Pradhan, Latest edition. ISBN: 978-0470512275.
3. Rock Blasting and Overbreak Control, Dr. Calvin Konya; Precision Blasting Services, Montville, Ohio 2nd edition. ISBN: 9780318198965.

Web Links:

1. <http://www.miningglobal.com/operations/gifs-5-stages-mining-life-cycle>
2. <https://www.mineactionstandards.org/fileadmin/MAS/documents/nmas-national>
3. [stabdards/afghanistan/AMAS_07.04_Storage_Transportation_Handling_of_Explosives.Pdf](#)

Green Mining

Course Code: 2501MN41

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 green mining.
- CO2:** Plan and scheduling of activities related to mine waste management.
- CO3:** Analyze the impact of water pollution due to mining.
- CO4:** Distinguish progressive and final mine closure planning
- CO5:** Explain the usage of renewable energy in mines.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Footprint Reduction: Importance of green mining, Sustainable project management, Corporate social responsibility for industrial sustainability, Environment Friendly Mining Equipment's, Clean development mechanism (CDM), CCUS technology, Application of Bio Fuels.

UNIT – II

Mine Waste Management: Types of mine waste Overburden, Tailings and other wastes. Characterization, disposal, management of different types of mining waste.

UNIT – III

Mine Water: Sources of pollution, Effect of mining on water bodies, Treatment of mine water, Water conservation initiatives in mines, zero waste water discharge.

UNIT – IV

Mine Closure Planning: Progressive and final mine closure planning, structure of mine closure report, Legislative provisions on mine closure planning.

UNIT – V

Renewable Energy: Usage of renewable energy in mines solar power, wind power; associated problems.

Text Books:

1. Green Mining: The Way Forward, Anil Jha, Das Gupta Co Pvt Ltd Publication, 2019. ISBN: 978-8194161424.
2. Sustainable Mining Practices, A.K. Gorai and D. Nimaje, Narosa Publishing House. ISBN: 9788184876048.

Reference Books:

1. Mining and Environmental Sustainability, G. S. Roonwal, ASTRAL Publication. ISBN: 9789351247591.
2. Advances in Productive, Safe, and Responsible Coal Mining, Joseph Hirschi, Elsevier Ltd, 2019. ISBN: 9780128156263.

Web Links:

1. <https://www.mdpi.com/books/pdfview/book/3216>
2. <https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/greenmining.html>
3. <https://www.sciencedirect.com/science/article/pii/S187661021200077X>
4. Oxford scientists show how green mining could pave the way to net zero and provide the metals we need for a sustainable future | University of Oxford
5. Green Mining (mdpi.com)

Surface Mining

Course Code: 2501MN06

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Analyze different surface mining methods
- CO2:** Design the layout of a large opencast mine
- CO3:** Design drilling and blasting for Surface mining
- CO4:** Choose the better excavation and loading equipments
- CO5:** Organize the transportation system

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Status and scope of surface mining- Applicability, Limitations and, advantages and disadvantages. Methods of opening box cut, selection of site for box cut. Surface Mining Methods: Open pit Mining, Open cast Mining, Quarrying, High-wall Mining Modern mining methods. Placer Mining.

UNIT – II

Open Pit Layout and Design: Planning the layout and open pit mine with special reference to large mechanized mines. Optimum dimensions of open pit mines. Removal of over burden and disposal, Bench Design/Geometry, Design and stability slopes.

UNIT – III

Blast Design in Surface Mines: Drillability, mechanics of drilling, major types of drilling machines. Blasting: Basics of mechanics of blasting, principles of fragmentation. Blast design, Adverse impacts of blasting in surface mines. Controlled blasting techniques. Novel methods of blasting.

UNIT – IV

Excavation and Loading: Shovels, Dragline, Front-end loader. Non-Cyclic Surface Mining: Bucket Wheel Excavators and Continuous surface miners. Auxiliary Equipment: Stackers, Graders, Dozers, Ripper.

UNIT – V

Transport Equipment: Selection of mode of transport. Dumpers, Aerial ropeways-monocable and bicable types and their constructional details. Conveyor systems, ICC system, Slurry Transportation.

Text Books:

1. Surface Mining Technology, S. K. Das, Lovely Prakashan, Dhanbad. ISBN: 978-0873351087.
2. Surface Mining, G. B. Mishra, Dhanbad Publishers. ISBN: 978-0873351027.

Reference Books:

1. Opencast Mining unit operations, V.V.Rzhevsky, Mir Publisher's, Moscow. ISBN: 978-0412298600.
Open Pit Mine Planing and Design Crawford, T.john, American Institute of Mining,
2. Metallurgical and Petroleum Engineers. ISBN: 978-0873352224.

Web Links:

1. <http://www.cienciaviva.pt/img/upload/Introduction%20to%20mining.pdf>
2. http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/safework/documents/normativeinstrument/wcms_107828.pdf
3. <https://www.iitbhu.ac.in/faculty/min/rajesh-rai/NMEICTSlope/Pdf/03%20Types%20of%20slope%20failure.pdf>

Drilling & Blasting

Course Code: 2501MN24

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Differentiate between types of drilling machines.
- CO2:** Identify and classify explosives
- CO3:** Analyze problems associated with open cast blasting and mitigation.
- CO4:** Analyze problems associated with underground blasting and mitigation.
- CO5:** Assess blasting in metal mines.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Drilling: Drillability, mechanics of drilling, major types of drilling machines, Principles of drilling, Types of drill, Drill rods and drill bits -Types and applications, Exploratory and Production Drilling.

UNIT – II

Explosives and Blasting Accessories: Mechanism of blasting, Explosives- types and properties. Selection of explosives, Handling, and storage of explosives. Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders. Blast Design in Surface and Underground Mines.

UNIT – III

Drilling and Blasting in Surface Mines: Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure.

UNIT – IV

Drilling and Blasting in Underground Coal Mines: Blast hole patterns and their applicability, blasting-off-solid, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

UNIT – V

Drilling and Blasting in Underground Metal mines: Blast hole patterns and their applicability, blast design for horizontal drivage, long hole blasting, vertical crater retreat blasting.

Text Books:

1. Principle of rock drilling, B. Misra, U.M. Rao Karanam, Taylor & Francis, CRC Press. ISBN: 9781138033646.
2. Drilling & Blasting Mine tech, Pradhan G.K., Ghose A.K., Bhubaneswar, India: Mintech. ISBN: 9789383183039.

Reference Books:

1. Elements of Mining Technology, DJ Deshmukh, Denett, First Edition, Vol. 1. ISBN: 978-81-89940-02-7.
2. Surface mining, GB Mishra, Dhanbad, Vol.1. ISBN: 978-0873351027.

Web Links:

1. <https://archive.nptel.ac.in/courses/123/105/123105003/>
2. <https://www.rpmdrilling.co.za/blast-hole-drilling-process/>
3. www.railsystem.net/drill-and-blast-method/

Course Code: 2501MN07

L T P C
3 0 0 3

Course Outcomes:

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

- CO1:** Illustrate the fundamentals of underground coal mining.
- CO2:** Explain the various mine development methods.
- CO3:** Explain the long wall mining method.
- CO4:** Analyze the various thick and deep seam mining methods.
- CO5:** Categorize the various modern mining methods.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Formation of coal deposits, structures associated with coal deposits, rank and grade of coal. Different coal mining methods: factors influencing choice of coal mining methods. Status of coal mining industry in India and global scenario.

UNIT – II

Bord and Pillar Mining: Applicability, limitations, advantages and disadvantages of Bord and pillar mining method. Development-Design of pillars and panel, supports. Depillaring-methods and sequence of operations, splitting and slicing of pillars, supports. Partial extraction techniques. Extraction of multi seams. Stowing Techniques. Mechanization- SDL, LHD, Continuous miners, belt conveyors, UDM etc. Case studies

UNIT – III

Longwall Mining: Applicability, limitations, merits and demerits, Longwall mining Methods- Advancing and Retreating, Thin and Thick seam. Longwall Development- Gate roads, longwall face. Face Mechanization, Shearer, Plough, AFC, Powered Supports. Sequence of operations- Cutting and conveying of coal from face. Case studies.

UNIT – IV

Thick Seam Mining: Applicability, limitations, and problems associated with thick seam mining, selection of mining method, caving and stowing methods. Different slicing methods- inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing, Caving methods- Sublevel Caving Working Steep and Moderately Thick Seams- Blasting Gallery method, Room and Pillar method, Descending Shield method of Mining. Design of Supports, Case studies.

UNIT – V

Modern Coal Mining Methods: Horizon Mining, Hydraulic Mining, Underground Coal Gasification. Case studies.

Text Books:

1. Principles and Practices of Modern Coal Mining, R. D. Singh, New Age International. ISBN: 978-8122429705.
2. Modern Coal Mining Technology, S. K. Das, Lovely Prakashan Publishers, 2nd edition. ISBN: 978-81-7850-043-6.

Reference Books:

1. Underground Coal Mining Methods, J. G. Singh, BrajKalpa Publishers, Varnasi. ISBN: 81-7525-204-9.
2. Coal Mining, I.C.F. Statham, The Caxton Publishing Company Ltd. Inc, Vol. I, II, III and Vol. III. ISBN: 978-81-7850-043-9.
3. Winning and working coal, R. T. Deshmukh, D.J Deshmukh Vol 1 & 2. ISBN: 97-88-189904333.

Web Links:

1. <https://osme.co.in/wp-content/uploads/2023/01/UCMR-BAL-1.pdf>
2. https://www.digitalxplore.org/up_proc/pdf/340-151522605452-56.pdf

Underground Metal Mining Technology

Course Code: 2501MN08

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Illustrate the fundamentals of metal mining
- CO2:** Analyze the various mine development methods.
- CO3:** Analyze the basics of stoping
- CO4:** Compare the various stoping methods.
- CO5:** Categorize the various special stoping methods.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Metal Mining: Terminologies in metal mining. Special Characteristics of Metalliferous deposit. Scope and limitations of underground metal mining. Access to deposits, Status of metal mining in India and World.

UNIT – II

Mine Developments: Factors affecting choice of level interval, Cross cuts, drive, shape and size of drive, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development. Division of mining area into working units and level pattern, dimensions of panels and blocks. Unit Operations in Metal Mining.

UNIT – III

Basics of Stopping: Stopping methods- applicability, limitations, merits and demerits. Selection of stopping methods. Stope design and production planning in various methods of stopping. Support design.

UNIT – IV

Stopping Methods: Supported and un-supported Stopping Methods, Caving methods. Description, application and design of stopping methods. Mechanisation of stopes.

UNIT – V

Novel Techniques: In-situ leaching, bio-mineral engineering, hydraulic mining, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.

Text Books:

1. Introductory Mining Engineering, H L Hartman, John Wiley and sons. ISBN: 978-0471811778.
2. Elements of Mining Technology, D.J.Deshmukh. Vol III. ISBN: 978-8184890700.

Reference Books:

1. Deep Mining, Jack Spalding, Mining Publications, ISBN: 978-0-903078-36-8.
2. Mineral Engineers Hand Book, Peele, Vol. I & II, ISBN: 978-0873352205 & 978-0873352212.
3. U/G Mining Method, Hustrulid, Society for Mining, Metallurgy & Exploration. ISBN: 978-0873352643.

Web Links:

1. <https://www.911metallurgist.com/methods-mining-metals/>
2. <https://www.greatmining.com/metals.html>

Mine Legislation & General Safety

Course Code: 2501MN14

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Illustrate the general principle of mining laws and regulations
- CO2:** Compare the rules and regulation framed under CMR& MMR.
- CO3:** Explain the various mining rules and Indian electricity rules
- CO4:** Explain the Mineral concession rules and mine act
- CO5:** Explain the training rules and DGMS circular

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

General principles of mining laws, The Mines Act 1952, The mines & Minerals (Regulation & Development) Act 2015, Industrial dispute Act 1947.

UNIT – II

The Coal Mines Regulations 2017 and The Metalliferous Mines Regulations 2019.

UNIT – III

The Mines Rules 1955, Mine rescue rule 1985, Indian Electricity rule 1956.

UNIT – IV

The Mineral Concession Rules 2017, The Mineral Concession and Development Rules 2017.

UNIT – V

Introduction to Environmental Legislation in mines, Land Acquisition & Revenue: Concepts: Related laws and regulations. Forest Conservation Act 1980.

Text Books:

1. Mines act, Mine Rules, CMR,MMR,MVTC, Mine Rescue Rules,DGMS.
2. Legislation in Indian Mines: A critical appraisal, Rakesh and S. D. Prasad, Mrs Asha Lata Varnasi, 5th edition, Vol I & II.

Reference Books:

1. Proceeding of the National Seminar on Policies, A. K. Ghosh, S. K. Ray and A. K. Patra, Statutes & Legislation in Mines, CIMFR, Dhanbad.
2. Mineral Concession Rules 1960, V. K. Malhotra, Malhotra Bros., Patna, Supplementary Edition.

Web Links:

1. <https://mines.gov.in/writereaddata/UploadFile/MMDR%20Act,1957.pdf>
2. <https://dgms.gov.in>.

Environmental Pollution & Control

Course Code: 2501MN28

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Illustrate the fundamentals of environmental issues in mining
- CO2:** Examine the various causes of water pollution.
- CO3:** Analyze the various causes of air pollution.
- CO4:** Analyze the methods for mine reclamation
- CO5:** Assess environmental impact due to mining.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Air Pollution: Atmospheric science; Sources of air pollution in mines; Effect of air pollution and preventive measures; Ozone layer and greenhouse effect; Dispersion model.

UNIT – II

Water Pollution: Sources of water pollution; Effect and preventive measures of water pollution; Ground water and its contamination; Water pollution modeling - biological oxygen demand and chemical oxygen demand; Acid mine drainage; Waste water treatment.

UNIT – III

Noise Pollution: Terminologies associated with noise; Sources and effects of noise; Measurement of noise; Noise standard and guidelines; Noise control strategies.

UNIT – IV

Land Reclamation and Rehabilitation: Causes of land degradation; Land reclamation method- Rehabilitation, Reclamation, Restoration; Factor affecting the land restoration; Land reclamation planning.

UNIT – V

Socio-Economic Impact Assessment: Socio-economic impact of mining, Quality of life index.

Text Books:

AUS 2025 B. Tech (PT) Curriculum

Page **194** of **242**

1. Environmental Pollution and Control, Peirce J. Jeffrey, Elsevier Science & Technology, Fourth Edition, 2018. ISBN: 978-0128125428.
2. Principle and practices of modern coal mining, R.D. Singh, New Age International. ISBN: 978-8122416464.

Reference Books:

1. Ground Control, Peng, S.S. Wiley Publications, New York. ISBN: 978-0471775410.
2. Open pit mine planning and Design, W. Hustrulid and M. Kuchta, A. A. Balkema Rotterdam, 1st edition, Vol – I. ISBN: 978-9056990736.
3. Surface Mining, G. B. Mishra, Lovely Prakashan Dhanbad, 1st edition. ISBN: 978-81-85500-42-6.

Web Links:

1. <https://miningandblasting.wordpress.com/2011/08/30/mine-planning-and-scheduling-smart-practice>
2. https://onlinecourses.nptel.ac.in/noc22_ce22/preview

Industrial Safety Practices

Course Code: 2501MN45

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Describe Occupational Health Hazards
- CO2:** Analyze the concept of Ergonomics and its importance in Industrial safety
- CO3:** Describe Importance of Industrial safety.
- CO4:** Analyze and apply effects of radiation on human body
- CO5:** Analyze different accident prevention techniques

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to industrial safety

Safety scenario in national and international arena, identification of safety issues in different industries and their remedial measures, general safety practices.

UNIT – II

Ergonomics

Ergonomics – Importance, Ergonomics Hazards – Musculoskeletal Disorders and Cumulative Trauma Disorders, ergonomics studies.

UNIT – III

Industrial Health and Hygiene

Occupational health hazard & classification of health hazards, Occupational health and hygiene surveillance, legislative measures and prevention of health hazards.

UNIT – IV

Personal Protective Equipment

Types of personal protective equipment and their usages.

UNIT – V

Accident Prevention Techniques

Types of accidents, causes of accidents- unsafe acts and conditions, accident investigation and prevention

Text Books:

1. The Factories Act with amendments , Govt. of India Publications DGFASLI, Mumbai. ISBN: 978-9352471010.
2. Frank P Lees – Loss of prevention in Process Industries, Butterworth- Heinemann Ltd., London, Vol. 1 and 2. ISBN: 978-0750633016 & 978-0750633023.

Reference Books:

1. Accident Prevention Manual, NSC, Chicago. ISBN: 978-1118240295.
2. Occupational safety Manual, BHEL, Trichy. ISBN: 978-81-73190163.
3. Safety Management, John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi. ISBN: 978-8173190162.

Web Links:

1. <https://www.osha.gov/>
2. <https://www.healthandsafetyatwork.com/>
3. <http://ohsonline.com/>

Ground Control

Course Code: 2501MN46

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Describe about concept of ground control in mines.
- CO2:** Analyze strata pressure and management.
- CO3:** Illustrate types of Roof support.
- CO4:** Analyze the design of structure in rock.
- CO5:** Explain about the Subsidence in mining.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Definition and concept of ground control in mines, Ground control practice in mines, constraints on ground control design.

UNIT – II

Strata pressure and management: The modern concept of strata pressure redistribution. Manifestation of strata pressure, convergence, load on the prop, creep, heave, roof fall, and fracture systems due to mining. In-situ stress measurement, instrumentation.

UNIT – III

Roof support: Timber and steel supports, friction and hydraulic prop, arches, shotcrete, roof truss, roof bolts and cable bolts, powered supports, stowing, caving, strip packing, pump packing, rock reinforcement.

UNIT – IV

Design of structures in rock: Design of underground openings. Design of pillars, design of open pit slopes, waste dumps, and embankments, design of stopes.

UNIT – V

Subsidence: Theories of subsidence, factors affecting subsidence, prediction, and measurement of subsidence. Damage and prevention of damage due to subsidence, Bumps and rock bursts-causes, occurrence, and control.

Text Books:

1. Rock Mechanics and Design of structures in rock, Obert & Duvall. ISBN: 978-0471192994.
2. Coal Mining Ground Control, Peng S.S. ISBN: 978-0470512277.

Reference Books:

1. Fundamental of Rock Mechanics, Jaeger and cook. ISBN: 978-0470015393.
2. Rock Mechanics and Ground Control, V. Singh & B.P. Khare. ISBN: 978-8187739557.

Web Links:

1. <https://www.sciencedirect.com/science/article/pii/S1877705812045055>
2. <https://core.ac.uk/download/pdf/237427482.pdf>
3. <https://raiseandlevel.com/how-to-prevent-ground-subsidence-in-residential-areas/>

Minor Degree in Agricultural Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501AE82	Fundamentals of Renewable Energy Sources	FC	3	0	0	3	50	50	100	-
2501AE83	Post-harvest Engineering of Cereal Crops	FC	3	0	0	3	50	50	100	-
2501AE84	Ground Water Hydrology	FC	3	0	0	3	50	50	100	-
2501AE85	Micro Irrigation Systems	IC	2	0	0	2	50	50	100	-
2501AE86	Surface Water Hydrology (or)	IC	3	0	0	3	50	50	100	GWH
2501AE87	Land & Water Management Engineering									
2501AE88	Agricultural Process Engineering & Food Quality (or)	AC	3	0	0	3	50	50	100	PHECC
2501AE89	Post-harvest Engineering for Horticultural Produce									
2501AE90	Agricultural Machinery & Equipment (or)	AC	3	0	0	3	50	50	100	FRES
2501AE91	Design of Bio-energy systems									
Total			20			20				

Fundamentals of Renewable Energy Sources

	L	T	P	C
Course Code: 2501AE82	3	0	0	3

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

- CO1:** Explain the fundamental concepts of renewable energy.
- CO2:** Analyze the principles of solar energy and explore its various applications.
- CO3:** Describe wind energy conversion systems, including wind generators, and evaluate their power generation capabilities.
- CO4:** Analyze the processes involved in biogas production from biomass.
Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy systems.
- CO5:** Explain the basic principles and operations of tidal energy, fuel cells, and geothermal 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	2	3	2	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-
CO3	3	-	3	-	2	-	-	-	-	-	1
CO4	3	-	3	2	-	1	-	-	-	-	-
CO5	3	-	3	2	-	1	-	-	-	-	-

UNIT – I

Renewable energy sources

Different sources of renewable energy- concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources. Criteria for assessing the potential of RES. Comparison of renewable energy sources with non-renewable sources.

UNIT – II

Solar energy

Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system. Solar photo voltaics- basics and applications, p-n junctions. Solar cells, PV systems, stand alone, grid connected solar power station. Calculation of energy through photovoltaic power generation and cost economics.

UNIT – III

Wind Energy

Wind energy- energy availability, general formula, lift and drag. Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators. Working principle of wind power plant. Wind farms, aero-generators, wind power generation system.

UNIT – IV

Energy from Biomass

Biogas- basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry. Generation of power from biogas. Design & use of different commercial biogas plants.

UNIT – V

Other source of energy

Power generation from urban, municipal and industrial waste. Ocean thermal and electric power generation, wave and tidal power. Power generation from biomass (gasification & Dendro- thermal). Mini and micro hydel plants. Fuel cells and its associated parameters

Text Books:

1. Rai G D. Non-Conventional Energy Sources. Khanna Publishers, New Delhi. (ISBN:978-81-7409-073-8)
2. Basu P. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press. (ISBN: 10-0123749883)

Reference Books:

1. Patel M R. Wind and Solar Power Systems. CRC Press, Bota Racon. (ISBN: 978-0849315701)
2. DeubleinD and SteinhäuserA. Biogas from Waste and Renewable Resources. WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim. (ISBN:9783527621705)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf

Post-Harvest Engineering of Cereal Crops

Course Code: 2501AE83

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 different unit operations and working of size reduction equipments.
- CO2:** Identify various methods for determining moisture content, EMC and drying.
- CO3:** Compare separator equipments based on physical characteristics of grains and explain material handling devices.
- CO4:** Explain the importance, design and working of milling equipments for cereals.
- CO5:** Explain the importance, design and working of milling equipments for rice.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Unit operations in grain processing

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals. Cleaning and grading: Principles of cleaning, scalping, sorting and grading; Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill.

UNIT – II

Drying

Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of cereal grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

UNIT – III

Separation and Material Handling

Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity,

magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes & hoists, pneumatic conveying, power requirement for conveying and elevating.

UNIT – IV

Milling of wheat, corn, pulses and oil seeds

Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods.

UNIT – V

Milling of Rice

Merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN-13. 978-8125911425)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta.(ISBN-10. 9788120409699)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-Hall Inc., New Jersey.(ISBN-13. 9788120409699)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P McGraw-Hill Book Co., Boston.(ISBN-13. 978-8184959635)

Web Links:

1. <http://www.cigr.org/documents/CIGRHandbookVol4.pdf>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=22>

Ground Water Hydrology

Course Code: 2501AE84

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain properties of various water bearing formations and movement of ground water.
- CO2:** Determine the aquifer properties under unsteady state and steady state subsurface flow conditions.
- CO3:** Explain design, development and construction of wells.
- CO4:** Analyze various water quality parameters and explain the occurrence of saline water intrusion.
- CO5:** Select appropriate method for exploration and replenishment of ground water.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO 10	PO11
CO 1	1	-	-	-	-	-	-	-	-	-	-
CO 2	-	2	-	-	3	-	1	-	-	-	-
CO 3	-	-	3	2	-	-	-	-	-	-	-
CO 4	1	-	2	-	-	-	-	-	-	-	-
CO 5	1	1	-	-	-	-	-	-	-	-	-

UNIT-I

Occurrence and Movement of Ground water: Introduction- Global water scenario; Water resources status in India; Origin and age of ground water; groundwater column, zones of aeration and saturation, Aquifer and its types; Aquifer characteristics.

Ground water movement: Darcy's law; Determination of Hydraulic conductivity; Ground water flow rates and directions; Ground water tracers, General flow equations through porous media.

UNIT-II

Well Hydraulics: Determination of aquifer parameters under steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer by different methods- Dupit Theim, Theis, Jacob and Chow's; Characteristic well losses; Specific capacity.

UNIT-III

Water Wells: Classification of wells; Methods of drilling of wells; Design and assembly of gravel packing; Installation of well screens; Common well drilling difficulties; Completion and development of well; Well Rehabilitation.

UNIT-IV

Ground water quality: Sources of salinity; Measures of water quality; Chemical, Physical and Biological analysis of ground water; Ground water samples; Water quality criteria; Occurrence of saline water intrusion- Ghyben-Herzberg relation between fresh and saline waters.

UNIT-V

Ground Water Investigations: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction-based methods for surface investigation of ground water, sub-surface ground water investigation through geophysical / resistivity; Methods of artificial recharge of ground water.

Text Books:

1. Groundwater, H.M. Raghunath, New Age International, 3rd Edition. (ISBN: 978-8122419047)
2. Groundwater Hydrology, D.K. Todd, John Wiley and Son, New York, 2nd Edition. (ISBN: 9788126508365)

Reference Books:

1. Land and Water Management Engineering, V.V.N Murty and M.K Jha, Kalyani Publishers, 6th Edition. (ISBN: 978-9327214659)
2. Groundwater and tube wells, Garg S.P, Oxford and IBH publishing company limited, New Delhi.(ISBN: 8120408268)

Web Links:

1. <http://nptel.ac.in/courses/105105042/>
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=124667/>

Micro Irrigation Systems

Course Code: 2501AE85

L	T	P	C
2	0	0	2

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

- CO1:** Assess the adaptability, problems, and prospects of different types of sprinkler irrigation systems.
- CO2:** Plan and design the layout of sprinkler irrigation systems, including the hydraulic design of lateral, sub-main, and main pipelines, and select appropriate pumps and power units.
- CO3:** Evaluate the performance of sprinkler irrigation systems by analyzing water distribution patterns, overlapping of sprinklers and laterals, uniformity coefficient, and pattern efficiency.
- CO4:** Explain the types, components, and advantages and disadvantages of micro irrigation systems (drip, spray, and bubbler), and design effective drip irrigation systems considering wetting patterns and irrigation requirements.
- CO5:** Perform proper operation and maintenance of micro irrigation systems, addressing issues like clogging, filter cleaning, flushing, and chemical treatment, and apply fertigation techniques, understanding their benefits, limitations, and best practices.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Sprinkler Irrigation Systems

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems.

UNIT – II

Design and Components of Sprinkler Irrigation Systems

Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system.

UNIT – III

Performance Evaluation and Micro Irrigation Systems

Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency; Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components.

UNIT – IV

Design and Operation of Drip Irrigation Systems

Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

UNIT – V

Fertigation in Micro Irrigation Systems

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Text Books:

1. Principles of Sprinkler Irrigation system, Mane M S and Ayare B L.Jain Brothers, New Delhi.(ISBN : 9788183601504)
2. Irrigation: Theory and Practice, Michael A M. ,Vikas Publishing, New Delhi. (ISBN:978-8125918677)

Reference Books:

1. Micro Irrigation - Theory and Practices, Suresh R, Standard Publishers Distributors, Delhi. (ISBN:9788180141508)
2. Sprinkler Irrigation, Sivanappan R K.,Oxford & IBH Publishing House, New Delhi. (ISBN:978-8120402324)

Web Links:

1. http://agritech.tnau.ac.in/agricultural_engineering/agriengg_swc_microirri_ferti.html
2. Course: Micro Irrigation Systems Design 3(2+1) (iasri.res.in)

Surface Water Hydrology

Course Code: 2501AE86

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Calculate the mean areal precipitation using various methods.
- CO2:** Explain rainfall characteristics and measuring devices in India.
- CO3:** Explain runoff and stream flow measurement methods.
- CO4:** Estimate the discharge volume of runoff using hydrographs and unit hydrographs.
- CO5:** Plan a reservoir using flood routing techniques for management of natural resources.

Mapping of course outcomes with program outcomes:

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

UNIT-I

Precipitation: Hydrology-definition, hydrological cycle and its components. Forms of Precipitation, Characteristics of rainfall in India (types of monsoon). Measurement of Rainfall – Recording and Non-Recording Rain gauges- Rain gauge network density for different topographic conditions – Point rainfall analysis - Presentation of Rainfall data – Mass Curve and hyetograph, Mean Precipitation over an area –

Arithmetic Mean, Thiessen Polygon, Isohyetal methods, DAD Relationships and curves. Probability Analysis of Rainfall – Return Period, Plotting position by Weibull's method – Rainfall events at different probability levels (20%, 40%, 60%, and 80 %).

UNIT-II

Runoff: definition-components of runoff-direct runoff and base flow, overload flow and interflows, pictorial representation of different routes of runoff. Runoff characteristics of streams – perennial, intermittent and ephemeral streams. Definition and Estimation of peak runoff using rational method.

Stream flow measurement: Measurement of stream flows. Measurement of stage and velocities, staff gauge, wire gauge, automatic stage recorders, current meters (horizontal and vertical axis meters), calibration ($V = a N_s + b$). Rainfall-Runoff relations ($R = a P + b$), curve fitting and determination of 'a' and 'b' and (correlation coefficient). Intensity-Duration-Frequency-Relationship ($i = ((K T_x) / (D + A))^n$). Determination of net effective rainfall-infiltration indices- Phi index.

UNIT-III

Hydrographs: definition and components, factors affecting flood hydrographs, hydrograph separation for simple and complex storms – Method I, II and III. Unit Hydrograph-concept and the three implications of the definitions and the two basic assumptions. Effects of the characteristics of storms (duration of rain, time-intensity pattern, areal distribution of runoff and amount of runoff) on the shape of the resulting hydrographs. Derivation of Unit hydrographs for simple and complex storms. Derivation of an average unit hydrographs from several storms of the same duration (proper procedure of computing average peak flow and time to peak).

UNIT-IV

Unit Hydrographs: The methods for conversion of unit hydrograph of different durations, (1) method of superposition and (2) S-curve. Concept of S-curve method, explanation application and determination of lower duration graph from the given higher duration graph and vice-versa. Concepts of Synthetic unit hydrograph, Snyder's synthetic unit hydrograph and formulas relating to hydrograph features (basin lag, Peak flow and time base of the unit hydrograph). Concept and application of Instantaneous unit hydrograph and SCS Triangular Hydrograph.

UNIT-V

Flood Routing: Flood Routing-introduction, two broad categories of flood routing and channel routing, hydrologic routing and hydraulic routing, basic equations. Hydrologic storage routing, Schematic representation of storage routing, modified Pul's method (semi-graphical method). Explanation of the features of the modified Pul's method. Flood routing through a reservoir by modified Pul's method.

Applications of Hydrology in land and water management, watershed management, Flood mitigation, Floodplain mapping, Retards, Flood control and Regulation.

Text Books:

1. Engineering Hydrology, Raghunath H.M., Willey Eastern Limited, New Delhi, 3rd Edition. (ISBN: 978-9393159045)
2. Watershed Hydrology, Suresh R., Standard Publisher and Distributors, New Delhi. (ISBN: 978-8186308233)

Reference Books:

1. Engineering Hydrology, Subramanyam K., Tata Mc. Graw – Hill Publishing Co., Limited, New Delhi. (ISBN: 978-1259029974)
2. Hydrology for Engineers, Linsley R.K. Kholer A. & Paul Hus J.L.H., Mc-Graw Hill Book Co. New Delhi. (ISBN-13. 978-0070379565)
3. Watershed Management, Dhruvanarayana, VV., ICAR Publication, New Delhi. (ISBN: 978-8120346765)

Web Links:

1. <http://www.nptelvideos.in/2012/11/advanced-hydrology.html>
2. <https://www.slideshare.net/MohammedSalahat1/chapter-3-surface-water-hydrolo>
3. <https://theconstructor.org/water-resources/types-of-rain-gauges/12801/>
4. <http://nptel.ac.in/downloads/105101002/>

Land & Water Management Engineering

Course Code: 2501AE87

L	T	P	C
3	0	0	3

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

- CO1:** Apply methods for assessing and mitigating soil erosion to enhance soil conservation and sustainable land management.
- CO2:** Design, implement, and evaluate various water erosion control measures, incorporating both agronomical and engineering approaches to enhance soil conservation and land sustainability.
- CO3:** Apply energy and momentum principles in open channels, design soil erosion control structures, and implementing permanent gully control structures, ensuring hydrologic, hydraulic, and structural integrity.
- CO4:** Demonstrate wind erosion control measures, land use capability classification and sedimentation of reservoirs.
- CO5:** Classify water harvesting techniques, design and construct various structures such as farm ponds and percolation ponds, and apply design considerations for nala bunds.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Soil Erosion: Causes, Types, Mechanisms, and Measurement

Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion; Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by $KE > 25$ and $EI30$ methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

UNIT – II

Water Erosion Control Measures and Techniques

Water erosion control measures- agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design.

UNIT – III

Hydraulic Principles and Soil Erosion Control Structures

Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump; Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis.

UNIT – IV

Wind Erosion and Sedimentation Control in Agriculture

Wind erosion- factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes; Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

UNIT – V

Water Harvesting Techniques and Structures for Agricultural Use

Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short- term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Text Books:

1. Open-Channel Hydraulics, Chow V T, McGraw- Hill Book Company, Inc.(ISBN: 9780070107762)
2. Manual of Soil and Water Conservation Practices, Singh. G., Venkataraman C, Sastry G and Joshi B P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.(ISBN: 978-8120405523)

Reference Books:

1. Land and Water Management Engineering, Murthy V V N., Kalyani Publishers, New Delhi, 4th Edition, (ISBN: 978-9327214659)
2. Principles of Agricultural Engineering, Michael A M and Ojha T.P, Volume II. Jain Brothers, New Delhi, 4th Edition. (ISBN: 978-8183601849)

Web Links:

1. Course: Soil & Water Conservation Engg. 3(2+1) (iasri.res.in)
2. Soil-and-Water-Conservation-Engineering.pdf (agrimoon.com)

Agricultural Process Engineering & Food Quality

Course Code: 2501AE88

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the functions of various unit operations and working of size reduction equipment's for processing of fibrous and dry size reduction in processing of agriculture produce.
- CO2:** Explain the design and working of mixing equipment's for powder, high and low viscosity liquids.
- CO3:** Classify separator equipment based on physical characteristics of grains.
- CO4:** Identify various methods for determining moisture content, EMC and drying process.
- CO5:** Explain the importance, design and working of milling and material handling devices, food quality control, food laws, food standards and HACCP.

Mapping of course outcomes with program outcomes:

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

UNIT-I

Unit operation in agricultural Processing:

Scope and importance crop processing – principles and methods of food processing, cleaning, grading, screening, scalping, sorting, size reduction, mixing, separation, drying, storage, milling, material handling, packaging, baking.

Size reduction:

Size reduction –principle of comminution/size reduction, particle shape, average particle size, crushing efficiency. Determination and designation of the fineness of ground material, screen analysis, Empirical relationships (Rittinger's, Kick's and Bond's equations) and related problems. Size reduction equipment – Crushers (Jaw crusher, Gyratory crusher, Crushing rolls), Grinders (Attrition mill, Hammer mill, Ball mill), Fine grinders (Rietz mill or disintegrator, Dispersion and colloid mills) and Cutting machines (Rotary knife cutter).

UNIT-II

Mixing:

Mixing –Introduction, theory of solids mixing, Mixing of low and moderate viscosity liquids (paddle mixer, turbine mixer, propeller mixer) its applications. Mixing of high viscosity liquids, pastes and plastic solids (pan mixer, kneaders) its applications.

Mixers for dry powders and particulate solids (Horizontal screw and ribbon mixer, Vertical screw mixer, Tumbling mixer) and its applications, mixing index,

Separator units:

Theory of separation, types of separators, separator based on length, width, shape of the grains, specific gravity, density, cyclone separators, Pneumatic separator. Air-screen grain cleaner principle and types, Design considerations of air-screen grain cleaners, Sieve analysis- particle size determination, Ideal screen and actual screen– effectiveness of separation and related problems.

UNIT-III

Drying:

Moisture content and its representation (wet basis, dry basis), methods for determination moisture content (direct and indirect methods) and related problems, Importance of EMC and methods of determination (static-dynamic methods), EMC models, hysteresis effect, bound, unbound and free moisture. Principles of drying, theory of diffusion, mechanism of drying, falling rate, constant rate period, thin layer, deep bed drying methods, Effect of different factors on the drying process, types of dryers.

UNIT-IV

Milling and Material handling devices:

Rice milling, principles and equipments, paddy parboiling methods and milling equipment, milling of pulses and oilseeds. Scope and importance of material handling devices, Belt Conveyor– idlers, idler spacing, belt tension, Bucket elevator–classification, operation, capacity, drive mechanism, advantages and disadvantages. Screw conveyor – Principle of operation, capacity, and power requirement. Pneumatic conveying system- types, limitations of pneumatic conveying system.

UNIT-V

Food Quality: Concept, objectives and importance. Sensory evaluation or organoleptic evaluation of food quality, Food laws and regulations in India. Food grade and standards –BIS, AGMARK, PFA, FPO. Hazard analysis and critical control point (HACCP) – objectives, principles, Steps involved in implementation of HACCP

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN: 978-8125911425)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta. (ISBN: 978-8120409699)
3. Unit operations in Food processing, Earle R L, Pergamon Press, New York. (ISBN: 978-0080255361)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-Hall Inc., New Jersey. (ISBN: 978-0134181028)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P McGraw-Hill Book Co., Boston. (ISBN: 978-0072848236)

Web Links:

1. <http://www.cigr.org/documents/CIGRHandbookVol4.pdf>
2. <http://www.rpaulsingh.com/Learning and teaching resources>
3. <http://ecoursesonline.iasri.res.in/course/view.php?id=22>
4. https://moodle.ufsc.br/pluginfile.php/772348/mod_resource/content/0/UnitOperations_in_Food_Engineering_-_A._Ibarz_G._BarbosaCanovas_CRC_2003_WW.pdf
5. <http://www.nzifst.org.nz/unitoperations/matleneg2.htm>

Post Harvest Engineering for Horticultural Produce

Course Code: 2501AE89

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain about various properties and factors affecting quality of fruits and vegetables.
- CO2:** Classify various post harvest operations involved in horticulture processing.
- CO3:** Identify various preservation techniques for processed foods.
- CO4:** Apply the advanced packaging technology in food preservation.
- CO5:** Categorize different beverages based on method of preparation and explain the procedure for extraction of oleoresins and essential oils.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	2	2	-	-	-	-	-	-	-
CO2	3	1	1	1	-	-	-	-	-	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-
CO4	3	2	2	2	-	-	-	-	-	-	-
CO5	3	1	1	1	-	-	-	-	-	-	-

UNIT-I

Properties of Fruits and Vegetables: Engineering properties of fruits and vegetables - physical, aerodynamic, rheological and thermal properties. Electrical properties- Near Infrared reflectance (NIR), radiation, dielectric properties and optical properties: Light transmittance, Light reflectance, machine vision. Quality parameters of fruits and vegetable for processing: sensory, biochemical and nutritional characteristics.

Factors affecting fruits and vegetables quality: Pre-harvest factors, environmental factors, cultural factors and post-harvest factors. Harvesting indices of different horticultural produce, modern techniques for determination of harvesting indices. Handling and transportation of fruits and vegetables. Determination of quality parameters for fruits and vegetables: aroma, fruit ripening, leaf changes, firmness, juice content, sugar content, skin color, total soluble solids, pH and acidity.

UNIT-II

Post-Harvest Operations: Cleaning of fruits & vegetables: soaking, rinsing, sanitizing, washing methods: agitating, spraying water, wet and dry brushing, chemical washing. Peeling of fruits and vegetables: hand peeling, mechanical peeling, peeling by heat treatment and lye peeling. Grading of fruits & vegetables, factors affecting grading, types of graders: screen grader, roller grader, rope and cable type grader and weight grader. Canning of fruits & vegetables: grading, washing, peeling, cutting, blanching, cooling, filling, syruping/brining, exhausting, sealing, retorting, cooling, storage, labeling. Cans making, causes of spoilage of canned foods.

UNIT-III

Principles of Preservation of Fruits & Vegetables: Asepsis, preservation by high temperature: pasteurization, flash pasteurization, sterilization. Chemical preservation with sulphur dioxide and benzoic acid, advantages, disadvantages. Drying and dehydration of fruits & vegetables (flow chart), types of dryers: cabinet dryer, tray dryers, tunnel dryer, freeze drying. Rehydration, ratio of rehydration coefficient. Freezing: Definition and methods - slow freezing, quick freezing and IQF, advantages and disadvantages. Types of freezing - direct immersion, indirect contact with refrigerant, air blast, cryogenic and de-hydro freezing. Cooling methods - pre-cooling, room cooling, hydro cooling, refrigerated trucks.

UNIT-IV

Packaging of Horticultural crops: Controlled atmospheric storage (CAS), factors effecting on CAS, additional benefits, limitations, maintaining CAS, modified atmosphere storage/packaging (MAS/MAP), maintenance of MAP, active modification, passive modification, requirements of fresh fruits package under CAS or MAS. Packaging of fruits and vegetables, advantages and disadvantages. Packaging materials: cellophane, poly vinyl chloride, polyethylene, ethyl vinyl alcohol. Packaging of horticultural crops.

UNIT-V

Preparation and Preservation of Beverages: Preservation of unfermented fruit beverages: apple juice, grape juice, pineapple juice, citrus juice, mango juice with all flow sheets. Fermented beverages: wine, grape wine with all flow charts. Preparation of vinegar - alcoholic fermentation and acetic acid fermentation.

Oleoresin and Essential Oil Extraction: Turmeric oleoresin and chilli oleoresin. Solvents used for oleoresin extraction, advantages and disadvantages. Extraction of essential oil from spices by steam distillation.

Text Books:

1. Food Science by Potter N. and Hotchkiss J. H, An Aspen Publication, 5th Edition. (ISBN:978-8123904726)
2. Fruits and Vegetable Preservation: Principles and Practices, Srivastava, R.P. & Kumar, S. CBS Publishing, 3rd Edition. (ISBN: 978-8123924373)
3. The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits & Vegetables by NIIR Project Consultancy Services, 3rd Edition. (ISBN: 978-9381039694)

Reference Books:

1. Fruits: Tropical and subtropical, Bose T. K & Mitre, S. K. Naya Prakash, 3rd Edition. (ISBN: 978-8185971810)
2. Fruits and Vegetable processing, Bhatti, S. and Varma U., CBS Publishers, 1st Edition. (ISBN: 978-8123904047)
3. Food Processing and Preservation, Sivasenkar, B., CBS Publications. (ISBN: 978-8120320864)

Web Links:

1. http://www.rpaulsingh.com/animations/animaitons_master3.html
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1098>
3. https://onlinecourses.nptel.ac.in/noc18_ar08/preview

Agricultural Machinery & Equipment

Course Code: 2501AE90

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the process of selection, cost estimation and methods of ploughing of farm mechanization.
- CO2:** Calculate the forces acting on tillage implements.
- CO3:** Explain inter-culture equipments and understand the sowing, planting and transplanting operation with various implements used for these operations.
- CO4:** Explain the harvesting and threshing operation with various implements used for these operations.
- CO5:** Explain the operation of grain combines harvesting mechanism.

Mapping of course outcomes with program outcomes:

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

UNIT-I

Introduction to farm mechanization: Classification of farm machines. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Selection of farm machinery and cost estimation. Hitching systems and controls of farm machinery. Introduction to seed-bed preparation. Familiarization with land reclamation and earth moving equipment. Methods of Ploughing.

UNIT-II

Tillage Practices: Definition, primary tillage, secondary tillage, rotary tillage, deep tillage, minimum tillage and conservation tillage. Draft measurement of tillage equipment, Identification and major functional components of mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, levelling, Forces acting on tillage implements. Cost of operation of farm machinery.

UNIT-III

Introduction to inter-culture equipments: Weeder – manual and powered, main components and their functional requirement.

Introduction to sowing, planting & transplanting equipment: Study of working of seed drills, no-till drills, happy seeder and strip-till drills. Brief description and working of planters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to plant protection equipment – sprayers and dusters.

Classification of sprayers. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.

UNIT-IV

Study of harvesting operation – methods and terminology. Study of Reapers, Mowers and windrowers – types, working and adjustments. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, factors affecting thresher performance. Chaff cutters and capacity calculations.

UNIT-V

Study of grain combines (Wheat and Paddy) - Combine terminology, Computation of combine losses, study of combine troubleshooting. Study of Root crop diggers –potato and groundnut. Cotton harvesting mechanisms, study of cotton pickers and strippers. Introduction to vegetables and fruit harvesting equipment and tools.

Text Books:

1. Principles of Agricultural Engineering (Vol. II). A. M. Michael and T.P. Ojha, Jain brothers, New Delhi. (ISBN: 8183601849)
2. Principals of Farm Machinery, R.A. Kepner, Bainer Roy, and E.C. Barges, Publishers and Distributors, Delhi-17. (ISBN: 8123909772)
3. Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2), Bosoi, E.S., Oxonion Press Pvt. Ltd., New Delhi. (ISBN: 9383692378)

Reference Books:

1. Agricultural Machines, Theory and Construction (Vol. 1 & 2). Kanafoshi, C.Z. and Karwawshi T. (ISBN: 9388399838)
2. Agricultural Machines, Kelnin, N.I., Popov, I.F., and Sakun, V.A Amerind Publishers, New Delhi. (ISBN: 978-9061914488)

Web Links:

1. <https://nptel.ac.in/courses/126/105/126105009/>
2. <http://www.hillagric.ac.in/edu/coa/agengg/lecture/243/agriengg-243.htm>

Design of Bio-Energy Systems

Course Code: 2501AE91

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Comprehend Biomass Sources and Fermentation Processes
- CO2:** Explore Biomass Production and Preparation
- CO3:** Analyze Biomass Conversion Technologies
- CO4:** Evaluate Biofuel Production Processes and Applications
- CO5:** Assess Environmental and Economic Aspects of Bio-Energy

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Biomass sources and characteristics. Fermentation processes and its general requirements. Aerobic and anaerobic fermentation processes and their industrial applications. Heat transfer processes in anaerobic digestion systems.

UNIT – II

Biomass production- wastelands, classification and their use through energy plantation. Selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

UNIT – III

Bio-energy

Properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs.

UNIT – IV

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Producer gas- type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Applications, shaft power generation, thermal application and economics.

UNIT – V

Trans-esterification for biodiesel production and application in CI engines. production process, properties and application of ethanol. Bio-hydrogen production routes. Environmental aspect of bio-energy. Assessment of greenhouse gas mitigation potential. Cost economics of bio-energy systems.

Text Books:

1. Biomass Gasification, Pyrolysis and Torrefaction, Basu P, Academic Press, 2018. (ISBN: 10-10128129921)
2. Renewable Energy Academy Training wood energy professionals, Butler S. (ISBN: 13-978-0128129920)

Reference Books:

1. The Biodiesel Handbook, Knothe G, Gerpen J V, Krah J. (Eds.), AOCS Press. (ISBN: 9781893997622)
2. Non-Conventional Energy Sources, Rai G D, Khanna Publishers, New Delhi. (ISBN: 978-8174090737)

Web links:

1. <https://elearning.icar.gov.in/>
2. https://saveetha.ac.in/images/sec/2021/Syllabus/Agriculture/19AG423-_BIO-ENERGY_SYSTEM_DESIGN_AND_APPLICATIONS.pdf

Minor Degree in Entrepreneurship Development & Incubation

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MB07	New Product Development	FC	3			3	50	50	100	-
2501MB08	Entrepreneurship & Small Business Management	IC	2			2	50	50	100	-
2501MB09	Insurance & Risk Management	IC	3			3	50	50	100	-
2501MB10	Change & Innovations Management	IC	3			3	50	50	100	-
2501MB11	Personal Financial Planning (or) E-Business management	IC	3			3	50	50	100	-
2501MB12										
2501MB13	Business Policy & Strategic Management (or) Green Marketing	AC	3			3	50	50	100	-
2501MB14										
2501MB15	Startup Management (or) Venture Management	AC	3			3	50	50	100	-
2501MB16										
Total			20			20				

New Product Development

Course Code: 2501MB07

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** To learn how to develop and implement a new product or service to an existing and potential target market.
- CO2:** Understand the importance of new product development to firm performance
- CO3:** To help the student to prepare a Business Plan for a new product or service.
- CO4:** Learn methods of generating, evaluating and testing product ideas.
- CO5:** Understanding the impact of intellectual property and patents on new product development and management

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	1	0	0	-
CO2	-	-	-	-	-	-	-	-	1	1	-
CO3	-	-	-	-	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	-	-	2	-	-	-

UNIT – I

Introduction- Types of products – Product development - Factors contributing to New Product Development - New product development process – product life cycle in theory and practice - Invention Vs Innovation.

UNIT – II

Strategic Planning for New Product - Sources of new product ideas - Generation of ideas - Criteria for screening – understanding customer needs – need assessment based on secondary and primary research - Concept generation

UNIT – III

Business Analysis – Purpose, Stages of Business analysis - Market potential and Demand - Estimating first time sales - Replacement Sales - Repeat Sales - Estimating costs, Sales and Profit – Business plan preparation

UNIT – IV

Product testing - Test Marketing, its advantages and disadvantages - Test marketing strategies - Launch cycle - Managing Growth and Maturity - Commercialization

UNIT – V

Defining Intellectual Property and Patents – Patent application – ownership and transfer of patent – infringements - The future of New Product management – Contemporary issues

Text Books:

- 1 “Product Management in India”, RamanujManjumdar, Prentice Hall Publication (ISBN: 9788120312524)
- 2 “Business plan template and example: How to write a BusinessPlan” Alex Genadinik (ISBN: 9781519741783).

Reference Books:

- 1 “Production design and Development” Karl T Ulrich, Steven D. Eppinger and Amita Goyal, Tata Mc GrawHill (ISBN: 9781260566437).
- 2 “New Products Management”, Crawford, Merle and Di Benedetto, Anthony, McGraw-Hill/Irwin (ISBN: 9781260575088)

Web Links:

1. <https://www.youtube.com/watch?v=QxQfAw1049M>
2. https://ocw.mit.edu/courses/15-783j-product-design-and-development-spring-2006/resources/clas7_cncpt_genr/

Entrepreneurship & Small Business Management

Course Code: 2501MB08

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Explain the nature of entrepreneurship and how it relates to small business.
- CO2:** Develop and demonstrate competence in basic business and marketing planning
- CO3:** Explain factors related to readiness for entrepreneurship and getting started in entrepreneurship career.
- CO4:** Identify the factors affecting choice of a business location and explain how layout of physical facility and equipment could lead to efficiency
- CO5:** Explore techniques for improving quality and productivity.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	3	-	-	-
CO2	-	-	-	-	-	-	-	-		1	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	-	1	-	-	-	-	-

UNIT – I

Fundamentals of Business: Forms of business organization, Small-scale industrial undertakings with particular reference to India, and Government incentives for entrepreneurial ventures.

UNIT – II

Business Model and Business Plan: Business plan, Business description, Business environment analysis, SWOT analysis, Competitor analysis, Market analysis, and Marketing, Operations and Financial plan.

UNIT – III

Funding new ventures: Fixed and working capital needs, Capital structure, Public and private sources of capital, Equity and debt financing, Terms loans, Private placements, Project finance, Miscellaneous sources, Special institutional schemes, Venture capital.

UNIT – IV

Launch of a Startup: Location, Facility planning, Resource acquisition, Business operations, Costing and pricing of product/service, and Marketing strategy.

UNIT – V

Managing and Growing the Enterprise: Transition to managerial approach and Functions of Management; Operations, quality and productivity management; Market segmentation, Product positioning.

Text Books:

1. Entrepreneurship and Small Business Management ,Dr. P.T. Vijayshree & Dr. M.Alagammai, Margham Publication, 2021
2. Essentials of Entrepreneurship and Small Business Management, M. Scarborough , Jeffrey R. Cornwell, Pearson Education (ISBN: 9780134741086)

Reference Books:

1. Entrepreneurship And Small Business, Dr. B. K. Mehta, Prof. R. C. Agarwal, SBPD Publishing House 1 Edition (ISBN: 9789350470688)
2. Entrepreneurship And Small-Scale Business, Sanjeet Sharma, VK Global Publications Pvt Ltd, 1 January 2020 (ISBN: 9780000861917)

Web Links:

1. <http://digimat.in/nptel/courses/video/110106141/L06.html>
2. <https://www.coursera.org/learn/fundamentals-of-management>

Insurance & Risk Management

Course Code: 2501MB09

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify and assess various types of risks, and develop strategies to mitigate or manage them.
- CO2:** Explain the principles of insurance, including types of insurance, policy terms, and claims processing.
- CO3:** Conduct risk assessments and analyses to determine potential losses and develop strategies to minimize them.
- CO4:** Develop and implement risk management strategies, including risk avoidance, transfer, mitigation, and acceptance.
- CO5:** Understand the differences between personal and commercial insurance, including types of policies and coverage.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	1	-	-	-	1	-
CO2	-	-	-	-	-	-	-	2	-	2	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	1	-	-	-	-	-

UNIT – I

Insurance: Concept, Nature of Insurance, Functions of Insurance, Importance of Insurance, Principles of Insurance Contract; Features of Life and Non-life Insurance.

UNIT – II

Insurance and IRDA: IRDA Act 1999, Provisions, Duties, Powers and Functions of IRDA.

UNIT – III

Risk and risk management process - Concept of risk, risk vs. Uncertainty, types of risks, risk identification and evaluation.

UNIT – IV

Risk management objectives-selecting and implementing risk management techniques. Commercial risk management applications.

UNIT – V

property, liability, commercial property insurance, different policies and contracts–business liability and risk management.

Text Books:

1. “Life and Health Insurance”, Black K. Jr., Skipper. H. D. Jr, Pearson Education (ISBN-13: 9780138912505).
2. “Insurance in India”, Response Books, Palande P.S., Shah R.S. and Lunawat M.L., Sage Publications Ltd. (ISBN: 9780761997481)

Reference Books:

1. Insurance and Risk Management”, Gupta, P.K., Himalaya Publishing House, New Delhi (ISBN: 978-9350246726).
2. Business Policy And Strategic Management, Vipin Gupta, Kamala Gollakota, R. Srinivasan, Phi Learning Pvt. Ltd., (ISBN: 9788120328624)

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105160/>
2. https://ocw.mit.edu/courses/15-997-practice-of-finance-advanced-corporate-risk-management-spring-2009/resources/mit15_997s09_1EC1_3/

Change & Innovations Management

Course Code: 2501MB10

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand innovation, innovative models and implementing those Models in organization.
- CO2:** Understand Intervention techniques and implement it effectively at the workplace.
- CO3:** Appreciate resistance-to-change, and strategies to overcome those resistances.
- CO4:** Enable learners with in-depth understanding of individual, team, work-group or organizational interventions to work successfully.
- CO5:** Develop and Enhance Competencies to use the Innovative and Change Management techniques effectively at workplace.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	2	-	1	-
CO2	-	-	-	-	-	-	-	-		3	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-	-

UNIT – I

Defining innovation, understanding the role of innovation, Understanding innovation, innovation and organizational performance, Understanding how to use innovation as strategy, Defining exploration vs. exploitation in innovation, and Defining disruptive, destructive, and displacement innovation.

UNIT – II

Frameworks for Creating Innovation & The Product Development Process: Identifying and understanding the sources of innovation, Defining and discussing a standard PDP phase gate methods vs. spontaneous methods for managing innovation and product development, Leading practices designed to foster creativity, open innovation vs. closed innovation, Understanding internal barriers to innovation and how to best address resistance, and Assessing the strategic and financial impact of innovation.

UNIT – III

Leading Innovation & Change: How to form innovation teams, Understanding team behavior & dynamics, How to manage innovation teams for high-performance results, How to best measure team performance, Discussion various tips & traps for leading innovation, Factors and considerations in selecting team members and managing innovation teams.

UNIT – IV

Implementation consideration in using incubators and accelerators, Understanding how and when to use DARPA, Skunk Works, and Accelerators for innovation, How to identify,

assess and address organizational, legal, and cultural impediments to innovation, Assessing environmental factors and how they affect innovation.

UNIT – V

Social Implications of Innovation: Understanding how innovation and society interact, Examining ethical issues of innovation, Determining the role of social entrepreneurship and innovation Creating social innovation.

Text Books:

1. Managing change, bernard burnes, seventh edition, pearson education, 30 june 2020 (ISBN: 9780273033769)
2. Change Management for Beginners, Steffen Lobinger, Tim Ongpublisher,2021(ISBN: 9781687022622)

Reference Books:

1. Innovation Management: Strategies, Concepts and Tools for Growth and Profit, Shlomo Maital , D V R Seshadri , SAGE Publications Pvt. Ltd (ISBN-13: 9788132107224).
2. Managing Innovation and Change, David Mayle, SAGE Publications (ISBN: 9781412922500).

Web Links:

1. <https://hits.digimat.in/nptel/courses/video/110107094/L31.html>
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/01_intro/

Personal Financial Planning

Course Code: 2501MB11

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** To provide basic principles for managing personal finance.
- CO2:** To help individual learn investment decisions
- CO3:** Identify and describe various types of risk associated with investments, such as market risk, credit risk, liquidity risk, and operational risk.
- CO4:** Calculate interest, dividend, and capital gains on personal investments, including bonds, stocks, and mutual funds.
- CO5:** To mitigate old age financial planning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	-	1	1	-	-	-	-

UNIT – I

Basics of Personal Financial Management: Basics of Personal Financial Management: Budget, The Personal Financial Planning Process, Preparation of Personal Budget, Personal Financial Statements, Personal Income Tax Planning. Case studies on personal financial planning of individuals.

UNIT – II

Personal Savings & Investment: Investment Criteria- liquidity, safety and profitability. Savings instruments of Post Office and Banks. Chit Funds. Investment in Shares, Debentures, Corporate and Government Bonds, Mutual Fund. Investment in Physical Assets – Real Estate, Gold and Silver, Gold certificates.

UNIT – III

Risk and Return associated with these investments: Case studies on risk and return perception of retail investors on various investments.

UNIT – IV

Computation of Return and Risk of Personal Investment: Present Value and Future Value of a Single Amount and an Annuity. Computation of interest, dividend and capital gains on personal investments. Impact of leverage on return. Personal tax planning.

UNIT – V

Retirement Savings Plans: Retirement Savings Plans: Gratuity plans from the government. Life Insurance types. Health insurance. Pension Plans- Defined Contribution Plan and Defined

Benefit Plan. Provident Fund, Gratuity. Life Insurance Plans. General Insurance Plans. Reverse Mortgage Plans.

Text Books:

1. Personal Financial Planning, CS Monika Saini, Dr. Neerza, Scholar Tech Press, 1 January 2024,
2. Personal Financial Planning, Dr Shalu Garg, Sultan Chand & Sons, 1 January 2024 (ISBN: 9780357987872)

Reference Books:

1. 5 W's of Financial Planning: Master the Art of Personal Finance Strategy, Dr Vimal Krishna Rajput, Sultan Chand & Sons 5 November 2021 (ISBN: 9781685388850)
2. Personal Financial Planning, Dr kamal Garg, Sultan Chand & Sons, 1 January 2020

Web Links:

1. <https://archive.nptel.ac.in/courses/122/106/122106031/>
2. <https://www.coursera.org/learn/fundamentals-of-management>

E-Business Management

Course Code: 2501MB12

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the concept and significance of e-business.
- CO2:** Evaluate and select appropriate hardware and software components for e-business.
- CO3:** Apply e-business technologies to enhance marketing strategies.
- CO4:** Design hybrid distribution networks that optimize cost and customer experience.
- CO5:** Understand the role of smart cards in payment systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	1	-	-	1	
CO2	-	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-	-

UNIT – I

Introduction Concept of e-business: Nature, scope, and impact of e-business; Difference between e-business and ecommerce; History and development of e-business; Advantages of e-business; Business models for e-products and e-services

UNIT – II

Technologies in e-business Introduction: e-business technologies - hardware, e-business software applications, internet and World Wide Web; Database management system; e-business security; Online payment technology

UNIT – III

Digital Marketing Concept: Effects of e-business technologies on marketing strategy, customer retention and e-CRM; Measuring the extent of digital marketing activity; Market analysis; Digital marketing tools

UNIT – IV

Online Distribution Components of a distribution system: Characterization of online distribution; hybrid distribution networks; Model for electronic software distribution.

UNIT – V

E-Payment System Characteristics of payment system; Classification of payment systems - E-cash, E-check, overview of smart card; Applications of IPSec.

Text Books:

1. E- Business & E- Commerce, Dr. P. Rizwan Ahmed, Margham Publication (ISBN: 978-9383242320).
2. E-Business and E-Commerce Management, Chaffey Dave, Pearson Education India,2020(ISBN: 978-0273707523)

Reference Books:

1. e-Business 2.0: Roadmap for Success, Kalakota,Pearson, 2nd Edition (ISBN: 978-8177581164).
2. Entrepreneurship And Small Business, Dr. B. K. Mehta, Prof. R. C. Agarwal,SBPD Publishing House1 Edition (ISBN · 9789350472712)

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105083/>
2. <https://srmuniv.digimat.in/nptel/courses/video/110105083/L57.html>

Business Policy & Strategic Management

Course Code: 2501MB13

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Apply the concepts in strategy and their application under various management functions.
- CO2:** Understand the importance of analyzing external factors that impact an organization.
- CO3:** Understand how organizations maintain their current position by focusing on existing products and markets.
- CO4:** Learn how to turn strategic plans into executable steps, ensuring alignment with organizational goals and objectives.
- CO5:** Explore the opportunities and threats posed by digital disruption.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	3	-	-	-
CO4	-	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	1	-	-	-	-	-

UNIT – I

Strategic Management: Meaning, Historical Development, Nature, Scope and Significance; Strategic Decision Making; Enterprise Strategists; Strategic Management Model; Strategic Intent- Vision, Mission and Objectives.

UNIT – II

External Environmental Appraisal: Meaning, Significance and Forces. Environmental Scanning: Process and Techniques; Corporate Appraisal- Meaning; Process; Significance & Techniques; Porter's Generic Strategies

UNIT – III

Strategy Alternatives, Variation and Choices: Stability, Growth, Retrenchment and Combination Strategies, Strategic Alliances, Mergers, Acquisitions, Diversification, Integration, Liquidation; Corporate Portfolio Analysis; Strategic Choices Models- BCG Matrix.

UNIT – IV

Strategic Implementation: Strategy Implementation Process, Issues in Strategy Implementation: Behavioral, Functional, Operational and Functional Implementation

UNIT – V

Strategy, Evaluation and Control : Process and Methods. Strategic Management in internet era.

Text Books:

1. Business Policy and Strategic Management, Dr. Sangeeta & Dr. Neeraj, Rigi Publication, 7TH Edition.(ISBN : 978-9391041656)
2. Business Policy (Strategic Management), by Shiva Manoj Bimal Jaiswal, New Royal Book Company, 1 January 2021(ISBN: 978-8195175215)

Reference Books:

1. Business Policy And Strategic Management, Vipin Gupta, Kamala Gollakota, R. Srinivasan, Phi Learning Pvt. Ltd.(ISBN:978-8120332447)
2. Business Strategies in Times of Crisis, Dr. Charles O. Usigbe, New Royal Book Company(ISBN : 978-1514431771)

Web Links:

1. <https://archive.nptel.ac.in/courses/110/105/110105161/>
2. <https://ocw.mit.edu/courses/15-904-strategic-management-ii-fall-2005/resources/strag/>

Green Marketing

Course Code: 2501MB14

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** To impart knowledge on this area of environmental marketing
- CO2:** To analyse the Environmental Ethics
- CO3:** To gain the knowledge in the area of environmental marketing.
- CO4:** Understand how CDM credits can be used by industrialized countries to meet their emission reduction targets.
- CO5:** Identify marketing opportunities in different countries and regions.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	1	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-	-

UNIT – I

Environment-Pollution, cause, and remedy, Biodiversity, Environmentalism- Definition, concepts, its impact and relationship to businesses, need to study environment in the modern era, environment- an interdisciplinary approach.

UNIT – II

Environment and its relevance to marketing- ethical products, creating awareness about Green Products, Green Labeling of products, Standards- environmental audit- Global environmental challenges. Environment conscious customer and consumer segment.

UNIT – III

Environment- Developed and developing countries- Influence of Green Marketing on corporate social responsibility, marketing ethical products- challenges and opportunities, promoting green products- advertising on the green platform, Environmental marketing strategies.

UNIT – IV

Building Green Brands, transforming non-green organizations to green organizations- greening the organization structure- building green business- challenges, international organizations, standards, Clean Development Mechanism (CDM), guides for the use of environmental marketing claims.

UNIT – V

The influence of global environmental issues on international business, international marketing opportunities, Project- mini- project- Business process reengineering with the

introduction of green technologies, developed and developing markets, environmental marketing of services.

Text Books:

1. “Environmental marketing- strategies, Practice, Theory and Research”, Michael J. Polansky, and Alma T. Mintu. Wimsatt, Kogan Page Publishers. (ISBN-13: 9781136590337)
2. “Environmental Marketing – positive strategies for reaching the green consumer” Walter Codrington Peter Florain, McGraw Hill Professional, 2020 (ISBN-13: 9780070115996)

Reference Books:

1. Green Marketing and management- A global perspective John. F. Wasik, Blackwell publisher, 2022 ISBN: 9781557866349
2. Marketing, Morality, and the natural environment Andrew Crane Routledge publishers. ISBN: 9780415439619

Web Links:

1. <https://www.youtube.com/watch?v=LxxpEKyu134>
2. <https://www.teachmint.com/tfile/studymaterial/b-com/management/unit-7lecture-14greenmarketingpdf/b3248a3e-01af-4f2a-bb41-695c71975ec1>

Startup Management

Course Code: 2501MB15

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Develop a start-up Enterprise with Big Idea Generation.
- CO2:** Analyze start-up capital requirement by analyzing legal factors.
- CO3:** Interpret feasibility Analysis towards funding issues.
- CO4:** Access growth stages in new venture and reasons for scaling ventures.
- CO5:** Evaluate financial stability and decide on expansion possibilities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	1	-	1	--	1	-
CO2	-	-	-	-	-	-	-	-		1	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	-	1		-	-	-	-

UNIT – I

Start-up opportunities: The New Industrial Revolution – The Big Idea- Generate Ideas with Brainstorming- Business Start-up - Ideation- Venture Choices - The Rise of The start up Economy - The Six Forces of Change- The Start-up Equation – The Entrepreneurial Ecosystem – Entrepreneurship in India. Government Initiatives.

UNIT – II

Startup Capital Requirements and Legal Environment: Identifying Startup capital Resource requirements - estimating Startup cash requirements - Develop financial assumptions- Constructing a Process Map - Positioning the venture in the value chain - Launch strategy to reduce risks- Startup financing.

UNIT – III

Starting up Financial Issues: Feasibility Analysis - The cost and process of raising capital – Unique funding issues of a high-tech ventures - Funding with Equity – Financing with Debt- Funding startups with bootstrapping- crowd funding- strategic alliances.

UNIT – IV

Start-up Survival and Growth: Stages of growth in a new venture- Growing with the market - Growing within the industry- Venture life patterns- Reasons for new venture failures- Scaling Ventures – preparing for change - Leadership succession. Support for growth and sustainability of the venture.

UNIT – V

Planning for Harvest and Exit: Dealing with Failure: Bankruptcy, Exit Strategies- Selling the business - Cashing out but staying in-being acquired- Going Public (IPO) – Liquidation.

Text Books:

1. Launching New Ventures, An Entrepreneurial Approach, Kathleen R Allen, CengageLearning (ISBN: 9780357039175).
2. Managing New Ventures Concepts and Cases, AnjanRaichaudhuri, Prentice Hall International, 2010.(ISBN:978-8120341562)

Reference Books:

1. Entrepreneurship, S. R. Bhowmik& M. Bhowmik, New Age International, (ISBN: 9788122419061).
The Startup Equation -A Visual Guidebook for Building Your Startup, Indian Edition,
2. Steven Fisher, Ja-nae' Duane, Mc Graw Hill Education India Pvt. Ltd,(ISBN: 9780071832366).

Web Links:

1. <http://tjsec.digimat.in/nptel/courses/video/110106141/L57.html>
2. <https://archive.nptel.ac.in/courses/127/105/127105007/>

Venture Management

Course Code: 2501MB16

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Describe the role of venture managers in promoting entrepreneurship.
- CO2:** Learn how to secure and manage IP assets within a venture.
- CO3:** Analyse and assess risks associated with ventures.
- CO4:** Evaluate and choose appropriate exit strategies based on venture goals and market conditions.
- CO5:** Develop a comprehensive plan for scaling and entering global markets.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	2	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-	-

UNIT – I

Introduction to Venture Management: Understanding the concept of venture management, Role of entrepreneurship and innovation in creating ventures,

Market Research and Opportunity Identification: Techniques for market research and identifying business opportunities, Analyzing customer needs, market trends, and competitive landscape.

UNIT – II

Legal and Regulatory Aspects: Legal structures for ventures (sole proprietorship, partnership, corporation, etc.). Intellectual property rights, contracts, and compliance.

Financial Management for Ventures: Budgeting, financial forecasting, and managing startup costs, Sources of funding (bootstrapping, angel investors, venture capital).

UNIT – III

Risk Management and Decision Making: Assessing and mitigating risks associated with ventures. Making informed decisions under uncertainty.

UNIT – IV

Exit Strategies and Succession Planning: Options for exiting the venture (selling, merging, going public), Planning for the long-term sustainability of the venture.

UNIT – V

Venture Scaling and Internationalization: Learn strategies for scaling ventures beyond their initial markets, Understand the challenges and opportunities of international expansion.

Text Books:

1. New Venture Creation: A Framework for Entrepreneurial Start-ups , Paul Burns , MacMillan publication, Latest edition (ISBN: 9781350321793)
2. Entrepreneurship: New Venture Creation, David H. Holt, Pearson publication, Latest edition (ISBN: 9780132826747)

Reference Books:

1. Entrepreneurship and new Venture Creation, Excel publication, Latest edition, A Sahay, V Sharma (ISBN: 978-9332568730)
2. Entrepreneurship: Successfully Launching New Ventures, Bruce R. Barringer, R. Duane Ireland , Pearson publication, Latest edition (ISBN:978-935306649)

Web Links:

1. <https://hits.digimat.in/nptel/courses/video/109105098/L17.html>
2. <https://ocw.mit.edu/courses/15-351-managing-the-innovation-process-fall-2002/resources/lecture2021/>
3. <https://ocw.mit.edu/courses/15-351-managing-the-innovation-process-fall-2002/resources/lecture2324/>

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	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)