B.E-COMPUTER SCIENCE AND ENGINEERING
Regulation 2024
CURRICULUM & SYLLABI

DEPARTMENT VISION

To provide quality education, to become a prominent centre of excellence for producing competent IT professionals, logical thinkers and empowering entrepreneurs to take up real world challenges in the emerging technological society.

DEPARTMENT MISSION

As a department, we are committed

- ❖ To provide high quality education to the students, and equip them with the state-of- the-art knowledge and skills in computer science that they need to take up real-world challenges.
- ❖ To make students to think beyond the boundaries using analytical and logical skills.
- ❖ To conduct cutting-edge research in areas of national need, frequently in collaboration with other disciplines.
- ❖ To gear up the graduates to grab the opportunities in the core field in pursuing higher education and to become empowering entrepreneurs.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Possess a strong foundation in computer science and apply to design and develop innovative computing solutions for a successful career (Technical Expertise).

PEO 2: Adapt to the rapidly evolving technologies, continuously learn and update their knowledge to pursue higher studies of research and solve problems effectively in a dynamic environment. (Adaptability and Lifelong Learning).

PEO 3: Exhibit strong communication and teamwork skills, the ability to work independently, an ethical understanding of the social and professional implications of computing, and the potential to pursue higher studies or research (Professional and Ethical Responsibility).

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: 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.

PO 4: 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.

PO 5: Modern 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.

PO 6: The engineer and society: 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.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: 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.

PO 11: 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.

PO 12: 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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Graduates will be able to:

PSO 1: Analyze, design and develop computing solutions by applying emerging technologies in areas like artificial intelligence, machine learning, and cyber security.

PSO 2: Apply software engineering principles and practices for developing quality software for scientific and business applications.

PSO 3: Adapt to emerging Information and Communication Technologies (ICT) to innovate ideas and solutions to existing/novel problems.

B.E-COMPUTER SCIENCE AND ENGINEERING
CURRICULUM AND SYLLABI (Regulation 2024)
(Applicable for students admitted from the Academic Year 2024-2025)
Minimum Credits to be Earned: 164

SEMESTER I

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA / ES	Course Type	Category
1	24HS101	Technical English	2	0	2	3	4	50/50	TP	HSMC
2	24MA101	Matrices and Calculus	3	1	0	4	4	40/60	T	BSC
3	24PH101	Engineering Physics	3	0	2	4	5	50/50	TP	BSC
4	24CY101	Engineering Chemistry	3	0	2	4	5	50/50	TP	BSC
5	24GE101	Problem Solving using Python Programming	3	0	2	4	5	50/50	TP	ESC
6	24GE102	தமிழர்மரபு / Heritage of Tamils	1	0	0	1	1	40/60	T	HSMC
7	24GE111	Engineering Practices Laboratory	0	0	4	2	4	60/40	P	ESC
8	24MC111	Induction Program	3 Weeks						MC	MC
						TOTAL	22	28		

SEMESTER II

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24MA202	Probability and Statistics	3	1	0	4	4	40/60	T	BSC
2	24CS201	Programming in C	3	0	2	4	5	50/50	TP	PCC
3	24PH205	Physics for Information Science	3	0	0	3	3	40/60	T	BSC
4	24EE204	Basic Electrical and Electronics Engineering	3	0	0	3	3	40/60	T	ESC
5	24GE201	Computer Aided Engineering Graphics	3	0	2	4	5	50/50	TP	ESC
6	24GE202	தமிழரும் ததொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	1	40/60	T	HSMC
7	24MC201	Environmental Science	2	0	0	0	2	100/0	MC	MC
		Work Integrated Learning (Industrial Practice)	Regulation 2024, Clause 4.4							AP
TOTAL							19	23		

SEMESTER III

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24HS301	Universal Human Values	2	0	0	2	2	100/0	T	HSMC
2	24MA302	Discrete Mathematics	3	1	0	4	4	40/60	T	BSC
3	24CS301	Data Structures	3	0	2	4	5	50/50	TP	PCC
4	24CS302	Digital Principles and Computer Organization	3	0	2	4	5	50/50	TP	ESC

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA / ES	Course Type	Category
5	24CS303	Object Oriented Programming	3	0	2	4	5	50/50	TP	PCC
6	24CS304	Database Management Systems	3	0	2	4	5	50/50	TP	PCC
7	24SD311	Aptitude and Coding Skills -1	0	0	2	1	2	100/0	P	EEC
8	24EL311	Innovation and Product Development -1 (Idea Generation)	0	0	2	1	1	100/0	EL	EEC
		Work Integrated Learning (Industrial Training-I)	Regulation 2024, Clause 4.4							AP
TOTAL						24	29			

SEMESTER IV										
S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24CS401	Theory of Computation	3	0	0	3	3	40/60	T	PCC
2	24CS402	Algorithms	3	0	2	4	5	50/50	TP	PCC
3	24CS403	Introduction to Operating Systems	3	0	2	4	5	50/50	TP	PCC
4	24CS404	Object Oriented Software Engineering	3	0	2	4	5	50/50	TP	PCC
5	24IT302	Foundations of Data Science	3	0	2	4	5	50/50	TP	PCC
6	24SD411	Aptitude and Coding Skills -2	0	0	2	1	2	100/0	P	EEC
7	24EL411	Innovation and Product Development -2 (Conceptualization)	0	0	2	1	2	100/0	EL	EEC
8		Mandatory Course- 3 (Choose from list)	2	0	0	0	2	100/0	MC	MC
		Work Integrated Learning (Industrial Training-II)	Regulation 2024, Clause 4.4							AP
					TOTAL	21	29			

SEMESTER V										
S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24CS501	Computer Networks	3	0	2	4	5	50/50	TP	PCC
2	24CS502	Compiler Design	3	0	2	4	5	50/50	TP	PCC
3	24CS503	Cryptography and Cyber Security	3	0	0	3	3	40/60	T	PCC
	24IT401	Artificial Intelligence and Machine Learning	3	0	2	4	5	50/50	TP	PCC
5		PEC-1	2	0	2	3	4	50/50	TP	PEC
6		OEC-1	3	0	0	3	3	40/60	T	OEC
7	24SD511	Advanced Aptitude and Coding Skills 1	0	0	2	1	2	100/0	P	EEC
8	24EL511	Innovation and Product Development-3 (Prototype Development and Testing)	0	0	2	1	2	100/0	EL	EEC

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA / ES	Course Type	Category
9		Mandatory Course- 4 (Choose from list)	2	0	0	0	2	100/0	MC	MC
		Work Integrated Learning (Industrial Problem Solving-I)	Regulation 2024, Clause 4.4							AP
					TOTAL	23	31			

SEMESTER VI										
S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24MG601	Economics, Finance & Accounting	3	0	0	3	3	40/60	T	HSMC
2	24AD505	Cloud Computing	2	0	2	3	4	50/50	TP	PCC
3	24CS601	Embedded Systems and IoT	3	0	2	4	5	50/50	TP	PCC
4		PEC-2	2	0	2	3	4	50/50	TP	PEC
5		PEC-3	2	0	2	3	4	50/50	TP	PEC
6		OEC-2	3	0	0	3	3	40/60	T	OEC
	24SD611	Technical Proficiency -1	0	0	2	1	2	100/0	P	EEC
8	24SD612	Advanced Aptitude and Coding Skills 2	0	0	2	1	2	100/0	P	EEC
9	24SD613	Corporate Communication Skills	0	0	4	2	4	100/0	P	HSMC
10	24EL611	Innovation and Product Development–4 (Patent Filing / Startup Registration)	0	0	2	1	2	100/0	EL	EEC
		Work Integrated Learning (Industrial Problem Solving-II)	Regulation 2024, Clause 4.4							AP
					TOTAL	24	33			

SEMESTER VII										
S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24CS701	Image and Video Analytics	2	0	2	3	4	50/50	TP	PCC
2		PEC-4	2	0	2	3	4	50/50	TP	PEC
3		PEC-5	2	0	2	3	4	50/50	TP	PEC
4		PEC-6	2	0	2	3	4	50/50	TP	PEC
5		OEC-3	3	0	0	3	3	40/60	T	OEC
6		OEC-4	3	0	0	3	3	40/60	T	OEC
7	24CS711	Mini Project	0	0	4	2	4	60/40	P	EEC
8	24SD711	Technical Proficiency -2	0	0	2	1	2	100/0	P	EEC
					TOTAL	21	28			

SEMESTER VIII										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24CS811	Project Work / Semester Internship	0	0	20	10	20	60/40	P	EEC
2	Personality and Character Development Activity Points (Refer Regulation 2024, Clause 4.2)									AP
3	Work Integrated Learning Activity Points (Refer Regulation 2024, Clause 4.4)									AP
						TOTAL 10	20			

Humanities, Social Science and Management Courses (12 Credits)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24HS101	Technical English	2	0	2	3	4	50/50	TP	HSMC
2	24GE102	தமிழர்மரபு / Heritage of Tamils	1	0	0	1	1	40/60	T	HSMC
3	24GE202	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	1	40/60	T	HSMC
4	24HS301	Universal Human Values	2	0	0	2	2	100/0	T	HSMC
5	24MG601	Economics, Finance & Accounting	3	0	0	3	3	40/60	T	HSMC
6	24SD613	Corporate Communication Skills	0	0	4	2	4	100/0	P	HSMC

Basic Science Courses (23 Credits)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24MA101	Matrices and Calculus	3	1	0	4	4	40/60	T	BSC
2	24PH101	Engineering Physics	3	0	2	4	5	50/50	TP	BSC
3	24CY101	Engineering Chemistry	3	0	2	4	5	50/50	TP	BSC
4	24MA202	Probability and Statistics	3	1	0	4	4	40/60	T	BSC
5	24PH205	Physics for Information Science	3	0	0	3	3	40/60	T	BSC
6	24MA302	Discrete Mathematics	3	1	0	4	4	40/60	T	BSC

Engineering Science Courses (17 Credits)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24GE101	Problem Solving using Python Programming	3	0	2	4	5	50/50	TP	ESC
2	24GE111	Engineering Practices Laboratory	0	0	4	2	4	60/40	P	ESC
3	24EE204	Basic Electrical and Electronics Engineering	3	0	0	3	3	40/60	T	ESC
4	24GE201	Computer Aided Engineering Graphics	3	0	2	4	5	50/50	TP	ESC
5	24CS302	Digital Principles and Computer Organization	3	0	2	4	5	50/50	TP	ESC

Professional Core Courses (60 Credits)										
S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24CS201	Programming in C	3	0	2	4	5	50/50	TP	PCC
2	24CS301	Data Structures	3	0	2	4	5	50/50	TP	PCC
3	24CS303	Object Oriented Programming	3	0	2	4	5	50/50	TP	PCC
4	24CS304	Database Management Systems	3	0	2	4	5	50/50	TP	PCC
5	24CS401	Theory of Computation	3	0	0	3	3	40/60	T	PCC
6	24CS402	Algorithms	3	0	2	4	5	50/50	TP	PCC
7	24CS403	Introduction to Operating Systems	3	0	2	4	5	50/50	TP	PCC
8	24CS404	Object Oriented Software Engineering	3	0	2	4	5	50/50	TP	PCC
9	24IT302	Foundations of Data Science	3	0	2	4	5	50/50	TP	PCC
10	24CS501	Computer Networks	3	0	2	4	5	50/50	TP	PCC
11	24CS502	Compiler Design	3	0	2	4	5	50/50	TP	PCC
12	24CS503	Cryptography and Cyber Security	3	0	0	3	3	40/60	T	PCC
13	24IT402	Artificial Intelligence and Machine Learning	3	0	2	4	5	50/50	TP	PCC
14	24AD505	Cloud Computing	2	0	2	3	4	50/50	TP	PCC
15	24CS601	Embedded Systems and IoT	3	0	2	4	5	50/50	TP	PCC
16	24CS701	Image and Video Analytics	2	0	2	3	4	50/50	TP	PCC

Professional Elective Courses - Vertical-1 (Data Science)										
S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24CSE01	Data Visualization	3	0	0	3	3	40/60	T	PEC
2	24ITE15	Deep Learning	3	0	0	3	3	40/60	T	PEC
3	24ITE16	Text and Speech Analytics	3	0	0	3	3	40/60	T	PEC
4	24ITE21	Exploratory Data Analysis	3	0	0	3	3	40/60	T	PEC
5	24ITE22	Recommender Systems	3	0	0	3	3	40/60	T	PEC
6	24CSE20	Business Analytics	3	0	0	3	3	40/60	T	PEC
7	24CSE02	Big Data Analytics	3	0	0	3	3	40/60	T	PEC

Professional Elective Courses - Vertical-2 (Full Stack Web Development)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA / ES**	**Course Type**	**Category**
1	24CSE03	Software Testing and Automation	3	0	0	3	3	40/60	T	PEC
2	24CSE04	DevOps	3	0	0	3	3	40/60	T	PEC
3	24CSE05	Principles of Programming Languages	3	0	0	3	3	40/60	T	PEC
4	24ITE02	App Development	3	0	0	3	3	40/60	T	PEC
5	24ITE03	Cloud Services Management	3	0	0	3	3	40/60	TP	PEC
6	24ITE04	UI and UX Design	3	0	0	3	3	40/60	TP	PEC
7	24ITE05	Web Application Security	3	0	0	3	3	40/60	T	PEC
8	24ADE05	Web Technologies	2	0	2	3	3	40/60	TP	PEC

Professional Elective Courses - Vertical-3 (Cloud Computing And Data Center)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24CSE06	Virtualization	3	0	0	3	3	40/60	T	PEC
2	24ITE03	Cloud Services Management	3	0	0	3	3	40/60	TP	PEC
3	24CSE07	Data Warehousing	3	0	0	3	3	40/60	T	PEC
4	24CSE08	Storage Technologies	3	0	0	3	3	40/60	T	PEC
5	24CSE09	Software Defined Networks and Applications	3	0	0	3	3	40/60	T	PEC
6	24CSE10	Stream Processing	3	0	0	3	3	40/60	T	PEC
7	24ITE13	Security and Privacy in Cloud	3	0	0	3	3	40/60	T	PEC

Professional Elective Courses - Vertical-4 (Cyber Security And Data Privacy)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24ITE06	Ethical Hacking	3	0	0	3	3	40/60	T	PEC
2	24ITE07	Digital and Mobile Forensics	3	0	0	3	3	40/60	T	PEC
3	24ITE08	Social Network Security	3	0	0	3	3	40/60	T	PEC
4	24ITE09	Modern Cryptography	3	0	0	3	3	40/60	T	PEC
5	24ITE10	Engineering Secure Software Systems	3	0	0	3	3	40/60	T	PEC
6	24ITE11	Cryptocurrency and Blockchain Technologies	3	0	0	3	3	40/60	T	PEC
7	24ITE12	Network Security	3	0	0	3	3	40/60	T	PEC
8	24ITE13	Security and Privacy in Cloud	3	0	0	3	3	40/60	T	PEC

Professional Elective Courses - Vertical-5 (Artificial Intelligence And Machine Learning)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24CSE18	Knowledge Engineering	3	0	0	3	3	40/60	T	PEC
2	24ADE01	Soft Computing	2	0	2	3	3	40/60	TP	PEC
3	24ITE15	Deep Learning	3	0	0	3	3	40/60	T	PEC
4	24ITE16	Text and Speech Analytics	3	0	0	3	3	40/60	T	PEC
5	24ITE17	Optimization Techniques	3	0	0	3	3	40/60	T	PEC
6	24CSE19	Game Theory	3	0	0	3	3	40/60	T	PEC
7	24ITE19	Cognitive Science	3	0	0	3	3	40/60	T	PEC
8	24ITE20	Ethics and AI	3	0	0	3	3	40/60	T	PEC

Professional Elective Courses - Vertical-6 (Emerging Technologies)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24CSE11	Game Development	3	0	0	3	3	40/60	T	PEC
2	24CSE12	FOG Computing	3	0	0	3	3	40/60	T	PEC
3	24CSE13	Robotic Process Automation	3	0	0	3	3	40/60	T	PEC
4	24CSE14	EDGE Computing	3	0	0	3	3	40/60	T	PEC
5	24CSE15	Natural Language Processing and Conversational AI	3	0	0	3	3	40/60	T	PEC
6	24CSE16	Quantum Computing	3	0	0	3	3	40/60	T	PEC
7	24CSE17	3D Printing and Design	3	0	0	3	3	40/60	T	PEC
8	24ITE11	Cryptocurrency and Blockchain Technologies	3	0	0	3	3	40/60	T	PEC

Open Elective Courses (12 Credits)										
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**C**	**Prds. /wk.**	**CA/ ES**	**Course Type**	**Category**
1	24CEO01	Environmental Science and Sustainability	3	0	0	3	3	40/60	T	OEC
2	24CEO02	Green Building Design	3	0	0	3	3	40/60	T	OEC
3	24CEO03	Municipal Solid Waste Management	3	0	0	3	3	40/60	T	OEC
4	24CEO04	Sustainable Infrastructure	3	0	0	3	3	40/60	T	OEC
5	24CEO05	Disaster Management	3	0	0	3	3	40/60	T	OEC
6	24CEO06	Geographical Information System	3	0	0	3	3	40/60	T	OEC
7	24CEO07	Environment and Agriculture	3	0	0	3	3	40/60	T	OEC
8	24CEO08	Earthquake Engineering	3	0	0	3	3	40/60	T	OEC

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA / ES	Course Type	Category
9	24EEO01	Electrical Safety	3	0	0	3	3	40/60	T	OEC
10	24EEO02	Introduction to E-Vehicle	3	0	0	3	3	40/60	T	OEC
11	24EEO03	Hybrid Energy Technology	3	0	0	3	3	40/60	T	OEC
12	24EEO04	Solar Photo voltaic System	3	0	0	3	3	40/60	T	OEC
13	24EEO05	Energy Forecasting, Modeling, and Project Management	3	0	0	3	3	40/60	T	OEC
14	24EEO06	Energy Efficient Buildings Design	3	0	0	3	3	40/60	T	OEC
15	24EEO07	Government Rules, Opportunities, Testing, and Certification of Electric Vehicles	3	0	0	3	3	40/60	T	OEC
16	24EEO08	PLC and Automation	3	0	0	3	3	40/60	T	OEC
17	24ECO01	Micro Sensors and Nano Sensors	3	0	0	3	3	40/60	T	OEC
18	24ECO02	Fundamentals of VLSI	3	0	0	3	3	40/60	T	OEC
19	24ECO03	Mass Communication	3	0	0	3	3	40/60	T	OEC
20	24ECO04	Sensor Technologies	3	0	0	3	3	40/60	T	OEC
21	24ECO05	Nanomaterials and Devices	3	0	0	3	3	40/60	T	OEC
22	24ECO06	Machine Learning for Electronics	3	0	0	3	3	40/60	T	OEC
23	24ECO07	Wireless and Mobile Communication	3	0	0	3	3	40/60	T	OEC
24	24ECO08	IOT AND ITS APPLICATIONS	3	0	0	3	3	40/60	T	OEC
25	24MEO01	Introduction to MEMS and NEMS	3	0	0	3	3	40/60	T	OEC
26	24MEO02	Energy Conservation and Management	3	0	0	3	3	40/60	T	OEC
27	24MEO03	Fundamentals of Additive Manufacturing	3	0	0	3	3	40/60	T	OEC
28	24MEO04	Lean Six Sigma	3	0	0	3	3	40/60	T	OEC
29	24MEO05	Agriculture Technology	3	0	0	3	3	40/60	T	OEC
30	24MHO01	Robots and systems in smart Manufacturing	3	0	0	3	3	40/60	T	OEC
31	24MHO02	Robotics and Automation	3	0	0	3	3	40/60	T	OEC
32	24MHO03	Autonomous Mobile Robots	3	0	0	3	3	40/60	T	OEC
33	24MHO04	Introduction to Drone Technologies	3	0	0	3	3	40/60	T	OEC
34	24MHO05	Medical Mechatronics	3	0	0	3	3	40/60	T	OEC
35	24MHO06	Sensors and Actuators	3	0	0	3	3	40/60	T	OEC
36	24MHO07	Micro Electro Mechanical System(MEMS)	3	0	0	3	3	40/60	T	OEC
37	24MHO08	Industry 4.0	3	0	0	3	3	40/60	T	OEC
38	24BMO01	Fundamentals of Radiological Equipments	3	0	0	3	3	40/60	T	OEC
39	24BMO02	Biomedical Instrumentation Basics	3	0	0	3	3	40/60	T	OEC

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA / ES	Course Type	Category
40	24BMO03	Medical Robotics	3	0	0	3	3	40/60	T	OEC
41	24BMO04	Principles of Telemedicine	3	0	0	3	3	40/60	T	OEC
42	24BMO05	Hospital Management	3	0	0	3	3	40/60	T	OEC
43	24BMO06	Bio MEMS and Applications	3	0	0	3	3	40/60	T	OEC
44	24BMO07	Fundamentals of Brain Computer Interface	3	0	0	3	3	40/60	T	OEC
45	24BMO08	Principles of Rehabilitation Engineering	3	0	0	3	3	40/60	T	OEC
46	24CHO01	Industrial pollution prevention and control	3	0	0	3	3	40/60	T	OEC
47	24CHO02	Petroleum Technology	3	0	0	3	3	40/60	T	OEC
48	24CHO03	Green Chemistry and Engineering	3	0	0	3	3	40/60	T	OEC
49	24CHO04	Bio-Energy Technology	3	0	0	3	3	40/60	T	OEC
50	24CHO05	Carbon capture utilization and storage	3	0	0	3	3	40/60	T	OEC
51	24CHO06	Battery Technology	3	0	0	3	3	40/60	T	OEC
52	24CHO07	Energy Management	3	0	0	3	3	40/60	T	OEC
53	24CHO08	Environmental Auditing	3	0	0	3	3	40/60	T	OEC
54	24ITO01	Introductions to Full Stack Web Development	3	0	0	3	3	40/60	T	OEC
55	24ITO02	Introduction to Digital Marketing	3	0	0	3	3	40/60	T	OEC
56	24ITO03	Social Media Marketing	3	0	0	3	3	40/60	T	OEC
57	24ITO04	Introduction to Ethical Hacking	3	0	0	3	3	40/60	T	OEC
58	24ITO05	Information Storage Management	3	0	0	3	3	40/60	T	OEC
59	24ITO06	Introduction to Cyber Security	3	0	0	3	3	40/60	T	OEC
60	24ITO07	Software Testing Essentials	3	0	0	3	3	40/60	T	OEC
61	24ITO08	Introduction to UI and UX Design	3	0	0	3	3	40/60	T	OEC
62	24ADO01	Introduction to Machine Learning	3	0	0	3	3	40/60	T	OEC
63	24ADO02	Introduction to Artificial Intelligence	3	0	0	3	3	40/60	T	OEC
64	24ADO03	Introduction to Big Data Analytics	3	0	0	3	3	40/60	T	OEC
65	24ADO04	Basics of Data Science	3	0	0	3	3	40/60	T	OEC
66	24ADO05	R Programming	3	0	0	3	3	40/60	T	OEC
67	24ADO06	Fundamentals of Deep Learning	3	0	0	3	3	40/60	T	OEC
68	24ADO07	AI in Healthcare Applications	3	0	0	3	3	40/60	T	OEC

Open Elective Courses (TO BE OFFERED TO OTHER DEPARTMENTS)

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24CSO01	Introduction to Algorithms	3	0	0	3	3	40/60	T	OEC
2	24CSO02	Fundamentals of Software Engineering	3	0	0	3	3	40/60	T	OEC
3	24CSO03	Introduction to Cloud Computing	3	0	0	3	3	40/60	T	OEC
4	24CSO04	Principles of Blockchain Technology	3	0	0	3	3	40/60	T	OEC
5	24CSO05	Machine Learning Using Python for Beginners	3	0	0	3	3	40/60	T	OEC
6	24CSO06	Multimedia and Computer Graphics	3	0	0	3	3	40/60	T	OEC
7	24CSO07	Introduction to App Development	3	0	0	3	3	40/60	T	OEC
8	24CSO08	Data Analytics	3	0	0	3	3	40/60	T	OEC

Employability Enhancement Courses (22 Credits)

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24SD311	Aptitude and Coding Skills -1	0	0	2	1	2	100/0	P	EEC
2	24EL311	Innovation and Product Development -1 (Idea Generation)	0	0	2	1	1	100/0	EL	EEC
3	24SD411	Aptitude and Coding Skills -2	0	0	2	1	2	100/0	P	EEC
4	24EL411	Innovation and Product Development -2 (Conceptualization)	0	0	2	1	2	100/0	EL	EEC
5	24SD511	Advanced Aptitude and Coding Skills 1	0	0	2	1	2	100/0	P	EEC
6	24EL511	Innovation and Product Development-3 (Prototype Development and Testing)	0	0	2	1	2	100/0	EL	EEC
7	24SD611	Technical Proficiency -1	0	0	2	1	2	100/0	P	EEC
8	24SD612	Advanced Aptitude and Coding Skills 2	0	0	2	1	2	100/0	P	EEC
9	24EL611	Innovation and Product Development–4 (Patent Filing / Startup Registration)	0	0	2	1	2	100/0	EL	EEC
10	24CS711	Mini Project	0	0	4	2	4	60/40	P	EEC
11	24SD711	Technical Proficiency -2	0	0	2	1	2	100/0	P	EEC
12	24CS811	Project Work / Semester Internship	0	0	20	10	20	60/40	P	EEC

MANDATORY COURSES –1 & 2

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24MC111	Induction Program	3 Weeks						MC	MC
2	24MC201	Environmental Science	2	0	0	0	2	100/0	MC	MC

MANDATORY COURSES – 3

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24MC301	Introduction to Women and Gender Studies	2	0	0	0	2	100/0	MC	MC

2	24MC302	Elements of Literature	2	0	0	0	2	100/0	MC	MC
3	24MC303	Film Appreciation	2	0	0	0	2	100/0	MC	MC
4	24MC304	Well, Being with Traditional Practices Yoga, Ayurveda and Siddha	2	0	0	0	2	100/0	MC	MC
5	24MC305	History of Science and Technology in India	2	0	0	0	2	100/0	MC	MC
6	24MC306	Political and Economic Thought for a Humane Society	2	0	0	0	2	100/0	MC	MC
7	24MC307	Indian Constitution	2	0	0	0	2	100/0	MC	MC
8	24MC308	Bureau of Indian Standards (BIS)	2	0	0	0	2	100/0	MC	MC
9	24MC309	Disaster Management and Preparedness	2	0	0	0	2	100/0	MC	MC

MANDATORY COURSES - 4

S.No.	Course Code	Course	L	T	P	C	Prds. /wk.	CA/ ES	Course Type	Category
1	24MC401	Japanese Language	2	0	0	0	2	100/0	MC	MC
2	24MC402	German Language	2	0	0	0	2	100/0	MC	MC
3	24MC403	Korean Language	2	0	0	0	2	100/0	MC	MC
4	24MC404	French Language	2	0	0	0	2	100/0	MC	MC
5	24MC405	Hindi Language	2	0	0	0	2	100/0	MC	MC
6	24MC406	Industrial Safety	2	0	0	0	2	100/0	MC	MC
7	24MC408	State, Nation Building and Politics in India	2	0	0	0	2	100/0	MC	MC

B.E-COMPUTER SCIENCE AND ENGINEERING

CURRICULUM AND SYLLABI (Regulation 2024)

SEMESTERWISE CREDITS DISTRIBUTION									
Category	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Credits**
HSMC	4	1	2			5			12
BSC	12	7	4						23
ESC	6	7	4						17
PCC		4	12	19	15	7	3		60
PEC					3	6	9		18
OEC					3	3	6		12
EEC			2	2	2	3	3	10	22
MC									
Total	**22**	**19**	**24**	**21**	**23**	**24**	**21**	**10**	**164**

Semester I

Course Code	24HS101	**Course Name**	TECHNICAL ENGLISH	**Course Category**	TP	Humanities and Management Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	NIL	**Progressive Courses**	NIL
Course Offering Department	Science & Humanities	**Data Book / Codes Standards**	NIL		

Course Objective: ***The purpose of learning this course is :***

- To improve the communicative competence of learners
- To learn to use basic grammatical structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Employ grammar and terminology appropriate for everyday situations.	U								2	2	3		2			
CO-2:	Understand the subtleties within both spoken and written interactions..	U								3	2	3		2			
CO-3:	Utilize vivid and analytical vocabulary, expressions, and sentence arrangements.	R								2	2	3		2			
CO-4:	Read various forms of writings and grasp both their literal and suggested interpretations.	E								2	2	3		2			
CO-5:	Compose various kinds of writings employing suitable structures.	AP								2	2	3		2			

Unit-1	**BASICS OF COMMUNICATION**	**6 Periods**
Grammar – Simple present tense, Present continuous tense, Asking questions (wh-questions); Vocabulary – One word substitutions, Synonyms		
Unit-2	**NARRATION**	**6 Periods**
Grammar – Subject – verb agreement, Simple past, Past continuous Tenses; Vocabulary – Antonyms, Word formation (Prefix and Suffix).Writing – Narrative (Event- Festivals, Birthday, personal experience		
Unit-3	**DESCRIPTION**	**6 Periods**
Writing – Definitions, Descriptive writing, Checklists; Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Adjectives and Adverbs		
Unit-4	**CLASSIFICATION**	**6 Periods**
Writing – Note making, Note taking; Grammar – Connectives, Transition words(linkers); Vocabulary – Contextual vocabulary, Words used both as noun and verb, Classification related words.		
Unit-5	**EXPRESSION OF VIEWS**	**6 Periods**
Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Question tags, Indirect questions, Yes / No questions; Vocabulary – Compound words, Phrasal verbs.		
		Total Theory: 30 Periods

List of Experiments	Total Practical: 30 Periods
1. Listening – Telephone conversation & Writing message, gap filling 2. Reading – Telephone message, bio-note; Writing – Personal profile 3. Listening – Travel podcast / Watching a travel documentary 4. Reading – An excerpt from a travelogue, Newspaper Report 5. Writing – Narrative (Event- Festivals, Birthday, personal experience- Excursion, Sports, Conference, etc 6. Listening – Conversation, Radio/TV advertisement, Commentary 7. Reading – A tourist brochure and planning an itinerary, descriptive article / excerpt from literature 8. Listening – Announcements and filling a table, Catalogue, List of Equipments 9. Reading – An article, social media posts and classifying (channel conversion – text to table 10. Listening – Debate / Discussion; Reading – Formal letters, Letters to Editor, Opinion articles / Blogs	

	Text Books	References
Learning Resources	1.Using English: A Course book for Undergraduate Engineers and Technologists. Orient Blackswan Limited, Hyderabad: 2015. 2.Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai, 2011.	1.Anderson, Paul V. Technical Communication: A Reader–Centered Approach. Cengage, New Delhi, 2008. 2.Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford, 2007. 3.Technical English I Course material of Agni College of Technology.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24MA101	Course Name	MATRICES AND CALCULUS	Course Category	T	Basic Science Courses	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Basic knowledge about Calculus And Ordinary Differential Equations	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Science and Humanities	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is:***

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Use the matrix algebra methods for solving practical problems.	U	3	2	2	2								2			
CO-2:	Use differential calculus ideas on several variable functions.	R	3	2	2	2								2			
CO-3:	Apply different methods of integration in solving practical problems by using Beta and Gamma functions.	AP	3	2	2	2								2			
CO-4:	Apply multiple integral ideas in solving areas and volumes problems.	AP	3	2	2	2								2			
CO-5:	Apply the concept of vectors in solving practical problems.	AN	3	2	2	2								2			

Unit-1 **MATRICES**	***12 Periods***
Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues - Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.	
Unit-2 **FUNCTIONS OF SEVERAL VARIABLES**	***12 Periods***
Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions - Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undetermined multipliers.	
Unit-3 **INTEGRAL CALCULUS**	***12 Periods***
Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of integrals by using Beta and Gamma functions – Error functions.	
Unit-4 **MULTIPLE INTEGRALS**	***12 Periods***
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals	
Unit-5 **VECTOR CALCULUS**	***12 Periods***
Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems – Verification and applications in evaluating line, surface and volume integrals	
Total:	**60 Periods**

	Text Books	References
Learning Resources	1.Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018. 2.Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi, 2013 3.Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009. 4.Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010	1.Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015. 2.Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education 2nd Edition, 5th Reprint, Delhi, 2009. 3.Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5 th Edition, New Delhi, 2017.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24PH101	Course Name	ENGINEERING PHYSICS	Course Category	TP	Basic Science Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil.	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Science & Humanities	**Data Book / Codes Standards**			

Course Objective: ***The purpose of learning this course is to:***

- Make the students effectively to achieve an understanding of mechanical properties of materials.
- Enable the students to gain knowledge of oscillations, sounds and applications of thermal physics.
- Introduce the basics of optics and lasers and its applications.
- Equipping the students to be successfully understand the importance of quantum physics
- Become proficient in crystal physics.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the important mechanical properties of materials.	U	3	2	2		2				1			2			
CO-2:	Express the knowledge of oscillations, sound and applications of Thermal Physics.	AN	3	2	2		2				1			2			
CO-3:	Know the basics of optics and lasers and its applications.	AP	3	2	2		2				1			2			
CO-4:	Understand the basics and importance of quantum physics.	U	3	2		2								2			
CO-5:	Understand the significance of crystal physics.	U	3	2			2							2			

Unit-1 MECHANICS OF MATERIALS **9 Periods**

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio -stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension

Unit-2 OSCILLATIONS, SOUND AND THERMAL PHYSICS **9 Periods**

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber –Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion– Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

Unit-3 OPTICS AND LASERS **9 Periods**

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals - Polarization -polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO2 laser, Semiconductor laser -Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers

Unit-4 - QUANTUM MECHANICS **9 Periods**

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (timeindependent and time-dependent) – Meaning and Physical significance of wave function - Normalization -Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope

Unit-5 CRYSTAL PHYSICS	9 Periods
Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems -unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures – crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.	
	Total Theory: 45 Periods

List of Experiments **Total Practical: 30 Periods**

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Non-uniform bending - Determination of Young's modulus
3. Uniform bending – Determination of Young's modulus
4. Simple harmonic oscillations of cantilever.
5. Laser- Determination of the wavelength of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. Optical fibre -Determination of Numerical Aperture and acceptance angle
8. Compact disc- Determination of width of the groove using laser.
9. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
10. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
11. Post office box -Determination of Band gap of a semiconductor.
12. Photoelectric effect
13. Michelson Interferometer.
14. Melde's string experiment
15. Experiment with lattice dynamics kit.

	Text Books	References
Learning Resources	1.Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013. 2.D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 2011. 3.N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer Verlag, 2012. 4.Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.	1.R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016. 2.D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017. 3.K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications. Springer, 2012

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CY101	Course Name	ENGINEERING CHEMISTRY	Course Category	TP	Basic Science Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Science & Humanities	**Data Book / Codes Standards**	NIL		

Course Objective: ***The purpose of learning this course is :***

- To inculcate knowledge on different types of polymers, their properties and preparation techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To facilitate the understanding of different types of corrosion and its control methods.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.
- To inculcate sound understanding of water quality parameters and water treatment techniques.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand and apply basic knowledge on different types of polymeric materials, their properties and various techniques of their fabrication.	U	3	2	1		2			1				2			
CO-2:	Identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technological applications.	AP	3	3	3		3							2			
CO-3:	Proficiently identify corrosion mechanisms, select control methods, and apply protective coatings.	AP	3	3	2	2		2			1			1			
CO-4:	Analyze and compare energy sources, discerning characteristics and applications.	AN	3	2	2		3					1					
CO-5:	Develop competence in assessing water quality, applying treatment methods, and implementing conditioning techniques.	AP	3	2	2		1		3	2	1			2			

Unit-1	**POLYMER CHEMISTRY**	**9 Periods**
Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index .Techniques of polymerization: Bulk, emulsion, solution and suspension.		
Unit-2	**NANOCHEMISTRY**	**9 Periods**
Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, chemical vapour deposition and electrospinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials - medicine, agriculture, electronics and catalysis.		
Unit-3	**CORROSION AND ITS CONTROL**	**9 Periods**
Introduction to corrosion - chemical and electrochemical corrosions-mechanism of electrochemical and galvanic corrosions-differential aeration corrosion-pitting, water line corrosions, factors influencing corrosion. Corrosion control-material selection and design- - sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions		

Unit-4 ENERGY SOURCES	9 Periods
Batteries - Characteristics - types of batteries – primary battery (dry cell), secondary battery (lead acid, lithium-ion-battery)- emerging batteries – nickel-metal hydride battery, aluminum air battery, batteries for automobiles and satellites - Fuel cells (Types) – H2-O2 fuel cell - Supercapacitors-Types and Applications, Renewable Energy:Solar- solar cells, DSSC	
Unit-5 WATER TECHNOLOGY	**9 Periods**
Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD and heavy metals. Boiler feed water – requirement –troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning - demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration and disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis.	
	Total Theory: 45 Periods

List of Experiments	Total Practical: 30 Periods

1. Estimation of HCl using Na2CO3 as primary standards
2. Determination of alkalinity in water sample.
3. Determination of hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method
5. Determination of chloride content of water sample by Argentometric method.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10- Phenanthroline/thiocyanate method).
10. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer
11. Determination of strength of an acid using conductivity meter.
12. Estimation of nickel content of the given solution by EDTA method

	Text Books	References
Learning Resources	1.Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi,2015. 2.Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi,2012. 3.Dara S.S., "A Textbook of Engineering Chemistry", Chand Publications, 2004.	1.Sachdeva M.V., "Basics of Nano Chemistry", Anmol Publications Pvt Ltd, 2011. 2. Friedrich Emich, "Engineering Chemistry", Medtech, 2014. 3.Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science" New AGE International Publishers, 2009.

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24GE101	Course Name	PROBLEM SOLVING USING PYTHON PROGRAMMING	Course Category	TP	Engineering Science Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the basics of algorithmic problem solving.
- Learn to solve problems using Python conditionals and loops
- Define Python functions and use function calls to solve problems
- Use Python data structures – lists, tuples, and dictionaries to represent complex data.
- Perform input/output operations with files in Python

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Develop algorithmic solutions to simple computational problems	AP	3	2	2	2	3								2	3	2
CO-2:	Develop and execute simple Python programs	AP	3	2	2	2	3								2	3	2
CO-3:	Develop Python programs using conditionals and loops for solving problems and decompose a Python program into functions.	AN	3	2	2	2	3								2	3	2
CO-4:	Represent compound data using Python lists, tuples, dictionaries etc.	AP	3	2	2	2	3								2	3	2
CO-5:	Read and write data from/to files in Python programs	AP	3	2	2	2	3								2	3	2

Unit-1 COMPUTATIONAL THINKING AND PROBLEM SOLVING **9 Periods**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

Unit-2 DATA TYPES, EXPRESSIONS, STATEMENTS **9 Periods**

Python interpreter and interactive mode,debugging; values and types: int, float, boolean, string , and list; variables, expressions, statements, tuple assignment, precedence of operators, comments.

Unit-3 CONTROL FLOW, FUNCTIONS, STRINGS **9 Periods**

Conditionals:Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays.

Unit-4 LISTS, TUPLES, DICTIONARIES **9 Periods**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension.

Unit-5 FILES, MODULES, PACKAGES **9 Periods**

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages;

Total Theory: 45 Periods

Suggested List of Experiments	Total Practical: 30 Periods

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
2. Python programming using simple statements and expressions.
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
8. Implementing programs using written modules and Python Standard Libraries
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
11. Exploring Pygame tool.
12. Developing a game activity using Pygame.

	Text Books	References
Learning Resources	1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016. 2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017	1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021. 2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021. 3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021 4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019. 5. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24GE102	Course Name	தமிழர்மரபு /HERITAGE OF TAMILS	Course Category	T	Humanities and Management Courses	L	T	P	C
							1	0	0	1

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Explore the history, significance, and classical status of the Tamil language and analyze the timeless management principles found in Thiruvalluvar's Thirukural.
- Learn about the development of Tamil art and sculpture over time, including temple arts, traditional crafts, and musical instruments.
- Familiarize the students with various Tamil folk dances, performances, and martial arts, and their significance in Tamil culture.
- Get the ancient Tamil way of classifying landscapes and life, their connection to nature, and the trade and conquests of the Chola dynasty.
- Explore the role of Tamils in India's freedom movement, their cultural influence across India, the Self-Respect Movement, and contributions to traditional medicine and literature.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Gain comprehensive knowledge about the linguistic diversity in India and the Dravidian language family and appreciate the classical status of Tamil and its rich literary heritage.	U															
CO-2:	Students will learn about the development of Tamil art and sculpture over time, including temple arts, traditional crafts, and musical instruments.	U															
CO-3:	Students will become familiar with various Tamil folk dances, performances, and martial arts, and their significance in Tamil culture.	U															
CO-4:	Students will understand the ancient Tamil way of classifying landscapes and life, their connection to nature, and the trade and conquests of the Chola dynasty.	U															
CO-5:	Students will learn about the role of Tamils in India's freedom movement, their cultural influence across India, the Self-Respect Movement, and contributions to traditional medicine and literature.	U															

Unit-1 **LANGUAGE AND LITERATURE** ***3 Periods***

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

Unit-2 **HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE** ***3 Periods***

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

Unit-3 **FOLK AND MARTIAL ARTS** ***3 Periods***

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

Unit-4 **THINAI CONCEPT OF TAMILS** ***3 Periods***

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age -

Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.	
Unit-5 **CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	***3 Periods***
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.	
	Total: 15 Periods

	Text Books	References
Learning Resources	1.தமிழக வரலொறு - மக்களும் பண்பொடும் - மக.மக. பிள்மள (தவளியீடு: தமிழ்நொடு பொடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்). 2.கணினித் தமிழ் - முமனவர் இல. சுந்தரம். (விகடன் பிரசுரம்). கீழடி - மவமக நதிக்கமரயில் ெ◌ங்ககொல நகர நொகரிகம் (ததொல்லியல் துமற தவளியீடு) தபொருமந - ஆற்றங்கமர நொகரிகம். (ததொல்லியல் துமற தவளியீடு) 3.Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print) 4.Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.	1.Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies). 2. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.) 3.Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu) 4. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author) 5. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu) 6. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24GE111	Course Name	ENGINEERING PRACTICES LABORATORY	Course Category	P	Engineering Science Courses	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes /Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To identify tools, work material and measuring instruments useful for welding, Machining, Plumbing and carpentry
- To provide exposure to the students with hands on experience on various wiring system
- To provide exposure to the students with hands on experience on various Electronic Components

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the concepts of welding safety protocols, equipment operation essential for successful welding practices in engineering applications.	U	3	2				1	1					2			
CO-2:	Make simple metal joints using welding equipment and wooden joints using carpentry tools	AP	3	2				1	1					2			
CO-3:	Apply the knowledge of pipeline connections to household fittings.	AP	3	2				1	1					2			
CO-4:	Demonstration on centrifugal pump and air conditioning working principles	U	3	2				1	1					2			
CO-5:	Apply the skills of basic electrical engineering for house wiring practice	AP	3	2				1	1					2			

List of Experiments **60 Periods**

1. PLUMBING WORK:
   a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
   b) Preparing plumbing line sketches.
   c) Laying pipe connection to the suction & delivery side of a pump
   d) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.
2. WOOD WORK:
   a) Sawing, b) Planing and c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.
3. Wood Work Study:
   a) Studying joints in door panels and wooden furniture b) Studying common industrial trusses using models.
4. WELDING WORK:
   a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. b) Practicing gas welding
5. BASIC MACHINING WORK:
   a) (simple)Turning. b) (simple)Drilling. c) (simple)Tapping.
6. ASSEMBLY WORK:
   a) Assembling a centrifugal pump. b) Assembling an air conditioner

7. SHEET METAL WORK:
    a) Making of a square tray
8. FOUNDRY WORK:
    a) Demonstrating basic foundry operations.
9. ELECTRICAL ENGINEERING PRACTICES
    a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
    b) Staircase wiring
    c) Fluorescent Lamp wiring with introduction to CFL and LED types.
    d) Energy meter wiring and related calculations/ calibration
    e) Study of Iron Box wiring and assembly
    f) Study of Fan Regulator (Resistor type and Electronic type using DIAC/TRIAC/QUADRAC)
    g) Study of emergency lamp wiring/Water heater
10. ELECTRONIC ENGINEERING PRACTICES- SOLDERING WORK:
    a) Soldering simple electronic circuits and checking continuity.
11. ELECTRONIC ASSEMBLY AND TESTING WORK:
    a) Assembling and testing electronic components on a small PCB.
12. ELECTRONIC EQUIPMENT STUDY:
    a) Study elements of smart phone.
    b) Assembly and dismantle of LED TV.
    c) Assembly and dismantle of computer/ laptop

Learning Assessment		
Continuous Learning Assessment (CLA) (60% weightage)		**End Semester Examination (40% weightage)**
Evaluation of Laboratory Observation, Record (45%)	**Model Lab Exam (15%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Semester II

Course Code	24MA202	Course Name	PROBABILITY AND STATISTICS	Course Category	T	Basic Science Courses	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Science and Humanities	**Data Book / Codes / Standards**	STATISTICAL TABLE		

Course Objective: ***The purpose of learning this course is:***

- This course aims at providing the required skill to apply the statistical tools in engineering problems
- To introduce the basic concepts of probability and random variables
- To introduce the basic concepts of two dimensional random variables
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon	R	3	2													
CO-2:	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications	AP	3	3			1										
CO-3:	Apply the concept of testing of hypothesis for small and large samples in real life problems	AN	3	3													
CO-4:	Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control	U	3	3	2						2						
CO-5:	Have the notion of sampling distributions and statistical techniques used in engineering and management problems	E	3	3									2				

Unit-1 **PROBABILITY AND RANDOM VARIABLES** ***12 Periods***

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

Unit-2 **TWO-DIMENSIONAL RANDOM VARIABLES** ***12 Periods***

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

Unit-3 **ESTIMATION THEORY** ***12 Periods***

Unbiased estimators - Efficiency - Consistency - Sufficiency -Robustness - Method of moments - Method of maximum Likelihood - Interval estimation of Means -Differences between means, variations and ratio of two variances.

Unit-4 **NON-PARAMETRIC TESTS** ***12 Periods***

Introduction-The Sign test –The Signed-Rank test-Rank –sum tests-The U test-The H test-Tests based on Runs-Test of randomness-The Kolmogorov Tests.

Unit-5	STATISTICAL QUALITY CONTROL	12 Periods
Control charts for measurements ($\bar{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits-Acceptance sampling.		
	Total:	60 Periods

	Text Books	References
Learning Resources	1. Johnson. R.A., Miller. I.Rand Freund . J.E, " Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia,9th Edition, 2016. 2.Milton. J. S. and Arnold.J.C., "Introduction to Probability and Statistics", Tata Mc GrawHill, 4th Edition, 2007. 3.JohnE.Freund,"MathematicalStatistics",PrenticeHall,5thEdition,1992 4.Walpole.R.E., Myers.R.H., Myers.S.L. and Ye.K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9thEdition, 2010.	1.Gupta. S.C. and Kapoor. V. K., “Fundamentals of Mathematical Statistics”, Sultan Chand &Sons, New Delhi, 12th Edition, 2020. 2.Devore. J.L., "Probability and Statistics for Engineering and the Sciences”,CengageLearning, New Delhi, 8th Edition, 2014. 3.Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5thEdition, Elsevier, 2014. 4.Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS201	Course Name	PROGRAMMING IN C	Course Category	TP	Professional Core Course	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the constructs of C Language and basic C programming
- Develop C programs using arrays and strings
- Develop modular applications in C using functions and pointers
- Develop applications in C using structures and unions
- Perform input/output operations and file handling in C

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Develop simple applications in C using basic knowledge on C Programming constructs	AP	3	2	2	2	3								2	3	2
CO-2:	Design and implement applications using arrays and strings	AP	3	2	2	2	3								2	3	2
CO-3:	Develop and implement modular applications in C using functions and pointers	AN	3	2	2	2	3								2	3	2
CO-4:	Develop applications in C using structures and union	AP	3	2	2	2	3								2	3	2
CO-5:	Design applications using sequential and random access file processing.	AP	3	2	2	2	3								2	3	2

Unit-1 BASICS OF C PROGRAMMING **9 Periods**

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process

Unit-2 ARRAYS AND STRINGS **9 Periods**

Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays - String operations: length, compare, concatenate, copy – Selection sort, linear and binary search

Unit-3 FUNCTIONS AND POINTERS **9 Periods**

Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion, Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value, Pass by reference

Unit-4 STRUCTURES AND UNION **9 Periods**

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility

Unit-5 FILE PROCESSING **9 Periods**

Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file - Command line arguments

Total Theory: 45 Periods

Suggested List of Experiments	Total Practical: 30 Periods
1. I/O statements, operators, expressions 2. Decision-making constructs: if-else, goto, switch-case, break-continue 3. Loops: for, while, do-while 4. Arrays: 1D and 2D, Multi-dimensional arrays, traversal 5. Strings: operations 6. Functions: call, return, passing parameters by (value, reference), passing arrays to function. 7. Recursion 8. Pointers: Pointers to functions, Arrays,Strings, Pointers to Pointers, Array of Pointers 9. Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions. 10. Files: reading and writing, File pointers, file operations, random access, processor directives.	

	Text Books	References
Learning Resources	1. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016. 2. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.	1. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018. 2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020. 3. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996. 4. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013. 5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24PH205	Course Name	PHYSICS FOR INFORMATION SCIENCE	Course Category	T	Basic Science Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to :***

- Gain knowledge on the electrical properties of materials.
- Explore the principles of semiconductor and Display Devices
- Make use of magnetic and optical data storage Devices.
- Implement the essential principles of digital electronics for communication.
- Understand the basics of quantum structures and their applications and basics of quantum computing

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand and apply the electrical properties of materials	U	3	2	2	1	2							2			
CO-2:	Understand and analysis the principles of semiconductor and Display Devices	U	3	2	2	2	2							2			
CO-3:	Make use of magnetic and optical data storage Devices.	AP	3	2	2	2	2							2			
CO-4:	Implement the essential principles of digital electronics for communication	AP	3	2	2	2	2				1	1		2			
CO-5:	Understand the basics of quantum structures and their applications and basics of quantum computing	U	3	2	2	2	2				1	1		2			

Unit-1 **ELECTRON THEORY OF MATERIALS** ***9 Periods***

Classical and quantum free electron theory of metals – merits and demerits -Fermi - Dirac statistics – density of states: electron concentration and Fermi Level - band theory of solids: energy band formation – electron effective mass - Intrinsic semiconductors energy band -diagram - direct and indirect band gap semiconductors - carrier concentrations and conductivity - extrinsic semiconductors: n and p-type doping, compensation doping-temperature dependence of conductivity-degenerate and nondegenerate semiconductors

Unit-2 **SEMICONDUCTORS AND DISPLAY DEVICES** ***9 Periods***

Hall effect and devices - Ohmic contacts – Peltier Coolers – Schottky diode - optical absorption and solar cell - Photoluminescence, cathodoluminescence, electroluminescence, injection luminescence – Phosphors – LED construction and working – White LED ' s – organic LEDs – principles of quantum well laser – liquid crystals and LCD construction and working–numeric displays.

Unit-3 **MAGNETIC/OPTICAL DATA STORAGE TECHNIQUES** ***9 Periods***

Introduction – magnetic material parameters –Ferromagnetic materials – Ferrites - Soft and Hard magnetic materials – GMR sensors - magnetic disk memories – Principle of magnetic recording – Materials for magnetic data storage - Optical data storage – Phase change recording – magnetooptical data storage – Hi-tech involved in system development – capacity of CD in normal use – advantages of CD –DVD – Blu-ray DVD - holographic storage – construction of a hologram – reconstruction of a hologram – photorefractive storage.

Unit-4 **DIGITAL ELECTRONICS** ***9 Periods***

Analog and digital signals - Digital circuits - Binary number system - conversion of Binary to decimal - decimal to binary - logic gates - OR gate - AND gate - NOT gate - Combination of Logic gates - NAND and NOR as universal building blocks. Boolean algebra and theorems: sum of products, products of sums expression, simplification by Karnaugh Map method, simplification based on basic Boolean theorems - don't care conditions.

Unit-5	**NANODEVICES AND QUANTUM COMPUTING**	***9 Periods***
Introduction - quantum confinement – quantum structures: quantum wells, wires and dots – band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade - single electron transistor - resonant-tunneling diode – quantum cellular automata - Quantum system for information processing - quantum states – classical bits – quantum bits or qubits –CNOT gate - multiple qubits – Bloch sphere – quantum gates – advantage of quantum computing over classical computing.		
	Total:	**45 Periods**

	Text Books	**References**
Learning Resources	1.S.O.Kasap. Principles of Electronic Materials and Devices. McGraw Hill Education, 2017. 2.Garcia, A. Damask and S.Schwarz. Physics for Computer Science Students. Springer -Verlag, 2012. 3.Principles of Electronics - V.K. Mehta - S.Chan Publication, New Delhi 4.Electronic devices and circuits - G.J.Mithal, Khana publishers, New Delhi 5.Basic Electronics - B.L. Theraja - S.Chan publication, New Delhi	1.Jasprit Singh, Optoelectronics: An Introduction to Materials and Devices, McGraw Hill, 1998. 2.Wilson, Jand Hawkes, J.F.B, Optoelectronics, Prentice Hall, 2002 3.Bhattacharya,B., Semiconductor optoelectronic devices, Prentice Hall of India,1995. 4.Kittel, C., Introduction to Solid State Physics, JohnWiley,1996 5.Kasap,S.O. Principles of Electronic Materials and Devices, Tata McGraw-Hill,2007.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24EE204	Course Name	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	Course Category	T	Engineering Science Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Electrical And Electronics Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the principles of DC and AC circuits, including circuit components, Ohm's Law, Kirchhoff's Laws, and analysis techniques such as nodal and mesh analysis
- Learn about the construction, working principles, and applications of various electrical machines, including generators, motors, transformers, and special machines
- Comprehend semiconductor materials and electronic devices such as diodes, transistors, SCR, and MOSFET, along with their characteristics, biasing, and applications in communication engineering
- Review and understand the fundamentals of digital electronics, including number systems, binary codes, logic functions, and minimization techniques using Karnaugh maps
- Gain knowledge of measurement principles and instrumentation techniques, including instrument components, standards, calibration, and various types of meters and instruments used in electrical engineering

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyse the electric circuit parameters for solving engineering problems. Also understand basic electrical safety concepts.	AP	3	2	1	-	-	3	-		-	-	2	2			
CO-2:	Explain the working principle and applications of AC/DC machines	U	2	2	1	-	-	-	-	1	-	-	2	2			
CO-3:	Analyse the characteristics of analog electronic devices to develop projects in multidisciplinary environment.	AN	2	1	1	-	-	-	-	1	-	-	2	2			
CO-4:	Explain the basic concepts of digital electronics and analyse complex engineering problems.	E	2	2	1	-	-	-	-	1	-	-	2	2			
CO-5:	Explain the operating principles of measuring instruments.	U	2	2	1	-	-	-	-	1	-	-	2	2			

Unit-1 **ELECTRICAL CIRCUITS** ***9 Periods***

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws– Nodal Analysis, Mesh analysis
Introduction to alternating voltage and currents: Waveforms, Average value, RMS Value, Powers in AC circuits, power factor – Star and Delta connection - Electrical safety- Fuses and Earthing.

Unit-2 **ELECTRICAL MACHINES** ***9 Periods***

DC Machine: Construction, Working principle, EMF equation, Types and Applications. Transformers: Construction, Working principle, EMF Equation and Applications. Three Phase Induction Motors: Construction, Working principle, and Applications. Special Machines: Stepper motor, Servo Motor and BLDC Motor - Construction, Working and Applications

Unit-3 **ANALOG ELECTRONICS** ***9 Periods***

Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, SCR, GTO, MOSFET, IGCT – Types, I-V Characteristics and Applications, Rectifier and Inverters.

Unit-4 **DIGITAL ELECTRONICS** ***9 Periods***

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps.

Unit-5 **MEASUREMENTS AND INSTRUMENTATION**	*9 Periods*
Functional elements of an instrument, Standards and calibration, Operating Principle, types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram- Data acquisition.	
	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020 2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017. 3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008	1. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018. 2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015. 3. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5th Edition, 2017. 4. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2022

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24GE201	Course Name	COMPUTER AIDED ENGINEERING GRAPHICS	Course Category	TP	Engineering Science Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand universal technical drawing standards
- Provide training on drafting software to draw simple sketches
- Demonstrate the concepts of orthographic and isometric projections
- Use drawing skills for communicating concepts, ideas for engineering product design
- Use pictorial views to visualize and draw the isometric view of the objects

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Perform freehand sketching of basic geometrical constructions and multiple views of objects	R	3	2	2		3					2		2	3		
CO-2:	Understand the concept of orthographic projections of lines and plane surfaces.	U	3	2	2		3					2		2	3		
CO-3:	Apply the Projection concepts and drafting tools to draw projection of solids.	AP	3	2	2		3					2		2	3		
CO-4:	Draw projections of the section of solids and development of surfaces	AP	3	2	2		3					2		2	3		
CO-5:	Visualize and to project isometric and perspective sections of simple solids.	AN	3	2	2		3					2		2	3		

Unit-1 CONCEPTS, CONVENTIONS, PLANE CURVES AND FREEHAND SKETCHING — 9 Periods

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning. Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method - Visualization concepts and Free Hand sketching: Visualization principles -Representation of Three-Dimensional objects - Layout of views- Freehand sketching of multiple views from pictorial views of objects (Draw without using drawing instruments)

Unit-2 PROJECTION OF POINTS, LINES AND PLANE SURFACE — 9 Periods

Orthographic projection - principles-Principal planes - First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Unit-3 PROJECTION OF SOLIDS — 9 Periods

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes

Unit-4 PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES — 9 Periods

Sectioning of simple solids like prisms, pyramids, cylinder, and cone in a simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other - obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids - Prisms, pyramids cylinders and cones

Unit-5 ISOMETRIC AND PERSPECTIVE PROJECTIONS — 9 Periods

Principles of isometric projection - isometric scale -Isometric projections and isometric views of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method

Total 45 Periods

List of Experiments	30 Periods
1. Drawing of a Title Block with necessary text and projection symbol. 2. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning 3. Drawing front view, top view and side view of objects from the given pictorial views (eg. V- block, Base of a mixie, Simple stool, Objects with hole and curves 4. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.) 5. Drawing of a simple steel truss. 6. Drawing sectional views of prism, pyramid, cylinder, cone, etc, 7. Drawing isometric projection of simple objects. 8. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.	

	Text Book	Reference
Learning Resources	1. Natarajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, Twenty ninth edition 2017 2. Dr. M.H Annaiah, Dr. B Sudheer Prem Kumar & Dr. C N Chandrappa, Computer Aided Engineering Drawing, New Age International (P) Limited, 7th Edition, 2023. 3. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.	1. S. Ramachandran and K. Pandian, “Engineering Graphics” Airwalk Publications; 8th edition 2014. 2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2018. 3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2018. 4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005

Course Code	24GE202	Course Name	தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY	Course Category	T	Humanities and Management Courses	L	T	P	C
							1	0	0	1

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Science & Humanities	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- provide a comprehensive understanding of the weaving industry and ceramic technology during the Sangam Age, with a particular focus on Black and Red Ware (BRW) Potteries and the graffiti found on these artifacts..
- Students will gain insight into the cultural, technological, and socio-political contexts that shaped temple constructions..
- Study of the iron and steel industries, coin minting, and bead making, alongside archaeological evidence and literary references Silappathikaram.
- Understand the ancient agricultural practices and irrigation technologies, focusing on various water management systems, animal husbandry, and agro-processing. It also explores ancient knowledge of the sea, including fisheries, pearl and conch diving, and oceanic knowledge.
- Learn the knowledge and skills to engage with modern technologies for the preservation and advancement of the Tamil language.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the technological and cultural developments of the Sangam Age, particularly in the areas of weaving and ceramics	U															
CO-2:	Appreciate the cultural and technological advancements reflected in the structural designs and materials used.	U															
CO-3:	Understand the technological and industrial advancements in ancient societies, particularly in the areas of metallurgy, shipbuilding, coin minting, and bead making.	U															
CO-4:	Gain the knowledge about the agricultural and irrigation technologies of ancient societies, as well as their maritime knowledge and practices,	U															
CO-5:	Understand the development and application of Scientific Tamil and Tamil computing.	U															

Unit-1 **நெசவு மற்றும் பீங்கான் தொழில்நுட்பம் / WEAVING AND CERAMIC TECHNOLOGY** ***3 Periods***

சங்க காலத்தில் நெசவுத் தொழில் - பீங்கான் தொழில்நுட்பம் - கருப்பு மற்றும் சிவப்பு பாத்திரங்கள் (BRW) - மட்பாண்டங்கள் மீது கீறல் குறியீடுகள்.
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

Unit-2 **வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம்/ DESIGN AND CONSTRUCTION TECHNOLOGY** ***3 Periods***

சங்க காலத்தில் வீடு வடிவமைத்தல், கட்டுமானம் மற்றும் வீட்டு உபயோகப் பொருட்களின் வடிவமைப்புகள் - சங்க காலத்தில்கட்டுமானப் பொருட்களும் நடுகல்லும் -சிலப்பதிகாரத்தில் மேடை பற்றிய பற்றிய விவரங்கள்-மாமல்லபுரத்தின் சிற்பங்கள் மற்றும் கோவில்கள் -

சோழர்களின் பெரிய கோவில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் -நாயக்கர் கால கோவில்கள் -மாதிரி கட்டமைப்புகள் பற்றி அறிதல்- மதுரை மீனாட்சி கோயில்- திருமலை நாயக்கர் மஹால் - செட்டி நாடு வீடுகள், இந்தோ - பிரிட்டிஷ் காலத்தில் மதராஸில் உள்ள சரசனிக் கட்டிடக்கலை. Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.		
Unit-3	**உற்பத்தி தொழில்நுட்பம் /MANUFACTURING TECHNOLOGY**	***3 Periods***
கப்பல் கட்டும் கலை - உலோகவியல் ஆய்வுகள் - இரும்புத் தொழில் - இரும்பு உருக்குதல், எஃகு - தாமிரம் மற்றும் தங்கம் - வரலாற்றின் ஆதாரமாக நாணயங்கள் - நாணயங்கள் - மணிகள் செய்யும் தொழில்கள் கல் மணிகள் - கண்ணாடி மணிகள் - டெரகோட்டா மணிகள் - ஷெல் மணிகள் / எலும்பு துடிப்புகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் விவரிக்கப்பட்டுள்ள ரத்தினக் கற்கள். Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.		
Unit-4	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	***3 Periods***
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.		
Unit-5	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	***3 Periods***
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
	Total:	**15 Periods**

	Text Books	**References**
Learning Resources	1. தமிழக வரலொறு - மக்களும் பண்பொடும் - மக.மக. பிள்மள (தவளியீடு: தமிழ்நொடு பொடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்). 2. கணினித் தமிழ் - முமனவர் இல. சுந்தரம். (விகடன் பிரசுரம்). 3. கீழடி - மவமக நதிக்கமரயில் ெங்ககொல நகர நொகரிகம் (ததொல்லியல் துமற தவளியீடு) 4. தபொருமந - ஆற்றங்கமர நொகரிகம். (ததொல்லியல் துமற தவளியீடு) 5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print) 6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.	1. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies). 2. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.) 3.. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu) 4. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author) 5. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu) 6. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

Learning Assessment	
Continuous Learning Assessment (CLA) (40% weightage)	**End Semester Examination**

Average of Internal Test (20%)	*Critical Thinking Assessment (20%)*	**(60% weightage)**
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MC201	Course Name	ENVIRONMENTAL SCIENCE	Course Category	T	Mandatory Course	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Science & Humanities	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is :***

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of the global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the influence of societal use of resources on the environment and introduce the legal provisions, National and International laws and conventions for environmental protection.
- To inculcate the effect of population dynamics on human and environmental health and inform about human rights, value education and role of technology in monitoring human and environmental issues.

			Program Outcomes (PO)												Program Specifi Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the functions of the environment, ecosystems and biodiversity and their conservation.	U						3	2					2			
CO-2:	Analyze the causes and effects of environmental pollution and contribute to the preventive measures in the immediate society.	AN						3	2	1							
CO-3:	Identify various natural resources and their contribution to mankind and apply sustainable measures to preserve them for future generations.	AP						3			2			2			
CO-4:	Identify the various sustainable measures for environmental protection against climatic changes and apply them for sustainable and societal development.	AP	3		2			3									
CO-5:	Demonstrate the knowledge of environmental issues and analyse the effect of population dynamics and role of technology in environmental issues.	U						3	3	2			2				

Unit-1 **ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** ***6 Periods***

Definition, scope and importance of environment -concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem– Introduction to biodiversity definition: genetic, species and ecosystem diversity –value of biodiversity-hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Unit-2 **ENVIRONMENTAL POLLUTION** ***6 Periods***

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies.

Unit-3 **NATURAL RESOURCES** ***6 Periods***

Forest resources: Use and over-exploitation, deforestation, Water resources: Use and over-utilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources.

Unit-4 SOCIAL ISSUES AND THE ENVIRONMENT	*6 Periods*
From unsustainable to sustainable development, rain water harvesting, Environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products.	
***Unit-5* HUMAN POPULATION AND THE ENVIRONMENT**	***6 Periods***
Population growth, variation among nations – population explosion – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health.	
Total: 30 Periods	

	Text Books	References
Learning Resources	1.Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers (2018). 2.Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2016). 3.Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).	1.R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 2.Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001. 3.Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007. 4.Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005). 5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. (2013).

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Semester III

Course Code	24HS301	Course Name	UNIVERSAL HUMAN VALUES	Course Category	T	Humanities, Social Sciences and Management Courses	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection.
- Development of commitment and courage to act.
-

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Become more aware of themselves, and their surroundings (family, society, nature)	U						1	1	1	3			3			
CO-2:	Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.	U						1	1	1	3			3			
CO-3:	Have better critical ability.	AN						3	3	2	3		1	3			
CO-4:	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).	U						3	3	2	3		1	3			
CO-5:	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.	U						3	3	2	3		2	3			

Unit-1 **INTRODUCTION** ***6 Periods***

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self- Exploration– Its content and process; „Natural acceptance" and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Practical Session: Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Unit-2 **HARMONY IN THE HUMAN BEING** ***6 Periods***

Understanding human being as a co-existence of the sentient „I" and the material „Body", Understanding the needs of Self („I") and „Body" - happiness and physical facility, Understanding the Body as an instrument of „I" (I being the doer, seer and enjoyer), Understanding the characteristics and activities of „I" and harmony in „I", Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health. Practical Session: Include sessions to discuss the role others have played in making material goods available to me. Identifying from one"s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Unit-3	**HARMONY IN THE FAMILY AND SOCIETY**	***6 Periods***
Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co- existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Practical Session: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students‟ lives		
Unit-4	**HARMONY IN THE NATURE AND EXISTENCE**	***6 Periods***
Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co- existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence. Practical Session: Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.		
Unit-5	**IMPLICATIONS OF HARMONY ON PROFESSIONAL ETHICS**	***6 Periods***
Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up. Practical Session: Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.		
	Total:	**30 Periods**

	Text Books	References
Learning Resources	1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023. 2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. 3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. 4. The Story of Stuff (Book). 5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi 6. Small is Beautiful - E. F Schumacher. 7. Slow is Beautiful - Cecile Andrews. 8. Economy of Permanence - J C Kumarappa 9. Bharat Mein Angreji Raj - PanditSunderlal 10. Rediscovering India - by Dharampal 11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi 12. India Wins Freedom - Maulana Abdul Kalam Azad 13. Vivekananda - Romain Rolland (English)	1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php 2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php 3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MA302	Course Name	DISCRETE MATHEMATICS	Course Category	T	Basic Science Courses	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	**Co-requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science and Humanities	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To extend students logical and mathematical ability to deal with abstraction.
- To introduce most of the basic terminologies used in computer science courses and application ideas to solve practical problems.
- To understand the basic concepts of combinatorics and graph theory.
- To familiarize the applications of algebraic structures .
- To understand the concepts and significance of lattices and Boolean algebra which are widely used in computer science and engineering.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the validity of the logical arguments, mathematical proofs and correctness of the algorithm	U	3	3	2	3	2	-	-	-	-	-	-	3	-		
CO-2:	Apply Combinatorial counting techniques in solving combinatorial related problems.	AP	3	3	2	3	2	-	-	-	-	-	-	3	-		
CO-3:	Use graph models and their connectivity, travers ability in solving real world problems.	AP	3	3	2	3	2	-	-	-	-	-	-	3	-		
CO-4:	Understand the significance of algebraic structural ideas used in coding theory and cryptography	U	3	3	2	3	2	-	-	-	-	-	-	3	-		
CO-5:	Apply Boolean laws and Boolean functions in combinatorial circuit designs	AP	3	3	2	3	2	-	-	-	-	-	-	3	-		

Unit-1 **LOGIC AND PROOFS** ***9+3 Periods***

Propositional Logic-Propositional Equivalences-Normal Forms-Predicates and Quantifiers-Nested Quantifiers-Rules of Inference-Introduction to Proofs-Proof Methods and Strategy

Unit-2 **COMBINATORICS** ***9+3 Periods***

Mathematical Induction -Strong Induction and Well Ordering-The Basics of Counting-The Pigeonhole Principle-Permutations and Combinations-Recurrence Relations-Solving Linear Recurrence Relations Using Generating Functions -Inclusion-Exclusion Principle and its Applications

Unit-3 **GRAPHS** ***9+3 Periods***

Graphs and Graph Models -Graph Terminology and Special types of Graphs -Matrix Representation of Graphs and Graph Isomorphism -Connectivity-Euler and Hamiltonian Paths.

Unit-4 **ALGEBRAIC STRUCTURES** ***9+3 Periods***

Groups-Subgroups - Homomorphisms - Normal Subgroups and Cosets - Lagrange’s Theorem -Rings and Fields (Definitions and Examples

Unit-5 **LATTICES AND BOOLEAN ALGEBRA** ***9+3 Periods***

Partial Ordering - Posets - Lattices as Posets- Properties of Lattices -Lattices as Algebraic Systems- Sub lattices -Direct Product and Homomorphism - Some Special Lattices- Boolean Algebra.

		Total **60 Periods**

	Text Book	**Reference**
Learning Resources	1. Kenneth H.Rosen, "Discrete Mathematics and its Applications", Tata McGraw Hill Pub.Co.Ltd., Seventh Edition, Special Indian Edition,NewDelhi,2011. 2. Tremblay J.P. and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Pub. Co. Ltd. ,Third Edition,NewDelhi,2013.	1. Thomas Koshy, "Discrete Mathematics with Applications", ElsevierPublications,Boston,2004. 2. GrimaldiR.P.,"Discrete and Combinatorial Mathematics", Pearson Education Pvt.Ltd.,5th Edition,Singapore,2004

Course Code	24CS301	Course Name	DATA STRUCTURES	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	C Programming	**Co- requisite Courses**	Nil	**Progressive Courses**	Algorithms
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the concepts of ADTs.
- Learn linear data structures - lists, stacks, and queues.
- Understand non-linear data structures - trees and graphs.
- Understand sorting, searching and hashing algorithms.
- Apply Tree and Graph structures.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Implement list ADT using arrays and linked lists (singly, circular, and doubly linked lists).	AP	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO-2:	Explain the structure and operations of Stack and Queue ADTs	U	1	1	1	1	-	-	-	-	-	-	-	-	1	1	1
CO-3:	Describe Tree ADT and different tree traversal techniques	U	1	1	1	1	-	-	-	-	-	-	-	-	1	1	1
CO-4:	Apply appropriate graph algorithms for graph applications	AP	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO-5:	Analyze the various searching and sorting algorithms	AN	3	2	2	2	3	-	-	-	-	-	-	-	3	3	3

Unit-1 LISTS **9 Periods**

Abstract Data Types (ADTs) - List ADT - Array-based implementation - Linked list implementation- Singly linked lists - Circularly linked lists - Doubly-linked lists - Applications of lists - Polynomial ADT .

Unit-2 STACKS AND QUEUES **9 Periods**

Stack ADT - Operations - Applications - Balancing Symbols - Evaluating arithmetic expressions-Infix to Postfix conversion - Function Calls - Queue ADT - Operations - Circular Queue - DeQueue- Applications of Queues.

Unit-3 TREES **9 Periods**

Tree ADT - Tree Traversals - Binary Tree ADT - Expression trees - Binary Search Tree ADT - AVL Trees - Priority Queue (Heaps) - Binary Heap.

Unit-4 MULTIWAY SEARCH TREES AND GRAPHS **9 Periods**

B-Tree - B+ Tree - Graphs - Types-Representation - Breadth-first traversal - Depth-first traversal – Bi-connectivity - Euler circuits - Dijkstra's algorithm - Minimum Spanning Tree - Prim's algorithm - Kruskal's algorithm.

Unit-5 SEARCHING, SORTING AND HASHING TECHNIQUES **9 Periods**

Searching - Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort - Quick sort -Merge Sort - Hashing - Hash Functions - Separate Chaining - Open Addressing -Rehashing - Extendible Hashing.

Total Theory: 45 Periods

List of Indicative Experiments	Total Practical: 30 Periods
1. Array implementation of Stack, Queue and Circular Queue ADTs 2. Implementation of Singly Linked List 3. Linked list implementation of Stack and Linear Queue ADTs 4. Implementation of Polynomial Manipulation using Linked list 5. Implementation of Evaluating Postfix Expressions, Infix to Postfix conversion 6. Implementation of Binary Search Trees 7. Implementation of AVL Trees 8. Implementation of Heaps using Priority Queues 9. Implementation of Dijkstra's and Kruskal's Algorithm 10. Implementation of Linear Search and Binary Search 11. Implementation of Insertion Sort and Merge Sort 12. Implementation of Open Addressing ((Linear Probing and Quadratic Probing)	

	Text Books	References
Learning Resources	1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2018 2. Kamthane, Introduction to Data Structures in C, 1st Edition, Pearson Education, 2020	1. Langsam, Augenstein and Tanenbaum, Data Structures Using C and C++, 2nd Edition, Pearson Education, 2015. 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, Introduction to Algorithms", Fourth Edition, Mcgraw Hill/ MIT Press, 2022. 3. Alfred V. Aho, Jeffrey D. Ullman,John E. Hopcroft ,Data Structures and Algorithms, 1st edition, Pearson, 2002. 4. Kruse, Data Structures and Program Design in C, 2nd Edition, Pearson Education, 2006.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS302	Course Name	DIGITAL PRINCIPLES AND COMPUTER ORGANIZATION	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Computer Networks
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Analyze and design combinational circuits.
- Analyze and design sequential circuits
- Understand the basic structure and operation of a digital computer.
- Study the design of data path unit, control unit for processor and to familiarize with the hazards.
- Understand the concept of various memories and I/O interfacing.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply Karnaugh Maps to simplify Boolean expressions and design efficient combinational circuits	AP	3	3	3	3	3	-	-	-	-	-	-	-	2	3	3
CO-2:	Design sequential circuits and analyze the design procedures	R	3	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO-3:	State the fundamentals of computer systems and analyze the execution of an instruction	U	3	3	3	3	2	-	-	-	-	-	-	-	2	3	1
CO-4:	Analyze execution, stack organization, micro-operations, data path design, control unit design (hardwired and microprogrammed), and pipelining with data and control hazards.	AN	3	3	3	3	1	-	-	-	-	-	-	-	1	3	1
CO-5:	Identify the characteristics memory hierarchy, management, cache memory techniques, interprocess communication, virtual memory, DMA, I/O interfaces, interrupt handling, and interconnection standards.	R	3	3	3	3	1	-	-	-	-	-	-	-	1	2	1

Unit-1	**COMBINATIONAL LOGIC**	**9 Periods**
Combinational Circuits – Karnaugh Map - Analysis and Design Procedures – Binary Adder – Subtractor – Decimal Adder - Magnitude Comparator – Decoder – Encoder – Multiplexers – Demultiplexers		
Unit-2	**SYNCHRONOUS SEQUENTIAL LOGIC**	**9 Periods**
Introduction to Sequential Circuits - Flip-Flops - Operation and Excitation tables -NAND- RS Latch - NOR LS Latch, RS flipflop, JK flipflop, T Flipflop, D flipflop-Half Adder- Full Adder-Triggering of FF, Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, State Minimization,State Assignment, Circuit Implementation - Registers – Counters.		
Unit-3	**COMPUTER FUNDAMENTALS**	**9 Periods**
Functional Units of a Digital Computer: Von Neumann Architecture - Operation and Operands of Computer Hardware Instruction ,Shift Register , Bidirectional Shift Register-Instruction Set Architecture (ISA): Memory Location, Address and Operation - Instruction and Instruction Sequencing - Addressing Modes, Encoding of Machine Instruction - Interaction between Assembly and High Level Language.		

<table>
<tr><td>Unit-4 PROCESSOR</td><td>9 Periods</td></tr>
<tr><td colspan="2">Instruction Execution -Stack Organization , Instruction Formats, Arithmetic Micro Operations , Logic Micro Operations , Shift Micro operations, Building a Data Path - Designing a Control Unit - Hardwired Control, Microprogrammed Control - Pipelining - Data Hazard - Control Hazards</td></tr>
<tr><td>Unit-5 MEMORY AND I/O</td><td>9 Periods</td></tr>
<tr><td colspan="2">Memory Concepts and Hierarchy - Memory Management - Cache Memories: Mapping and Replacement Techniques , Cache Coherence , Inter Process Communication and synchronization -Virtual Memory - DMA - I/O - Accessing I/O: Parallel and Serial Interface - Interrupt I/O - Interconnection Standards: USB, SATA</td></tr>
<tr><td></td><td>Total Theory: 45 Periods</td></tr>
<tr><td>List of Indicative Experiments</td><td>Total Practical: 30 Periods</td></tr>
<tr><td colspan="2">1. Verification of Boolean theorems using logic gates
2. Design and implementation of combinational circuits using gates for arbitrary functions.
3. Implementation of 4-bit binary adder/subtractor circuits.
4. Implementation of code converters.
5. Implementation of BCD adder, encoder and decoder circuits
6. Implementation of functions using Multiplexers.
7. Implementation of the synchronous counters
8. Implementation of a Universal Shift register
9. Simulator based study of Computer Architecture</td></tr>
</table>

<table>
<tr><td></td><td>Text Books</td><td>References</td></tr>
<tr><td>Learning Resources</td><td>1. M. Morris Mano, Michael D. Ciletti, “Digital Design : With an Introduction to the Verilog HDL, VHDL, and System Verilog”, Sixth Edition, Pearson Education, 2018.
2. David A. Patterson, John L. Hennessy, “Computer Organization and Design, The Hardware/Software Interface”, Sixth Edition, Morgan Kaufmann/Elsevier, 2020.</td><td>1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, “Computer Organization and Embedded Systems”, Sixth Edition, Tata McGraw-Hill, 2012.
2. William Stallings, “Computer Organization and Architecture - Designing for Performance”, Tenth Edition, Pearson Education, 2016.
3. M. Morris Mano, “Digital Logic and Computer Design”, Pearson Education, 2016.
4. Rajaraman, V., & Radhakrishnan, T. (2018). Computer Organization and Architecture. Prentice Hall India. (Author: Former Professor, IIT Kanpur)
5. Bhaskaran, R. (2021). Fundamentals of Digital Logic and Microprocessors. NIT Trichy Publications.
6. Ghosh, K. (2019). Advanced Computer Architecture and Parallel Processing. IIT Kharagpur Press.</td></tr>
</table>

<table>
<tr><td colspan="5">Learning Assessment</td></tr>
<tr><td colspan="4">Continuous Learning Assessment (CLA) (50% weightage)</td><td rowspan="3">End Semester Examination (50% weightage)</td></tr>
<tr><td colspan="2">Theory (25% weightage)</td><td colspan="2">Practical (25% weightage)</td></tr>
<tr><td>Average of Internal Test (15%)</td><td>Critical Thinking Assessment (10%)</td><td>Evaluation of Laboratory Observation, Record (15%)</td><td>Model Lab Exam (10%)</td></tr>
<tr><td colspan="5">* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%</td></tr>
</table>

Course Code	24CS303	Course Name	OBJECT ORIENTED PROGRAMMING	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses		Co- requisite Courses	Data Structures	Progressive Courses	OBJECT ORIENTED SOFTWARE ENGINEERING
Course Offering Department	Computer Science and Engineering		Data Book / Codes Standards	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Understand the fundamental concepts of Object-Oriented Programming and the basics of Java programming.
- Learn the core principles of packages, inheritance, and interfaces in Java.
- Define and implement exception handling and I/O stream operations in Java applications.
- Develop Java applications utilizing threads and generic classes for enhanced functionality.
- Design and create Graphical User Interface (GUI) applications using JavaFX.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply the principles of classes and objects to develop solutions for fundamental problems.	U	3	2	3	1	3	2	1	-	3	1	1	1	3	1	1
CO-2:	Develop programs that use inheritance, packages, and interfaces to improve modularity and reusability of code.	U	3	3	3	1	3	2	1	-	2	1	1	1	3	2	1
CO-3:	Create Java applications that effectively use string manipulation, exception handling, and I/O stream operations.	AP	3	3	3	1	2	2	1	-	3	1	1	1	3	3	1
CO-4:	Build multithreaded applications and use generic classes in Java to address real-world problems.	AP	3	3	3	2	3	2	2	-	1	2	1	1	3	2	2
CO-5:	Apply event handling and JavaFX components to develop interactive graphical user interface (GUI) applications.	AP	3	3	3	3	2	2	2	-	2	2	1	1	3	3	2

Unit-1	**INTRODUCTION TO OOP AND JAVA**	**9 Periods**
Programming Paradigms - Features of Object-Oriented Programming - Data Types, Variables and Arrays - Operators - Control Statements -Classes - Methods -Constructors- -Access specifiers - Static members- Overloading Methods - Objects -Passing Object Parameters - Returning Objects -Classes-Static- Nested - Inner Classes-Final.		
Unit-2	**INHERITANCE, PACKAGES AND INTERFACES**	**9 Periods**
Inheritance-Super -Abstract Classes- Method Overriding - Dynamic Method Dispatch - Packages and Interfaces: Packages -Importing Packages - Interfaces.		
Unit-3	**STRING HANDLING, I/O AND EXCEPTION HANDLING**	**9 Periods**
String class- Methods - String Buffer Class-Streams API-File Streams - Reading and Writing Files-Object Serialization-Exception Handling -Try Clause - Catch Clause -Final Clause - Nested try Statements - Built-in Exceptions - User defined Exception-JDBC		
Unit-4	**MULTITHREADING AND GENERIC PROGRAMMING**	**9 Periods**
Multithreaded Programming- Threads - Priorities - Synchronization - Interthread Communication-Generic Programming - Generic classes - Generic Methods - Generic Collections-Bounded Types - Streams API		

Unit-5	JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS	9 Periods
JAVAFX Events and Controls- Key and Mouse Events-Text Controls- Layouts -Menus -Spring Boot Framework		
		Total Theory: 45 Periods

List of Experiments	Total Practical: 30 Periods
1. Implement basic programming using Java 2. Create programs using classes,methods,constructors. 3. Implement inheritance using abstract classes. 4. Implement interface . 5. Implement Exception handling. 6. Develop programs to implement Multithreading. 7. Develop programs to perform File operations and JDBC. 8. Develop programs using Generic classes. 9. Develop Event-driven programs for GUI applications 10. Mini project-Spring Boot	

	Text Books	References
Learning Resources	1. Y. Daniel Liang, “Introduction to Java Programming and Data Structures, Comprehensive Version”, 12th Edition, Pearson Education, 2021. 2. Paul Dietel and Harvey Deitel, “Java - How to Program Early Objects”, 11th Edition, Pearson Education, 2018	1. Sachin Malhotra, Sourabh Choudhary, “Programming in Java”, Revised 2nd Edition, Oxford University Press, 2018.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24CS304	Course Name	DATABASE MANAGEMENT SYSTEMS	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering		**Data Book / Codes Standards**	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Learn the fundamentals of data models, relational algebra and SQL
- Represent a database system using ER diagrams and to learn normalization techniques
- Understand the fundamental concepts of transaction, concurrency and recovery processing
- Understand the internal storage structures using different file and indexing techniques which will help in physical DB design
- Have an introductory knowledge about the Distributed databases, NOSQL and database security

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Construct SQL Queries using relational algebra	U	2	2	3	2	1	-	-	-	-	-	-	-	2	1	3
CO-2:	Design database using ER model and normalize the database	AP	3	1	1	1	1	1	1	1	1	1	1	1	3	1	2
CO-3:	Construct queries to handle transaction processing and maintain consistency of the database	AP	3	2	3	2	1	1	1	1	1	1	1	1	2	3	3
CO-4:	Compare and contrast various indexing strategies and apply the knowledge to tune the performance of the database	AN	1	2	3	2	2	2	2	2	2	2	2	2	1	2	3
CO-5:	Appraise how advanced databases differ from Relational Databases and find a suitable database for the given requirement.	AN	1	1	3	3	2	2	2	2	2	2	2	2	2	2	2

Unit-1	**RELATIONAL DATABASES**	**7 Periods**
Database system- Data Models - System Architecture- Relational Model - Keys - Relational Algebra - SQL - Embedded SQL		
Unit-2	**DATABASE DESIGN**	**9 Periods**
Entity-Relationship model - ER Diagrams - Enhanced ER Model - ER to Relational Mapping - Functional Dependencies - Non-loss Decomposition - First, Second, Third Normal Forms, Dependency Preservation - Boyce/Codd Normal Form - Multi-valued Dependencies and Fourth Normal Form - Join Dependencies and Fifth Normal Form		
Unit-3	**TRANSACTIONS**	**9 Periods**
Transaction Concepts - ACID Properties - Schedules - Serializability - Need for Concurrency - Concurrency control -Two Phase Locking- Timestamp - Multiversion - Validation and Snapshot isolation- Multiple Granularity locking - Deadlock Handling - Recovery Concepts - Recovery based on deferred and immediate update - Shadow paging - ARIES Algorithm		
Unit-4	**STORAGE AND QUERY PROCESSING**	**9 Periods**
RAID - File Organization - Organization of Record in Files - Data dictionary Storage - Column Oriented Storage- Indexing and Hashing -Ordered Indices - B+ tree Index Files - B tree Index Files - Static Hashing - Dynamic Hashing - Query Processing Overview - Algorithms for Selection, Sorting and join operations - Query optimization using Heuristics - Cost Estimation.		

Unit-5 ADVANCED TOPICS	11 Periods
Distributed Databases: Architecture, Data Storage, Transaction Processing, Query processing and optimization - NOSQL Databases: Introduction - CAP Theorem - Document Based systems - Key value Stores - Database Security:Security issues - Access control based on privileges - Role Based access control - SQL Injection - Statistical Database security - Flow control - Encryption and Public Key infrastructures - Challenges. Hadoop-Mongo DB	
	Total Theory: 45 Periods

List of Indicative Experiments — **Total Practical: 30 Periods**

1. Create a database table, add constraints (primary key, unique, check, Not null), insert rows, update and delete rows using SQL DDL and DML commands.
2. Create a set of tables, add foreign key constraints and incorporate referential integrity.
3. Query the database tables using different 'where' clause conditions and also implement aggregate functions.
4. Query the database tables and explore sub queries and simple join operations,natural, equi and outer joins.
5. Write user defined functions and stored procedures in SQL.
6. Execute complex transactions and realize DCL and TCL commands.
7. Write SQL Triggers for insert, delete, and update operations in a database table.
8. Create View and index for database tables with Kaggle dataset.
9. Create Document using NOSQL database tools.
10. Case Study using **any one** of the real life database applications from the following list a) Inventory Management for a EMart Grocery Shop b) Society Financial Management c) Cop Friendly App - Eseva d) Property Management - eMall e) Star Small and Medium Banking and Finance

    Repository Dataset to be used

	Text Books	References
Learning Resources	1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2020. 2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education, 2021	1. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24SD311	Course Name	Aptitude and Coding Skills -1	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering (Common to all Branches)	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Provide logical reasoning abilities through scenario-based problems
- Enhance problem solving skills related to divisibility decimal fractions, profit, loss and compound interest
- Augment fundamentals related to probabilities, number system, ages, speed, time and distance
- Supplement the foundational coding concepts
- Develop the C-programming skills in searching and sorting problems

Course Outcomes (CO): *At the end of this course, learners will be able to:*		*BL*	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Apply their logical reasoning and analytical abilities to solve scenario-based problems, namely deductive reasoning, objective reasoning, inductive reasoning and abductive reasoning.	AP															
CO-2:	Solve problems related to divisibility decimal fractions, profit, loss and compound interest	AP															
CO-3:	Apply quantitative reasoning ability to solve problems in logarithms, permutation, combinations, number system, ages, speed, time and distance	AP															
CO-4:	Code for simple programming examples using foundational concepts	AP															
CO-5:	Design and develop algorithm, pseudo code and codes for searching and sorting problems	AN															

List of Exercises **30 Periods**

1. **Logical Reasoning**
   Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency
2. **Quantitative Aptitude – Foundational Problems**
   Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest
3. **Quantitative Aptitude – Moderate Problems**
   Engineering Mathematics: Logarithms, Permutation and Combinations, Probability, Number system, percentage
4. **Programming – Foundational Concepts**
   Data Types/Operators, Managing input& output/if else statement, Logical, Unary, ternary operators/Constants MACROS /goto, continue statements, Loops(for/while/do while), switch break

5. **Programming – Problems for Logical Thinking**
   Algorithms and Pseudo codes for problems using Arrays, Arrays- Multi Dimensional, String – Data search and sort problems – linear search, binary search and interpolation search, Insertion sort, heap sort and merge sort

Learning Assessment	
Continuous Learning Assessment (CLA) (100% weightage)	
Evaluation of Laboratory Observation, Record (60%)	**Model Lab Exam (40%)**

Course Code	24EL311	Course Name	INNOVATION AND PRODUCT DEVELOPMENT-1 (Idea Generation)	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	24EL411
Course Offering Department		**Data Book/Codes/ Standards**	Nil		

Course Objective: ***The purpose of learning this course is:***

- The students will understand the concepts of idea generation to develop the market driven product by generating, assessing, and refining creative ideas using structured brainstorming, feedback integration, and feasibility evaluation.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Generate creative ideas to address specific problems through structured brainstorming sessions.	C	3	3	3	3		2			3			2			
CO-2:	Assess and refine initial ideas by integrating feedback and evaluating feasibility.	E	3	3	3	3		2			3			2			
CO-3:	Analyze problems and articulate solutions using the Problem Statement and Value Proposition Canvas.	AN	3	3	3	3		2			3			2			
CO-4:	Conduct SWOT analyses to evaluate strengths, weaknesses, opportunities and threats of their ideas, effectively assessing viability and potential impact.	AN	3	3	3	3		2			3			2			
CO-5:	Construct comprehensive documentation detailing key features, functionalities, and target audience of refined concepts.	U	3	3	3	3		2			3			2			

List of Activity

Team of three to five members preferably from a multi-disciplinary department initiates the innovative Product development journey by fostering creative idea generation and Strategic planning. They shall follow the below activities but not limited to;

Week1-2: Engage in brainstorming sessions with a focus on addressing specific problems or fulfilling particular needs.

Week 3-4: Iterate on the initial ideas by incorporating feedback and assessing their feasibility.

Week 5-6: Make the Problem Statement Canvas and the Value Proposition Canvas to articulate and refine the problem being addressed and the unique value proposition offered by the concept.

Week 7-8: Conduct the SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) of each idea to assess its viability and potential impact.

Week 9-10: Document the refined concept comprehensively, outlining its key features, functionalities, and target audience.

Key Deliverables: Problem Statement Canvas, Value Proposition Canvas and SWOT analysis reports.

Learning Assessment

Continuous Learning Assessment (CLA) (100 % weightage)		
Report 40%	**Presentation 40%**	**Viva-Voce 20%**

Semester IV

Course Code	24CS401	Course Name	THEORY OF COMPUTATION	Course Category	T	Professional Core Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Discrete Mathematics	Co- requisite Courses	Nil	Progressive Courses	Compiler Design
Course Offering Department	Computer Science and Engineering	Data Book / Codes / Standards			

Course Objective: ***The purpose of learning this course is to:***

- Understand foundations of computation including automata theory
- Construct models of regular expressions and languages.
- Design context free grammar and push down automata
- Understand Turing machines and their capability
- Understand Undecidability and NP class problems

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Construct automata theory using Finite Automata	C	1	3	2	3	-	-	-	-	-	-	-	-	1	3	2
CO-2:	Write regular expressions for any pattern	U	2	2	3	2	-	-	-	-	-	-	-	-	3	1	2
CO-3:	Design context free grammar and Pushdown Automata	U	2	2	3	2	-	-	-	-	-	-	-	-	1	2	2
CO-4:	Design Turing machine for computational functions	AP	2	2	2	1	-	-	-	-	-	-	-	-	3	1	3
CO-5:	Differentiate between decidable and undecidable problems	R	2	2	2	2	1	-	-	-	-	-	-	-	2	2	2

Unit-1	**AUTOMATA AND REGULAR EXPRESSIONS**	***9 Periods***
Automata theory - Finite Automata (FA) - Deterministic Finite Automata (DFA) - Non-deterministic Finite Automata (NFA) - Finite Automata with Epsilon transitions - Equivalence of NFA and DFA- Conversion of NFA into DFA – Minimization of DFAs.		
Unit-2	**REGULAR EXPRESSIONS AND LANGUAGES**	***9 Periods***
Regular expression - Regular Languages- Equivalence of Finite Automata and regular expressions - Pumping Lemma - Closure properties .		
Unit-3	**CONTEXT FREE GRAMMAR AND PUSH DOWN AUTOMATA**	***9 Periods***
Types of Grammar - Chomsky's hierarchy of languages -Context-Free Grammar (CFG) and Languages - Ambiguity- Push Down Automata (PDA)- Instantaneous descriptions- Languages of pushdown automata - Equivalence of pushdown automata and CFG-CFG to PDA-PDA to CFG - Deterministic Pushdown Automata.		
Unit-4	**NORMAL FORMS AND TURING MACHINES**	***9 Periods***
Normal forms for CFG - Simplification of CFG- Chomsky Normal Form (CNF) and Greibach Normal Form (GNF) - Pumping lemma for CFL - Closure properties of Context Free Languages -Turing Machine- Language acceptance by TM – TM as Computer of Integer functions – Programming techniques for Turing machines. Case study-Turing Machine.		
Unit-5	**UNDECIDABILITY**	***9 Periods***
Unsolvable Problems and Computable Functions -PCP-MPCP- Recursive and recursively enumerable languages - Properties - Universal Turing machine -Tractable and Intractable problems - P and NP completeness – Kruskal's algorithm – Travelling Salesman Problem- 3-CNF SAT problems.Applications of NLP in Robotics.		
	Total:	**45 Periods**

Learning Resources	Text Books	References
	1. Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2020. 2. John C Martin , "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill, 2011.	1. Harry R Lewis and Christos H Papadimitriou , "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015. 2. Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016. 3.K.L.P.Mishra and N.Chandrasekaran, “Theory of Computer Science: Automata Languages and Computation”, 3rd Edition, Prentice Hall of India, 2006.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS402	Course Name	ALGORITHMS	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Data Structures	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand and apply the algorithm analysis techniques on searching and sorting algorithms for real world problems.
- Critically analyze the efficiency of graph algorithms
- Understand different algorithm design techniques
- Solve programming problems using state space tree
- Understand the concepts behind NP Completeness, Approximation algorithms and randomized algorithms.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyze the efficiency of algorithms using various frameworks	AP	2	3	1	2	2	1	1	1	1	1	1	1	2	1	3
CO-2:	Solve problems using algorithm design techniques like divide and conquer, dynamic programming and greedy techniques.	AP	2	2	1	2	2	1	1	1	1	1	1	1	2	2	2
CO-3:	Apply dynamic programming and graph algorithms to solve problems and analyze their efficiency.	AP	2	3	1	2	3	1	1	1	1	1	1	1	2	1	2
CO-4:	Implement the state space tree method and string matching algorithm for solving problems.	AN	3	2	1	1	3	2	2	2	2	2	2	2	2	3	1
CO-5:	Analyse approximation algorithms for real world applications.	AN	3	2	1	2	3	2	2	2	2	2	2	2	2	2	3

Unit-1	**INTRODUCTION**	**9 Periods**
Time and space complexity - Asymptotic Notations and its properties- Recurrence relation- substitution method Recurrence tree method-Master's method- Best case, Worst case and average case analysis for linear search, binary search and Interpolation Search, Best case, Worst case and average case analysis for Insertion sort.		
Unit-2	**DIVIDE AND CONQUER AND GREEDY ALGORITHMS**	**9 Periods**
Divide and Conquer methodology–Analysis of Merge sort - Analysis of Quick sort -Finding maximum and minimum - Greedy Technique-Elements of the greedy strategy – Activity selection problem -- Optimal Merge pattern – Huffman Trees. Randomized Algorithms- Randomized quick sort - Finding kth smallest number.		
Unit-3	**DYNAMIC PROGRAMMING AND GRAPH ALGORITHMS**	**9 Periods**
Dynamic programming- Elements of dynamic programming — Matrix-chain multiplication -Longest common search. - Shortest path: Bellman-Ford algorithm - Floyd-Warshall algorithm Network flow: Flow networks - Ford-Fulkerson method		
Unit-4	**STATE SPACE AND STRING MATCHING ALGORITHMS**	**9 Periods**
Backtracking: n-Queens problem - Hamiltonian Circuit Problem - Branch and Bound: Knapsack Problem - Travelling Salesman Problem -String Matching- The naïve string matching algorithm - Knuth-Morris-Pratt algorithm.		

Unit-5 NP-COMPLETE AND APPROXIMATION ALGORITHMS	**9 Periods**
Tractable and intractable problems: Polynomial time algorithms – NP-algorithms - NP-hardness and NP-completeness -Problem reduction-CNF-3-CNF problem- TSP. Approximation Algorithms: TSP-The Vertex Cover problem	
	Total Theory: 45 Periods

List of Indicative Experiments	**Total Practical: 30 Periods**

1. Develop a program to analyse Linear and Binary search algorithms.
2. Develop a program to analyse insertion sort
3. Develop a program to analyse merge sort
4. Develop a program to optimize the cost in merging multiple sorted list using Greedy algorithm
5. Implement randomized algorithms for finding the kth smallest number.
6. Implement Floyd's algorithm for the All-Pairs- Shortest-Paths problem.
7. Compute the transitive closure of a given directed graph using Warshall's algorithm.
8. Develop a program to find out the maximum and minimum numbers in a given list of n numbers using the divide and conquer technique.
9. Implement N Queens problem using Backtracking.
10. Implement any scheme to find the optimal solution for the Traveling Salesperson problem and then solve the same problem instance using any approximation algorithm and determine the error in the approximation

	Text Books	References
Learning Resources	1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 4th Edition, Prentice Hall of India, 2022. 2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran "Computer Algorithms/C++" Orient Blackswan, 2nd Edition, 2019.	1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012. 2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Reprint Edition, Pearson Education, 2006. 3. S. Sridhar, "Design and Analysis of Algorithms", Oxford university press, 2014

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS403	Course Name	INTRODUCTION TO OPERATING SYSTEMS	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Programming in C	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand the basics and functions of operating systems.
- Understand processes and threads.
- Analyze scheduling algorithms and process synchronization.
- Understand the concept of deadlocks.
- Analyze various memory management schemes.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Illustrate the concepts of operating systems.	U	3	1	2	2	-	-	-	-	-	-	-	-	1	2	2
CO-2:	Analyze various scheduling algorithms and process synchronization and explain deadlock prevention and avoidance algorithms.	AP	2	2	3	1	1	-	-	-	-	-	-	-	2	1	2
CO-3:	Compare and contrast various memory management schemes.	U	1	3	2	2	1	-	-	-	1	1	1	1	1	2	2
CO-4:	Explain the storage management and functionality of file systems, I/O systems.	U	1	3	3	3	2	2	2	2	2	2	2	2	1	3	2
CO-5:	Apply virtualization to OS, implement VMs, and analyze mobile OS .	AP	3	1	2	1	2	2	2	2	2	2	2	2	1	2	2

Unit	Title	Periods
Unit-1	**INTRODUCTION**	**7 Periods**
Operating System concepts - Evolution - Structures -Services - User Operating System Interface - System Calls - System Programs - Design and Implementation - Structuring methods.		
Unit-2	**PROCESS MANAGEMENT**	**11 Periods**
Process Concept - Process Scheduling - Operations on Processes - Inter-process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms: Threads - Multi Thread Models - Threading issues; Process Synchronization - The Critical-Section problem - Synchronization hardware - Semaphores - Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.		
Unit-3	**MEMORY MANAGEMENT**	**10 Periods**
Main Memory - Swapping - Contiguous Memory Allocation - Paging - Structure of the Page Table - Segmentation, Segmentation with paging; Virtual Memory - Demand Paging - Copy on Write - Page Replacement - Allocation of Frames -Thrashing - working set model.		
Unit-4	**STORAGE MANAGEMENT**	**10 Periods**
Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection- File System Implementation - File System Structure - Directory implementation - Allocation Methods - Free Space Management; I/O Systems - I/O Hardware- Application I/O interface- Kernel I/O subsystem -Storage structure-Linux File system		

Unit-5 VIRTUAL MACHINES AND MOBILE OS	7 Periods
Virtual Machines - History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components; Mobile OS - iOS and Android.	
	Total Theory: 45 Periods

List of Indicative Experiments	Total Practical: 30 Periods

1. Implementation of Unix System Calls
2. Simulation and Analysis of Non Preemptive and Preemptive CPU Scheduling Algorithms
3. i. Simulation of Producer - Consumer Problem using Semaphores
   ii. Implementation of Dining Philosophers Problem to demonstrate Process Synchronization
4. Simulation of Banker's Algorithm for Deadlock Avoidance
5. Analysis and Simulation of Memory Allocation and Management Techniques
6. Implementation of Page Replacement Techniques
7. Simulation of Disk Scheduling Algorithms
8. Implementation of File organization Techniques
9. Case study -analysis of any OS

	Text Books	References
Learning Resources	1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts" 10th Edition, John Wiley and Sons Inc., 2018. 2. Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 5th Edition, 2022 New Delhi.	1. Ramaz Elmasri, A. Gil Carrick, David Levine, " Operating Systems - A Spiral Approach", Tata McGraw Hill Edition, 2010. 2. William Stallings, "Operating Systems: Internals and Design Principles",7th Edition, Prentice Hall, 2018. 3. Achyut S.Godbole, Atul Kahate, "Operating Systems", McGraw Hill Education, 2016.

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS404	**Course Name**	OBJECT ORIENTED SOFTWARE ENGINEERING	**Course Category**	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	OBJECT ORIENTED PROGRAMMING LANGUAGE	**Co- requisite Courses**		**Progressive Courses**	SOFTWARE TESTING AND AUTOMATION
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand Software Engineering Lifecycle Models
- Perform software requirements analysis
- Gain knowledge of the System Analysis and Design concepts using UML.
- Understand software testing and maintenance approaches
- Work on project management scheduling using DevOps

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Compare various Software Development Life cycle Models	U	2	2	1	2	2	-	-	-	-	1	1	2	2	2	1
CO-2:	Evaluate project management approaches as well as cost and schedule estimation strategies.	U	2	3	2	3	2	-	-	-	-	2	1	2	3	2	1
CO-3:	Perform formal analysis on specifications.	U	2	3	2	1	1	-	-	-	-	2	1	2	2	3	1
CO-4:	Use UML diagrams for analysis and design.	AP	2	3	2	2	3	-	-	-	-	2	1	2	2	3	1
CO-5:	Architect and design using architectural styles and design patterns, and test the system	AN	2	1	1	2	2	2	2	2	2	2	2	2	3	2	2

Unit-1	**SOFTWARE PROCESS AND AGILE DEVELOPMENT**	**9 Periods**
Introduction to Software Process-Software Life cycle model-Process Models-Agile Process-Extreme programming-XP Process.		
Unit-2	**REQUIREMENTS ANALYSIS AND SPECIFICATION**	**9 Periods**
Requirement analysis specification - Software Requirement Specification - Formal system specification - Finite State Machines - Petri Nets - Object modelling using UML-Use case Model - Class diagrams - Interaction diagrams - Activity Diagrams-State chart Diagrams-Functional Modelling-Data Flow Diagram.		
Unit-3	**SOFTWARE DESIGN**	**9 Periods**
Software design - Design process - Design concepts - Coupling - Cohesion - Functional independence - Design patterns - Model-view-controller - Publish-subscribe - Adapter - Command - Strategy - Observer - Proxy - Facade -Architectural styles - Layered - Client Server - Tiered - Pipe and filter- User interface design.		
Unit-4	**SOFTWARE TESTING AND MAINTENANCE**	**9 Periods**
Testing-Unit Testing-Black box testing-White box testing-Integration and System testing- Regression Testing-Debugging-Program Analysis-Symbolic Execution- Model Checking.		
Unit-5	**PROJECT MANAGEMENT**	**9 Periods**
Software Project Management- Software Configuration Management - Project Scheduling- DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline: Overall Architecture Building and Testing-Deployment- Tools.		
		Total Theory: 45 Periods

List of Indicative Experiments	Total Practical: 30 Periods

1. Identify the software system requirements.
2. Document the Software Requirements Specification(SRS).
3. Identify use cases and develop the Use Case model.
4. Identify the conceptual classes and develop a Domain Model and also derive a Class Diagram from that.
5. Using the identified scenarios, find the interaction between objects and represent them using UML Sequence and Collaboration Diagrams
6. Draw relevant Statechart and Activity Diagrams .
7. Implement the system.
8. Test the software system for all the scenarios identified as per the use case diagram.
9. Improve the reusability and maintainability of the software system by applying appropriate design patterns.
10. Implement the Modified System and Test it for various scenarios.

Choice of Applications

1. Passport automation system. 2. Book bank 3. Exam registration 4. Stock maintenance system. 5. Online course reservation system 6. Airline/Railway reservation system 7. Software personnel management system 8. Credit card processing 9. e-book management system 10. Recruitment system 11. Foreign trading system 12. Conference management system 13. BPO management system 14. Library management system 15. Student information system

	Text Books	References
Learning Resources	1. Bernd Bruegge and Allen H. Dutoit, "Object-Oriented Software Engineering: Using UML, Patterns and Java", Third Edition, Pearson Education, 2009. 2. RogerS.Pressman,Object-Oriented Software Engineering: An Agile Unified Methodology, First Edition, Mc Graw-Hill International Edition, 2014.	1. Carlo Ghezzi,Mehdi Jazayeri,Dino Mandrioli, Fundamentals Software Engineering,2nd edition, PHI Learning Pvt. Ltd., 2010. 2. Craig Larman, Applying UML and Patterns,3rd ed,PearsonEducation,2005. 3.LenBass,Ingo Weber andLiming Zhu,"DevOps: A Software Architect's Perspective", Pearson Education, 2016 4. Rajib Mall, Fundamentals of Software Engineering, 3rd edition, PHI Learning Pvt. Ltd.,2009. 5. Stephen Schach,Object-Oriented and Classical Software Engineering,8th, McGraw-Hill, 2010.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24IT302	Course Name	FOUNDATIONS OF DATA SCIENCE	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the data science fundamentals and process.
- To learn to describe the data for the data science process.
- To learn to describe the relationship between data.
- To utilize the Python libraries for Data Wrangling.
- To present and interpret data using visualization libraries in Python

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Learn the key stages of data science process	U	2	2	1	2	2	-	-	-	1	1	1	2	2	3	3
CO-2:	Understand different types of data description for data science process	U	2	1	-	1	1	-	-	-	2	1	1	2	2	3	3
CO-3:	Gain knowledge on relationships between data	AN	2	2	1	2	2	1	1	-	1	2	1	3	3	2	3
CO-4:	Use the Python Libraries for Data Wrangling	AP	3	2	2	1	2	-	-	-	1	1	2	2	2	3	3
CO-5:	Apply visualization Libraries in Python to interpret and explore data	AP	2	2	1	2	2	-	-	-	1	1	1	2	3	2	3

Unit-1 INTRODUCTION	**9 Periods**
Data Science: Benefits and uses – Facets of Data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data Analysis –build the model– presenting findings and building applications - Data Mining - Data Warehousing – Analytics for Data Science – Examples of Data – Ethics in Data Science.	
Unit-2 DESCRIBING DATA	**9 Periods**
Basic Statistical descriptions of Data -Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores.– Probability distribution of Data	
Unit-3 DESCRIBING RELATIONSHIPS	**9 Periods**
Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations - Logistic regression –regression towards the mean.	
Unit-4 PYTHON LIBRARIES FOR DATA WRANGLING	**9 Periods**
Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, Boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables.	
Unit-5 DATA VISUALIZATION	**9 Periods**
Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – Data Visualization Techniques and Tools – three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn	
	Total Theory: 45 Periods

Suggested List of Experiments	Total Practical: 30 Periods

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.
2. Working with Numpy arrays .
3. Working with Pandas data frames.
4. Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics on the Iris data set.
5. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:
   a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
   b. Bivariate analysis: Linear and logistic regression modeling
   c. Multiple Regression analysis
   d. Also compare the results of the above analysis for the two data sets.
6. Apply and explore various plotting functions on UCI data sets.
   a. Normal curves
   b. Density and contour plots
   c. Correlation and scatter plots
   d. Histograms
   e. Three dimensional plotting.
7. Visualizing Geographic Data with Basemap.

	Text Books	References
Learning Resources	1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. (Unit I) 2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017. (Units II and III) 3. Jake Vander Plas, “Python Data Science Handbook”, O’Reilly, 2016. (Units IV and V) 4. Wes McKinney , “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter” , O’Reilly., 3rd Edition, 2022.	1.Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press,2014. 2.Foster Provost , Tom Fawcett , “Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking”

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24SD411	Course Name	Aptitude and Coding Skills -2	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering (Common to all Branches)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Build quantitative skills in ages, speed, time and distance
- Enhance analytical reasoning skills to solve problems in surds, indices, boats, streams, pipes, cisterns, allegation and mixtures
- Supplement foundational data structure concepts in programming
- Provide problem solving skills in data structures and algorithms
- Develop advanced level coding skills

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Solve aptitude problems in Ages, Speed, Time and Distance, Ratio and proportion, Arithmetic progression	AP															
CO-2:	Apply analytical reasoning skills to solve problems in surds, indices, boats, streams, pipes, cisterns, allegation and mixtures	AP															
CO-3:	Code for foundational data structure concepts	AP															
CO-4:	Apply data structures and algorithms in problem solving.	AP															
CO-5:	Design algorithms and code for advanced level problems	AN															

List of Exercises **30 periods**

1. **Quantitative Aptitude – Advanced Problems-I**
   Ages, Speed, Time and Distance, Ratio and proportion, Arithmetic progression
2. **Quantitative Aptitude – Advanced Problems-II**
   Surds-and-Indices, Boats-and-Streams, Pipes-Cisterns, allegation and mixtures
3. **Coding – Data Structure Foundational Concepts**
   Linked List – Singly and Doubly linked list, Stack and Queue, Array implementation of stack and queue
4. **Coding – Data Structure Moderate Problems**
   Linked list implementation of stack and queue, Problems using Trees and Graphs
5. **Coding – Data Structure Advanced-level problems**
   Hashing, Minimum path problems, Pattern search problems and problems using Greedy algorithms

Learning Assessment	
Continuous Learning Assessment (CLA) (100% weightage)	
Evaluation of Laboratory Observation, Record (60%)	Model Lab Exam (40%)

Course Code	24EL411	Course Name	INNOVATION AND PRODUCT DEVELOPMENT - 2 (CONCEPTUALIZATION)	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	24EL511
Course Offering Department		**Data Book/Codes/ Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- The students will learn to transform conceptual ideas into tangible designs and viable product concepts with focusing on customer needs and aspirations.
- This course focuses on the early stages of the product development process, emphasizing ideation, market analysis, conceptual design, and feasibility assessment

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes(CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Enumerate detailed product specifications, including dimensions, materials, software, and technical requirements	C	3	3	3	3	3	2			3			2			
CO-2:	Create sketches or digital renderings to visualize and refine the product design.	C	3	3	3	3	3	2			3			2			
CO-3:	Integrate insights from the Business Model Canvas to align the product concept with the business strategy.	AP	3	3	3	3	3	2			3			2			
CO-4:	Outline prototype development steps and resources with the Prototype Planning Canvas.	AP	3	3	3	3	3	2			3			2			
CO-5:	Determine the key features and functionalities of the MVP with the MVP Canvas, focusing on delivering maximum value to early adopters	AP	3	3	3	3	3	2			3			2			

List of Experiments

Students shall continue their semester 1 ideation to conceptualization focussing on shaping the product concept into a tangible design aligned with customer needs. They shall follow the below activities but not limited to;

Week 1-2: Defining detailed product specifications, covering aspects such as dimensions, materials, Software specifications and technical requirements

Week 3-4: Sketching or digital rendering/wireframe to visualize the design of a product, facilitating communication and idea refinement

Week 5-6: Incorporate insights from the Business Model Canvas to align the product concept with the overall business strategy, considering aspects such as revenue streams, cost structure, and customer segments.

Week 7-8: Utilize the Prototype Planning Canvas to outline the steps and resources required for prototype development, ensuring a systematic and efficient approach.

Week 9-10: Define the key features and functionalities of the Minimum Viable Product (MVP) using the MVP Canvas, focusing on delivering maximum value to early adopters with minimal resources.

Key Deliverables: Detailed product specifications, Initial sketches or digital renderings, Aligned Business Model Canvas, and a Structured Prototype Planning Canvas.

Learning Assessment

Continuous Learning Assessment (CLA) (100 % weightage)		
Report 40%	**Presentation 40%**	**Viva Voce 20%**

Mandatory Course-3

Course Code	24MC301	Course Name	INTRODUCTION TO WOMEN AND GENDER STUDIES	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce students with foundational concepts in Women and Gender Studies.
- Familiarize students with the key feminist theories to understanding gender inequality.
- Explore the historical and contemporary women's movements globally and in the Indian context.
- Study the intersection of gender with language, representation, and media.
- Equip students with critical tools to challenge gender norms and engage in informed gender discourse.

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand and differentiate core concepts of gender and analyze its societal structures.	U			2			1									
CO-2:	Critically evaluate various feminist theoretical frameworks and eco feminist perspectives.	E			2			1									
CO-3:	Recognize the development and impact of women's movements both globally and in India.	U			2			1									
CO-4:	Comprehend and assess the role of discourse in perpetuating gender norms through language.	U			2			1				3					
CO-5:	Critically assess gender representation in mainstream, alternative and social media platforms.	E			2		2	1									

Unit-1	**CONCEPTS**	***6 Periods***
Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.		
Unit-2	**FEMINIST THEORY**	***6 Periods***
Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.		
Unit-3	**WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL**	***6 Periods***
Rise of Feminism in Europe and America. Women's Movement in India.		
Unit-4	**GENDER AND LANGUAGE**	***6 Periods***
Linguistic Forms and Gender. Gender and narratives.		
Unit-5	**GENDER AND REPRESENTATION**	***6 Periods***
Advertising and popular visual media. Gender and Representation in Alternative Media. Gender and social media.		
	Total:	**30 Periods**

<table>
<tr><td rowspan="2">Learning Resources</td><td>Text Books</td><td>References</td></tr>
<tr><td>1. Colleen Lutz Clemens, “Introduction to Women’s & Gender Studies” 1st Edition, The Pennsylvania Alliance, 2023.
2. Madhu Nagla “Women and Gender Studies” 1st Edition, Rawat Publications, 2025.</td><td>1. Melissa J. Gillis , Andrew T. Jacobs “ Introduction to Women's and Gender Studies : An Interdisciplinary Approach” 3rd Edition, 2024.
2. L. Ayu Saraswati, Barbara L. Shaw, and Heather Rellihan, “Introduction to Women's, Gender and Sexuality Studies: Interdisciplinary and Intersectional Approaches” 3rd Edition, Oxford University Press, 2025.</td></tr>
</table>

<table>
<tr><td colspan="3">Learning Assessment</td></tr>
<tr><td colspan="2">Continuous Learning Assessment (CLA) (100% weightage)</td><td rowspan="2">End Semester Examination
(0% weightage)</td></tr>
<tr><td>Average of Internal Test
(0%)</td><td>Critical Thinking Assessment
(100%)</td></tr>
</table>

Course Code	24MC302	Course Name	ELEMENTS OF LITERATURE	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To make the students aware about the finer sensibilities of human existence through an art form.
- The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.	U						2	1					3			
CO-2:	Differentiate between fiction, fact, and literary truth, and explain how fiction constructs meaning.	U						1						3			
CO-3:	Interpret the emotional and imaginative elements that define poetic expression.	U						2						3			
CO-4:	Students will understand the basic elements of drama and how it is performed on stage.	U						1						2			
CO-5:	Students will identify different types of drama like tragedy, comedy and satire.	U						2						2			

Unit-1 **RELEVANCE OF LITERATURE** ***6 Periods***

Enhances Reading, thinking, discussing and writing skills-Develops finer sensibility for better human relationship-Increases understanding of the problem of humanity without bias-Providing space to reconcile and get a cathartic effect.

Unit-2 **ELEMENTS OF FICTION** ***6 Periods***

Fiction, fact and literary truth-Fictional modes and patterns-Plot character and perspective.

Unit-3 **ELEMENTS OF POETRY** ***6 Periods***

Emotions and imaginations-Figurative language-Simile, metaphor, conceit, symbol, pun and irony-Personification and animation-Rhetoric and trend.

Unit-4 **FUNDAMENTALS OF DRAMA** ***6 Periods***

Elements of drama. Drama as a representational act. Content mode and elements. Theatrical performance.

Unit-5 **FORMS AND FUNCTIONS OF DRAMA** ***6 Periods***

Drama as narration, mediation and persuasion. Features of comedy. Features of satire.

Total: 30 Periods

Learning Resources	Text Books	References
	1.An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007. 2.An Introduction to Literary Studies, Mario Klarer, Routledge, 2013. 3.The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991. 4.The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114. 5.The Elements of Drama, J.L.Styan, Literary Licensing, 2011.	To be decided by the teacher and student, on the basis of individual students so as to enable him or her to write the term paper.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC303	Course Name	FILM APPRECIATION	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Students will understand the basic elements involved in making a film, including equipment, script, crew and production process.	U						2						2			
CO-2:	Students will learn how film language developed from early silent films to talkies, and understand key milestones in film history.	U						2						3			
CO-3:	Students will be able to recognize major film theories and apply them to analyze and appreciate films	U						2						1			
CO-4:	Students will explore the development of cinema in different countries like the Soviet Union, Japan, Italy and the U.S	U						1						2			
CO-5:	Students will gain knowledge about the history of Indian Cinema, important directors, regional films and documentaries.	U						2						2			

Unit-1 **THE COMPONENT OF FILMS**	***6 Periods***
A-1:The material and equipment A-2: The story, screenplay and script A-3: The actors, crew members, and the director A-4: The process of film making… structure of a film	
Unit-2 **EVOLUTION OF FILM LANGUAGE**	***6 Periods***
B-1: Film language, form, movement etc. B-2: Early cinema… silent film (Particularly French) B-3: The emergence of feature films: Birth of a Nation B-4: Talkies	
Unit-3 **FILM THEORIES AND CRITICISM/APPRECIATION**	***6 Periods***
C-1: Realist theory; Auteurists C-2: Psychoanalytic, Ideological, Feminists C-3: How to read films? C-4: Film Criticism / Appreciation	

Unit-4	**DEVELOPMENT OF FILMS**	***6 Periods***
D-1: Representative Soviet films D-2: Representative Japanese films D-3: Representative Italian films D-4: Representative Hollywood film and the studio system		
Unit-5	**INDIAN FILMS**	***6 Periods***
E-1: The early era E-2: The important films made by the directors E-3: The regional films E-4: The documentaries in India		
	Total:	**30 Periods**

	Text Books	**References**
Learning Resources	A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.	To be decided by the course handling faculty and student, on the basis of individual students.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC304	Course Name	WELL – BEING WITH TRADITIONAL PRACTICES – YOGA, AYURVEDA, SIDDHA	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few life style changes that will prevent many health disorders
- To be cool and handle every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Learn about holistic health and lifestyle habits to prevent disease and stay healthy.	U	2	1	3			2	2	3	3	2		3			
CO-2:	Understand the importance of a balanced diet, nutrients, and healthy cooking for good nutrition and weight management.	U	2	1	3				1	3	3	2		3			
CO-3:	Explore Ayurveda and Siddha for their preventive health practices and lifestyle approaches.	U	2	1	3			2	1	3	3	2		3			
CO-4:	Learn how to manage stress, improve sleep, boost immunity, and support mental well-being.	U	2	1	3			2	1	3	3	2		3			
CO-5:	Understand and practice yoga for physical health, mental clarity, and overall well-being.	U	1	1	3			2	1	3	3	2		3			

Unit-1 **HEALTH AND ITS IMPORTANCE** ***6 Periods***

Health: Definition-Importance of maintaining health- More importance on prevention than treatment Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath. Present health status- The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities. Types of diseases and disorders- Lifestyle disorders – Obesity – Diabetes – Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues. Causes of the above diseases /disorders -Importance of prevention of illness- Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Unit-2 **DIET** ***6 Periods***

Role of diet in maintaining health- energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.
Balanced Diet and its 7 Components- Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water. Food additives and their merits & demerits- Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

Definition of BMI and maintaining it with diet: Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM		
Unit-3	**ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH**	***6 Periods***
AYUSH systems and their role in maintaining health- preventive aspect of AYUSH - AYUSH as a soft therapy. Secrets of traditional healthy living- Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life. Principles of Siddha & Ayurveda systems- Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles – Uyir Thathukkal(Tri-Dosha Theory) – Udal Thathukkal		
Unit-4	**MENTAL WELLNESS**	***6 Periods***
Emotional health- Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions. Stress management- Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement. Sleep- Sleep and its importance for mental wellness - Sleep and digestion.		
Unit-5	**YOGA**	***6 Periods***
Definition and importance of yoga- Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.		
		Total: 30 Periods

Learning Resources	**Text Books**	**References**
	1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA 2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California	To be decided by the teacher and student, on the basis of individual students so as to enable him or her to write the term paper.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC305	Course Name	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To help students understand the basic ideas and methods used in writing history, especially about science and technology.
- To introduce students to important Indian thinkers who studied the history of science and technology.
- To learn about how science and technology developed in ancient India.
- To study the growth and exchange of scientific knowledge in medieval India.
- To understand how British rule affected science and technology in India.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Students will be able to explain basic historical ideas and how they relate to science and technology.	U						1						2			
CO-2:	Students will know about key Indian scholars and their work on science and technology history.	U						2						2			
CO-3:	Students will describe important scientific and technological progress in ancient India.	U						1						2			
CO-4:	Students will understand the scientific developments and cultural exchanges in medieval India.	U						2						1			
CO-5:	Students will explain how colonialism changed science and technology in India.	U						1						2			

Unit-1 **CONCEPTS AND PERSPECTIVES** ***6 Periods***

Meaning of History, Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

Unit-2 **HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA** ***6 Periods***

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

Unit-3 **SCIENCE AND TECHNOLOGY IN ANCIENT INDIA** ***6 Periods***

Technology in pre-historic period, Beginning of agriculture and its impact on technology, Science and Technology during Vedic and Later Vedic times Science and technology from 1st century AD to C-1200.

Unit-4 **SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA** ***6 Periods***

Legacy of technology in Medieval India, Interactions with Arabs, Development in medical knowledge, interaction between Unani and Ayurveda and alchemy Astronomy and Mathematics: interaction with Arabic Sciences, Science and Technology on the eve of British conquest

Unit-5	SCIENCE AND TECHNOLOGY IN COLONIAL INDIA	6 Periods
Science and the Empire, Indian response to Western Science Growth of techno-scientific institutions		
		Total: 30 Periods

	Text Books	References
Learning Resources	1.History of Indian Science, Technology and Culture (Vol. III, Part I), A. Rahman,1999, Oxford University Press.	1.History of Science, Philosophy and Culture in Indian Civilization: Science, Technology and Medicine in Colonial India (Vol. XV, Part 1), Deepak Kumar, 1999, Pearson Education India

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC306	Course Name	POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfil them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the principles of a humane society and the importance of harmony within individuals, communities, and nature.	U						1	1					2			
CO-2:	Analyze the characteristics and impacts of capitalism, liberal democracy, fascism, and totalitarian regimes in modern history.	AN						2						1			
CO-3:	Explain the fundamental concepts of communism and welfare states and their influence on society and human empowerment.	U						1	2					1			
CO-4:	Appreciate Gandhian philosophy and its relevance to Indian civilization, community governance, and ecological balance.	U						1						2			
CO-5:	Evaluate the role of technology and education in societal development and envision future directions for social progress.	E						2	1					2			

Unit-1	**CONCEPTS OF HUMANE SOCIETY AND SOCIETAL HARMONY**	***6 Periods***
Considerations for humane society, holistic thought. Human desires, harmony in self, relationships, society, and nature. Societal systems		
Unit-2	**ECONOMIC AND POLITICAL SYSTEMS – CAPITALISM, FASCISM, AND TOTALITARIANISM**	***6 Periods***
Capitalism: free markets, demand-supply, competition, laissez-faire, monopolies, imperialism. Liberal democracy. Fascism, totalitarianism, World War I & II, Cold War		
Unit-3	**COMMUNISM AND WELFARE STATE**	***6 Periods***
Communism: mode of production, theory of labour, surplus value, class struggle, dialectical & historical materialism. Russian and Chinese models . Welfare state, relation with human desires, empowerment		
Unit-4	**GANDHIAN THOUGHT AND INDIAN CIVILIZATION**	***6 Periods***
Gandhian philosophy: Swaraj, decentralized economy and polity, community, control over lives. Relationship with nature. Essential elements of Indian civilization		
Unit-5	**TECHNOLOGY, EDUCATION, AND FUTURE DIRECTIONS**	***6 Periods***
Technology as a driver of society. Role of education in shaping society. Future societal directions.		
	Total:	**30 Periods**

Learning Resources	Text Books	References
	1. Social and Political Philosophy: Readings from Plato to Gandhi. John G. Gunnell, Robert B. Talisse. Wadsworth Publishing	1. Political Philosophy: A Very Short Introduction, David Miller, Oxford University Press.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC307	Course Name	INDIAN CONSTITUTION	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the historical background and philosophical foundations of the Indian Constitution.
- Explore the structure and functions of both Union and State Governments under the Constitution.
- Gain knowledge of the Fundamental Rights and Directive Principles of State Policy.
- Study the roles of various political institutions and judicial bodies in the governance of India.
- Develop an understanding of the process of constitutional amendments and the dynamic nature of the Constitution.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Demonstrate an understanding of the evolution and key philosophical principles of the Indian Constitution.	U						1		1							
CO-2:	Analyze the structure, functions, and powers of the Union and State Governments.	AN						1		1							
CO-3:	Assess the relationship between Fundamental Rights and Directive Principles of State Policy.	E						1		1							
CO-4:	Critically examine the role of the Judiciary in interpreting the Constitution.	E						1		1							
CO-5:	Understand and explain the processes involved in the amendment of the Constitution.	U						1		1							

Unit-1	**INTRODUCTION TO THE INDIAN CONSTITUTION**	***6 Periods***
Historical Background - Constituent Assembly of India - Philosophical Foundations of the Indian Constitution - Preamble of the Constitution- Fundamental Rights -Directive Principles of State Policy (DPSP)- Fundamental Duties – Citizenship - Constitutional Remedies for Citizens		
Unit-2	**UNION GOVERNMENT**	***6 Periods***
Structure of Union Government - President of India - Vice President of India - Prime Minister and Cabinet - Parliament of India - Supreme Court of India		
Unit-3	**STATE GOVERNMENT**	***6 Periods***
Structure of State Government - Governor of the State - Chief Minister and Cabinet - State Legislature - Judicial System in States (High Courts and Subordinate Courts)		
Unit-4	**LOCAL GOVERNMENT AND PANCHAYATS**	***6 Periods***
Structure and Functions of Local Government - Panchayati Raj System - Municipalities and Local Administration		
Unit-5	**AMENDMENT PROCESS AND SPECIAL PROVISIONS**	***6 Periods***
Constitutional Amendment Process - Special Provisions for States -Recent Amendments to the Constitution		
	Total:	**30 Periods**

	Text Books	References
Learning Resources	1. "Introduction to the Constitution of India" by D.D. Basu 2. "Indian Polity" by M. Laxmikanth 3. "The Constitution of India" by P.M. Bakshi	1."Indian Constitution: A Comprehensive Commentary" by H.M.Seervai 2."The Indian Constitution" by V. N. Shukla 3."Constitutional Law of India" by J.N. Pandey 4."Indian Political System" by Rajni Kothari 5."Constitution of India: Text and Commentary" by S. C. Kashyap

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC308	Course Name	BUREAU OF INDIAN STANDARDS	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To provide an understanding of the history, evolution, and role of the Bureau of Indian Standards (BIS) in national and international standardization processes.
- To familiarize students with the BIS Act, rules, and regulations, and the legal framework governing the certification and quality control processes.
- To explore the various types of Indian Standards (IS), codes of practice, and their application across different sectors.
- To introduce the services and activities provided by BIS, including product certification, quality control, and consumer protection.
- To highlight the international cooperation of BIS, its role in global standardization forums, and its contributions to global trade and sustainable development.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Demonstrate a clear understanding of the Bureau of Indian Standards, its functions, history, and importance in the standardization process.	U		1				2	1	1		2		3			
CO-2:	Analyze the BIS Act and its legal framework, understanding the processes of certification, compliance, and the legal consequences of non-adherence.	AN		3				2		3		2		3			
CO-3:	Identify various Indian Standards (IS) and their relevance in ensuring quality, safety, and uniformity in products and services.	AP		2				1	1	2		2		3			
CO-4:	Understand the services offered by BIS, including product certification and quality control, and how they benefit industries, consumers, and the economy.	U		1				2		2		2		3			
CO-5:	Evaluate the role of BIS in international cooperation, particularly in aligning Indian standards with global standards, and its contribution to international trade and sustainable development goals.	E		2				2	1	2		3		2			

Unit-1	**INTRODUCTION TO BUREAU OF INDIAN STANDARDS (BIS)**	***6 Periods***
Overview of BIS - History and Evolution of BIS - Role and Functions of BIS -BIS Organizational Structure - Importance of Standardization in India - BIS and its relationship with International Standardization Bodies (ISO, IEC, etc.)		
Unit-2	**BIS ACTS, RULES, AND REGULATIONS**	***6 Periods***
BIS Act, 2016: Objectives and Provisions - Legal Framework and Powers of BIS - Certification Marks (ISI Mark) - BIS Certification Process for Products and Services = Legal Consequences of Non-Compliance.		
Unit-3	**STANDARDS AND CODES OF PRACTICE**	***6 Periods***
Types of Standards: Product Standards, Process Standards, etc. - National Standards and their Importance - IS (Indian Standard) Codes and their Application - Adoption of International Standards in India - Role of BIS in Developing Standards for Various Sectors.		
Unit-4	**BIS SERVICES AND ACTIVITIES**	***6 Periods***
Product Certification and Quality Control - Training and Awareness Programs by BIS - BIS and Consumer Protection - Role of BIS in Ensuring Safety and Quality of Products - Research and Development Activities by BIS.		

Unit-5	BIS AND INTERNATIONAL COOPERATION	6 Periods
BIS’s Role in International Standardization Forums - BIS’s Membership in ISO, IEC, and Other Global Bodies - Harmonization of Indian Standards with International Standards - BIS's Contributions to Sustainable Development Goals (SDGs) - BIS and Global Trade: Ensuring Export Quality and Compliance.		
	Total:	**30 Periods**

	Text Books	References
Learning Resources	1."Bureau of Indian Standards (BIS) Handbook" Bureau of Indian Standards. 2."Indian Standards and Quality Control" M. P. P. K. Nair. 3."Standardization and Quality Control" S. K. Gupta.	1."The Bureau of Indian Standards Act, 2016" Indian Government. 2."Fundamentals of Quality Control and Improvement". Amitava Mitra. 3."International Standards and Certification" C. B. Gupta. 4."Standardization in Global Supply Chains: Opportunities and Challenges". Rajesh Kumar.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

Course Code	24MC309	Course Name	DISASTER MANAGEMENT AND PREPAREDNESS	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department		**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the basic concepts and key terms related to disasters and risks.
- Help students understand different types of natural and man-made disasters.
- Explain the various impacts that disasters create on people, society, and the environment.
- Provide knowledge on disaster risk reduction methods and disaster management systems.
- Understand how development activities and environmental changes influence disaster risks.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain basic disaster-related terms and concepts.	U						1	1		2			2			
CO-2:	Classify disasters and describe major natural and man-made hazards in India.	U						1	2		2			2			
CO-3:	Describe the different impacts of disasters have on people and the environment.	U						1	3		2			2			
CO-4:	Outline the disaster management cycle and identify key risk-reduction measures.	U						2	3		2			3			
CO-5:	Explain how development and environmental changes can increase or reduce disaster risks.	U						2	3		2			3			

Unit-1 **Introduction** ***6 Periods***

Concepts and definitions: disaster, hazard, vulnerability, risks- severity, frequency and details, capacity, impact, prevention, mitigation).

Unit-2 **Disasters** ***6 Periods***

Disasters - Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility. Illustrative Case Studies in India during 2015-2025.

Unit-3 **Disaster Impacts** ***6 Periods***

Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

Unit-4 **Disaster Risk Reduction (DRR)** ***6 Periods***

Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Unit-5	**Disasters, Environment and Development**	***6 Periods***
Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods. Sustainable & Climate-Resilient Development		
	Total:	**30 Periods**

	Text Books	**References**
Learning Resources	1. http://ndma.gov.in/ (Home page of National Disaster Management Authority) 2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs). 3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall. 4. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication	1. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation 2. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003 3. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Semester V

Course Code	24CS501	Course Name	COMPUTER NETWORKS	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	DIGITAL PRINCIPLES AND COMPUTER ORGANIZATION	**Co- requisite Courses**	NIL	**Progressive Courses**	NETWORK SECURITY, SOFTWARE DEFINED NETWORKS
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand network communication fundamentals, protocol layering, and the role of application layer protocols in real-world scenarios.
- Analyze transport-layer protocols and their mechanisms for connection management, flow control, and congestion control.
- Visualize the end-to-end flow of information.
- Learn the functions of the network layer and the various routing protocols.
- Familiarize the functions and protocols of the Transport layer.

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Evaluate the role of application layer protocols (HTTP, FTP, Email, DNS, SNMP) in network communication.	AP	3	2	1	1	3	-	-	-	-	1	1	3	2	3
CO-2:	Compare transport-layer protocols (UDP, TCP, SCTP) and their mechanisms for flow and congestion control.	AP	3	3	2	2	2	-	-	-	1	1	2	3	-	3
CO-3:	Describe the role of packet switching in modern enterprise networks.	U	3	2	3	1	2	-	-	2	-	3	3	3	-	3
CO-4:	Apply multicast routing protocols (DVMRP, PIM) for optimizing bandwidth usage in large-scale networks	AP	3	3	3	1	3	-	-	2	1	2	1	3	-	2
CO-5:	Apply transmission media selection techniques for different communication requirements.	AP	3	2	2	3	3	2	-	-	1	-	1	1	-	1

Unit-1	**INTRODUCTION AND APPLICATION LAYER**	**10 Periods**
Data Communication - Networks - Network Types - Protocol Layering - TCP/IP Protocol suite - OSI Model - Introduction to Sockets - Application Layer protocols: HTTP - FTP - Email protocols (SMTP - POP3 - IMAP - MIME) - DNS - SNMP-Case Study: Software Defined Networking for IoT		
Unit-2	**TRANSPORT LAYER**	**9 Periods**
Introduction - Transport-Layer Protocols:UDP - TCP: Connection Management - Flow control - Congestion Control - Congestion avoidance (DECbit, RED) - SCTP - Quality of Service-Case study-Transport Layer in IoT and Real-Time Communication Systems		
Unit-3	**NETWORK LAYER**	**7 Periods**
Switching : Packet Switching- Internet protocol - IPV4 - IP Addressing -Subnetting - IPV6, ARP, RARP, ICMP, DHCP-Application of switching and networking for a corporate enterprise.		
Unit-4	**ROUTING**	**7 Periods**
Routing and protocols:Unicast routing-Distance Vector Routing-RIP-Link State Routing-OSPF - Path-vector routing - BGP - Multicast Routing: DVMRP - PIM		

Unit-5	DATA LINK AND PHYSICAL LAYERS	12 Periods
Data Link Layer -Framing-Flow control-Error control-Data-Link Layer Protocols -HDLC- PPP - Media Access Control - Ethernet Basics - CSMA/CD - Virtual LAN - Wireless LAN (802.11) - Physical Layer: Data and Signals - Performance - Transmission media- Switching - Circuit Switching		
		Total Theory: 45 Periods

List of Experiments — **Total Practical: 30 Periods**

1. Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture ping and trace route PDUs using a network protocol analyzer and examine.
2. Write a HTTP web client program to download a web page using TCP sockets.
3. Applications using TCP sockets like: a)Echo client and echo server b)Chat
4. Simulation of DNS using UDP sockets.
5. Use a tool like Wireshark to capture packets and examine the packets
6. Write a code simulating ARP/RARP protocols.
7. Study of Network simulator(NS) and Simulation of Congestion Control Algorithms using NS.
8. Study of TCP/UDP performance using Simulation tool.
9. Simulation of Distance Vector/Link State Routing algorithm.
10. Simulation of an error correction code(like CRC)

	Text Books	References
Learning Resources	1. James F.Kurose, Keith W.Ross,Computer Networking, A Top-Down Approach Featuring the Internet, Eighth Edition, Pearson Education, 2021. 2. BehrouzA.Forouzan,Data Communications and Networking with TCP/IP Protocol Suite,Sixth Edition TMH, 2022	1. LarryL. Peterson,BruceS. Davie, Computer Networks:A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012. 2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013. 3. Nader F.Mir, Computer and Communication Networks, Second Edition, Prentice Hall,2014. 4. Ying-DarLin,Ren-Hung Hwang, Fred Baker,"Computer Networks: An Open Source Approach", McGraw Hill, 2012.

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS502	Course Name	COMPILER DESIGN	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Theory of Computation	Co- requisite Courses	Nil	Progressive Courses	
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To learn the various phases of compiler.
- To learn the various parsing techniques.
- To understand intermediate code generation and run-time environment.
- To learn to implement code generator.
- To learn to implement code optimization.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the techniques in different phases of a compiler and learn to use LEX tool	U	3	3	3	3	-	-	-	-	3	3	1	3	2	3	2
CO-2:	Apply different parsing algorithms to develop a parser and learn to use YACC tool	AP	3	3	3	3	3	-	-	-	3	2	3	2	2	1	2
CO-3:	Understand semantics rules (SDT), intermediate code generation and run-time environment	U	3	3	2	2	3	-	-	-	3	1	1	1	2	2	3
CO-4:	Implement code generation and apply code generation techniques	AP	3	2	2	1	1	-	-	-	2	3	2	3	1	2	1
CO-5:	Understand the techniques in code optimization	U	3	3	3	2	1	-	-	-	2	1	1	3	2	1	2

Unit-1	**INTRODUCTION TO COMPILERS & LEXICAL ANALYSIS**	**8 Periods**
Introduction- Translators- Compilation and Interpretation- The Phases of Compiler – Role of Lexical Analyzer – Input Buffering – Specification of Tokens– Recognition of Tokens – Finite Automata – Regular Expressions to Automata NFA-DFA – Minimizing DFA – Compiler construction tools - Language for Specifying Lexical Analyzers.		
Unit-2	**SYNTAX ANALYSIS**	**11 Periods**
Role of Parser – Grammars – Context-free grammars – Writing a grammar - Top Down Parsing - General Strategies - Predictive Parser- LL(1) Parser - Shift Reduce Parser-LR Parser- LR (0) Item - Construction of SLR Parsing Table - LALR Parser - Error Handling and Recovery in Syntax Analyzer- YACC tool - Design of a syntax Analyzer for a Sample Language.		

Unit-3	**SYNTAX DIRECTED TRANSLATION & INTERMEDIATE CODE GENERATION**	**9 Periods**
Syntax directed Definitions-Construction of Syntax Tree-Bottom-up Evaluation of S-Attribute Definitions- Design of predictive translator - Type Systems-Specification of a simple type Checker-Equivalence of Type Expressions-Type Conversions. Intermediate Languages: Syntax Tree, ThreeAddress Code – Quadruples, Triples and Indirect triples -Translation of Expressions, Type Checking, Back patching		
Unit-4	**RUN-TIME ENVIRONMENT AND CODE GENERATION**	**9 Periods**
Runtime Environments – source language issues – Storage organization – Storage Allocation Strategies: Static, Stack and Heap allocation - Parameter Passing-Dynamic Storage Allocation - Issues in the Design of a code generator – Basic Blocks and Flow graphs - Design of a simple Code Generator - Optimal Code Generation for Expressions– Dynamic Programming Code Generation.		
Unit-5	**CODE OPTIMIZATION**	**8 Periods**
Principal Sources of Optimization – Peep-hole optimization - DAG- Optimization of Basic Blocks -Global Data Flow Analysis - Efficient Data Flow Algorithm		
		Total Theory: 45 Periods

Suggested List of Experiments	**Total Practical: 30 Periods**

1. Study of Lex tools
2. Using the LEX tool, Develop a lexical analyzer and Create a symbol table while recognizing identifiers.
3. Implement a Lexical Analyzer using any language
4. Generate YACC Program to recognize a valid arithmetic expression that uses operator +, -, * and /.
5. Program to recognize a valid variable which starts with a letter followed by any number of letters or digits using YACC
6. Implement YACC Program to recognize a valid control structures syntax of C language (For loop,while loop, if-else, if-else-if, switch-case, etc.).
7. Implementation of calculator using LEX and YACC
8. Generate three address code for a simple program using LEX and YACC.
9. Implement type checking using Lex and Yacc.
10. Implement simple code optimization techniques (Constant folding, Strength reduction and Algebraic transformation)
11. Implement back-end of the compiler for which the three address code is given as input and the 8086 assembly language code is produced as output
12. Mini project using AI tools in any one phase.

	Text Books	**References**
Learning Resources	1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles,Techniques and Tools”, Second Edition, Pearson Education, 2024.	1. *Engineering a Compiler*, Keith D. Cooper and Linda Torczon, 3rd Edition, Morgan Kaufmann Publishers, 2022. 2. *Crafting Interpreters*, Robert Nystrom, Genever Benning Publishers, 2021. 3. *Writing a C Compiler*, Nora Sandler, No Starch Press, 2024. 4. *Introduction to Compilers and Language Design*, Douglas Thain, 2nd Edition, Lulu Press, 2023.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
  - Lower-order thinking skills: not more than 40%
  - Higher-order thinking skills: not less than 60%

Course Code	24CS503	Course Name	Cryptography and Cyber Security	Course Category	T	Professional Core Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Learn to analyze the security of in-built cryptosystems.
- Know the fundamental mathematical concepts related to security.
- Develop cryptographic algorithms for information security.
- Comprehend the various types of data integrity and authentication schemes
- Understand cyber crimes and cyber security.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Explain core security concepts, attacks, and basic cryptographic principles.	U	3	3	1	2	1	-	-	-	-	1	-	2	2	1	3
CO-2:	Apply mathematical concepts to analyze and use symmetric key algorithms.	AP	3	3	3	2	1	-	-	-	-	1	-	2	3	2	3
CO-3:	Apply the different cryptographic operations of public key cryptography .	AP	3	3	3	2	1	-	-	-	-	1	-	2	3	2	3
CO-4:	Apply authentication methods, hash functions, and digital signatures.	AP	3	3	3	2	1	-	-	-	-	1	-	2	3	2	3
CO-5:	Identify cybercrimes and apply security measures across technologies.	AN	3	3	3	2	1	1	1	1	-	1	-	2	3	2	3

Unit-1	**INTRODUCTION TO SECURITY**	**9 Periods**
Computer Security Concepts - The OSI Security Architecture - Security Attacks - Security Services and Mechanisms - A Model for Network Security - Classical encryption techniques: Substitution techniques, Transposition techniques, Steganography - Foundations of modern cryptography: Perfect security - Information Theory - Product Cryptosystem – Cryptanalysis.		
Unit-2	**SYMMETRIC CIPHERS**	**8 Periods**
SYMMETRIC KEY CIPHERS: SDES - Block Ciphers - DES- Differential and linear cryptanalysis - Block cipher design principles - Block cipher mode of operation - AES - Pseudorandom Number Generators - RC4.		

Unit-3	ASYMMETRIC CRYPTOGRAPHY	9 Periods
MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing – Euler's totient function, Fermat's and Euler's Theorem – Chinese Remainder Theorem – Exponentiation and logarithm. ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange –- Elliptic curve arithmetic – Elliptic curve cryptography.		
Unit-4	**INTEGRITY AND AUTHENTICATION ALGORITHMS**	**10 Periods**
Authentication requirement – Authentication function – MAC – Hash function – Security of hash function: HMAC, CMAC -SHA 512 – Digital signature and authentication protocols – DSS – Schnorr Digital Signature Scheme – ElGamal cryptosystem – Entity Authentication: Biometrics, Passwords, Challenge Response protocols – Authentication applications – Kerberos- - Key management and distribution – Symmetric key distribution using symmetric and asymmetric encryption – Quantum Key distribution -Distribution of public keys – X.509 Certificates.		
Unit-5	**CYBER SECURITY**	**9 Periods**
Cyber Crime and Information Security – Classifications of Cyber Crimes – Tools and Methods – Password Cracking- Brute force attacks-Rainbow attacks-Keyloggers, Spywares, Trojan Horses and backdoors-DoS ,DDoS attacks, SQL Injection – Network Access Control – Cloud Security – Web Security – Wireless Security		
		Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. William Stallings, "Cryptography and Network Security - Principles and Practice", Eighth Edition, Pearson Education, 2024. 2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber crimes, Computer Forensics and Legal Perspectives", First Edition, Wiley India, 2011.	1. Behrouz A. Ferouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3rd Edition, Tata Mc Graw Hill, 2015. 2. Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, "Security in Computing", Fifth Edition, Prentice Hall, New Delhi, 2015.

Learning Assessment		
Continuous Learning Assessment (CLA) (50% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24IT401	**Course Name**	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	**Course Category**	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To study about uninformed and heuristic search techniques
- To learn techniques for reasoning under uncertainty
- To understand Machine and supervised learning algorithms
- To Study about ensembling and unsupervised learning algorithms
- To learn the basics of deep learning using neural networks

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Use appropriate Search Algorithms for Problem Solving	AP	3	2	3	3	-	-	-	-	1	3	3	3	3	2	1
CO-2:	Apply Logical Reasoning and Decision-Making in Uncertainty	AP	1	1	1	3	1	-	-	-	1	2	1	3	3	2	2
CO-3:	Apply real world problems for Supervised Learning Models	AP	2	1	2	1	1	-	-	-	2	1	1	3	3	3	2
CO-4:	Use Ensemble and Unsupervised Learning Models	AP	3	1	3	1	-	-	-	-	2	1	2	1	3	3	2
CO-5:	Apply and Train Deep Learning Neural Network Models	AP	3	1	1	2	2	-	-	-	3	1	2	3	3	3	3

Unit-1 PROBLEM SOLVING **9 Periods**

Introduction to AI - AI Applications -Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).

Unit-2 PROBABILISTIC REASONING **9 Periods**

Acting under uncertainty – Bayesian inference – Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

Unit-3 SUPERVISED LEARNING **9 Periods**

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.

Unit-4 ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING **9 Periods**

Ensemble Learning - Combining multiple learners: Model combination schemes, Voting bagging, boosting, and stacking. Unsupervised learning - Clustering Analysis, K-means, Instance Based Learning - KNN, Gaussian mixture models and Expectation maximization.

Unit-5 NEURAL NETWORKS **9 Periods**

Perceptron- Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks – Unit saturation (aka the vanishing gradient problem) – CNN- RNN-ANN- ReLU, hyperparameter tuning, batch normalization, regularization, dropout. Application of Deep Learning Architectures in Large Language Models (LLMs).

Total Theory: 45 Periods

Suggested List of Experiments	Total Practical: 30 Periods
1. Implementation of Uninformed search algorithms 2. Implementation of Informed search algorithms 3. Implement naive Bayes models for real world problems 4. Implement Bayesian Networks 5. Build Regression models 6. Build decision trees and random forests 7. Build SVM models 8. Implement ensembling techniques 9. Implement clustering algorithms 10. Implement EM for Bayesian networks 11. Build simple NN models 12. Build deep learning NN model.	

	Text Books	References
Learning Resources	1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021. 2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.	1. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, Pearson Education,2007 2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008 3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006 4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013 (http://nptel.ac.in/) 5. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006. 6. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997. 7. Charu C. Aggarwal, “Data Classification Algorithms and Applications”, CRC Press, 2014 8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012. 9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24SD511	Course Name	Advanced Aptitude and Coding Skills – 1	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering (Common to all branches)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To strengthen analytical and quantitative skills with advanced-level aptitude topics
- To enhance object-oriented programming principles using Java for modular and reusable code design

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply advanced logical reasoning and data interpretation to complex scenarios	AP															
CO-2:	Solve quantitative problems involving time–work, probability, permutations–combinations with constraints, and geometry–mensuration	AN															
CO-3:	Understand and apply object-oriented principles such as encapsulation, inheritance, and polymorphism using Java	AP															
CO-4:	Design and implement algorithms using recursion, divide-and-conquer, and dynamic programming in Java	AN															
CO-5:	Develop modular and reusable Java programs for mathematical and real-world problem statements	C															

List of Exercises **30 Periods**

1. Time and Work, Work–Wages, Pipes–Cistern combinations (complex cases)
2. Permutation and Combination with Restrictions
3. Probability (conditional, Bayes theorem, expected value)
4. Geometry and Mensuration (2D & 3D solids)
5. Algebraic Equations – Linear, Quadratic, and Inequalities
6. Set Theory, Venn Diagram-based Logical Data Interpretation

7. Introduction to Java Programming: Syntax, data types, control structures
8. OOP Principles: Classes, objects, constructors, encapsulation, inheritance, polymorphism
9. Interfaces and Abstract Classes: Design flexibility and hierarchy
10. Exception Handling and Packages
11. Recursion and Divide-and-Conquer in Java: Implementing quick sort, merge sort, and binary search
12. Dynamic Programming and Greedy Algorithms in Java
13. File Handling and Basic I/O Streams

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage		
Written Test (20%)	Proctored Test (Two test during assessment schedule) (40%)	Performance (Daily Challenge + Daily Tracks + Coding test) (40%)

Course Code	24EL511	Course Name	INNOVATION AND PRODUCT DEVELOPMENT - 3 (Prototype development and Testing)	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	24EL411 INNOVATION AND PRODUCT DEVELOPMENT -2 (Conceptualization)	Co- requisite Courses	Nil	Progressive Courses	24EL611 INNOVATION AND PRODUCT DEVELOPMENT -4 (Patent Filing/Startup Registration)
Course Offering Department	Mechanical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is :***

- To guide students in developing and testing a functional prototype based on given design specifications.
- To enhance students' ability to refine and improve prototypes through systematic testing, feedback incorporation, and usability enhancement.
- To prepare students for validating and documenting the final prototype for transition toward an MVP.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Collaborate effectively as a team to create a functional or semi-functional prototype to satisfy the intended functional and design objectives.	C	3	2	3		3				3						
CO-2:	Evaluate the prototype through systematic testing to identify core functional issues and performance gaps.	E	3	3	2	3	3				2						
CO-3:	Analyze feedback and diagnostic results to refine, debug, and optimize the prototype for improved performance, usability, and reliability.	AN	3	3	2	3	2				2	2					
CO-4:	Validate the prototype's functionality and usability through limited user trials or demonstrations and interpret user insights.	E	3	2	2	2	2				2	2		2			
CO-5:	Prepare structured documentation for the finalized prototype, including features, test outcomes, key learnings, and readiness for MVP	AP	2									3		3			

List of Activity: **30 Periods**

Week 1-2: Build the first functional or semi-functional prototype (hardware or software) according to the design specifications.
Week 3-4: Test the prototype for core functionalities; identify issues and gather feedback from team or small test group.
Week 5-6: Incorporate feedback, fix identified issues, and improve prototype features to enhance performance, usability, and reliability.
Week7-8 : Conduct limited user trials or demonstrations to validate functionality, usability.
Week 9-10: Finalize working prototype, document all features, functionality, learnings, and test results.
Key deliverables: Prototype, Test Report, User Feedback Report

Learning Assessment

Continuous Learning Assessment (CLA) (100% weightage)		
Review 1 (30%)	**Review 2 (30%)**	**Report (40%)**

Semester VI

Course Code	24MG601	Course Name	Economics, Finance & Accounting	Course Category	T	Humanities, Social Science and Management Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand basic economic concepts and their use in engineering decisions.
- To learn how production, markets, and pricing work for managerial decision-making.
- To understand national economic indicators, money systems, and types of business organizations.
- To learn basic financial management concepts and simple investment evaluation methods.
- To understand basic accounting processes and interpret financial statements for decisions.

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand fundamental economic concepts relevant to engineering.	U	3										2	3			
CO-2:	Analyze demand, supply, and cost relationships in decision-making.	AN	3	3		2							2	3			
CO-3:	Apply basic financial and accounting principles to business and project contexts.	AP	2	2		3							2	2			
CO-4:	Apply basic financial and accounting principles to business and project contexts.	AP	2	2		3							2	2			
CO-5:	Apply simple financial tools to make investment decisions.	AP	2	2		3							2	2			

Unit-1 **Introduction to Engineering Economics** ***9 Periods***

Nature and scope of economics and its relevance to engineering. Fundamental concepts: scarcity, choice, and opportunity cost. Law of demand and supply – determinants and elasticity. Demand forecasting – methods and applications. Cost concepts – types of costs, cost curves, and cost–output relationship.

Unit-2 **Production and Market Analysis** ***9 Periods***

Production function – law of variable proportions and returns to scale. Least-cost input combinations, Isoquants. Market structures – perfect competition, monopoly, monopolistic, and oligopoly. Pricing under different market conditions. Break-even analysis and applications in decision-making.

Unit-3 **National and Business Economics** ***9 Periods***

National Income – concepts and methods of measurement (GNP, NNP, GDP). Inflation and deflation – meaning, causes, and control. Money and banking – functions of commercial banks. Overview of Indian economic systems – liberalization, privatization, and globalization (LPG). Forms of business organizations – sole proprietorship, partnership, joint stock company.

Unit-4 **Fundamentals of Finance** ***9 Periods***

Introduction to financial management – objectives and scope. Sources of finance – short-term and long-term (shares, debentures, loans). Time value of money – present and future value concepts. Basic investment appraisal methods – Payback period, NPV, IRR, Benefit–Cost ratio. Risk and return concepts in investment decisions.

Unit-5 **Fundamentals of Financial Accounting** ***9 Periods***

Accounting principles and concepts – double-entry system. Journal, ledger, and trial balance. Preparation of trading, profit and loss account, and balance sheet. Financial statement analysis – ratio analysis, cash flow and funds flow analysis. Interpretation of financial statements for managerial decisions.

Total: 45 Periods

Learning Resources	Text Books	References
	1. D.N. Dwivedi, Managerial Economics, Vikas Publishing / S.Chand 2024, 10th Edition. 2. S.N. Maheshwari, Financial Accounting for Management, Sultan Chand & Sons 2022, 5th Edition.	1. R.R. Barthwal, Industrial Economics, New Age International (P) Ltd .ISBN 10: 8195175546 2. G.S. Gupta, Managerial Economics, Tata McGraw Hill. ISBN 13: 978-0-07-106786-7 3. M.Y. Khan & P.K. Jain, Financial Management, Tata McGraw Hill. ISBN 13: 978-9353162191.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24AD505	Course Name	CLOUD COMPUTING	Course Category	TP	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Artificial Intelligence and Data Science	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the principles of cloud architecture, models and infrastructure.
- To understand the concepts of virtualization and virtual machines.
- To gain knowledge about virtualization Infrastructure.
- To explore and experiment with various Cloud deployment environments.
- To learn about the security issues in the cloud environment.

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Understand the design challenges in the cloud.	U	3	2	1	1	1	-	-	-	2	3	1	3	2	1	3
CO-2:	Apply the concept of virtualization and its types.	AP	3	1	2	2	1	-	-	-	1	2	1	3	2	2	1
CO-3:	Experiment with virtualization of hardware resources and Docker.	AN	2	3	2	3	1	-	-	-	3	1	1	3	1	1	1
CO-4:	Develop and deploy services on the cloud and set up a cloud environment.	C	1	2	3	3	3	-	-	-	3	3	1	2	1	3	3
CO-5:	Explain security challenges in the cloud environment.	U	2	3	3	1	3	-	-	-	2	2	1	2	2	2	3

Unit	Title	Periods
Unit-1	**UNIT I CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE**	**6 Periods**
	Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges	
Unit-2	**UNIT II VIRTUALIZATION BASICS**	**6 Periods**
	Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts – Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices.	
Unit-3	**UNIT III VIRTUALIZATION INFRASTRUCTURE AND DOCKER**	**7 Periods**
	Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management -Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.	
Unit-4	**UNIT IV CLOUD DEPLOYMENT ENVIRONMENT**	**6 Periods**
	Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus.	
Unit-5	**UNIT V CLOUD SECURITY**	**5 Periods**
	Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyper jacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.	
		Total Theory: 30 Periods

List of Experiments	Total Practical: 30 Periods
1. Install Virtualbox/VMware/ Equivalent open source cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above. 2. Install a C compiler in the virtual machine created using a virtual box and execute Simple Programs 3. Install Google App Engine. Create a hello world app and other simple web applications using python/java. 4. Use the GAE launcher to launch the web applications. 5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim. 6. Find a procedure to transfer the files from one virtual machine to another virtual machine. 7. Install Hadoop single node cluster and run simple applications like wordcount. 8. Creating and Executing Your First Container Using Docker. 9. Run a Container from Docker Hub.	

	Text Books	References
Learning Resources	1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012. 2. James Turnbull, "The Docker Book", O'Reilly Publishers, 2014. 3. Krutz, R. L., Vines, R. D, "Cloud security. A Comprehensive Guide to Secure Cloud Computing", Wiley Publishing, 2010. 4. "Cloud Computing: Concepts, Technology, Security, and Architecture – 2nd Edition" – Thomas Erl, Ricardo Puttini, Zaigham Mohammad,2023	1. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005. 2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24CS601	Course Name	EMBEDDED SYSTEMS AND IOT	Course Category	TP	Professional Core Courses	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Microprocessors and Microcontrollers	**Co-requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand embedded systems and 8051 programming.
- Learn IoT architecture and communication technologies.
- Study IoT network and application protocols.
- Develop IoT applications using embedded platforms.
- Understand IoT security and real-time applications.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Use microcontroller for assembly language programming and design simple Embedded applications..	AP	3	2	2	1	3	-	-	-	-	-	-	1	3	1	3
CO-2:	Understand the architectures, Communication models and IoT infrastructure Protocols to design IoT solutions.	U	3	2	2	1	2	-	-	-	-	-	-	1	3	1	3
CO-3:	Analyze and suggest application protocols for the target IOT use case.	AN	2	3	2	2	2	-	-	-	-	-	-	1	3	1	3
CO-4:	Develop IoT applications using Arduino/Raspberry Pi/open platform and Test and experiment different sensors.	AP	3	2	3	2	3	-	-	-	-	-	-	1	3	1	3
CO-5:	Analyze applications of IoT in real– time scenario and explore deployment platforms for IoT applications.	AN	2	3	2	2	1	1	1	-	-	-	-	2	3	1	3

Unit-1 EMBEDDED PROGRAMMING	**9 Periods**
8051 microcontroller architecture, instruction set, addressing modes, assembly language programming. Introduction to Embedded Systems – Programming Embedded Systems in C – Need for RTOS – Multiple Tasks and Processes – Context Switching – Priority Based Scheduling Policies.	
Unit-2 IOT ARCHITECTURE AND CONNECTIVITY	**9 Periods**
Introduction to IoT – Enabling Technologies, IOT architectures, functional stack, IOT data management and compute stack, IoT devices, Sensors, actuators– Design & functional blocks of IoT – Control Units – Communication modules – Bluetooth – Zigbee – WiFi – GPS – GSM modules – Infrastructure Protocols – IEEE 802.15.4, IEEE 802.11ah, Zigbee, Bluethooth Low Energy, LTE, LoRAWAN– TTS.	
Unit-3 IOT NETWORK LAYER AND APPLICATION PROTOCOLS	**9 Periods**
IP as the IOT network layer, Optimizing IP for IOT – 6LoWPAN adaptation, Header Compression, Fragmentation, RPL. Application protocols – SCADA, Tunnelling SCADA over IP, CoAP, MQTT, AMQP, XMPP	
Unit-4 IOT PROGRAMMING	**9 Periods**
Introduction to Raspberry Pi – Integration of Sensors and Actuators– Architecture– Programming– Interfacing – Reading from Sensors– Connecting to the cloud– IoT deployment for Raspberry Pi /Arduino/ESP 32/Equivalent platform– Application layer protocol simulation with any popular IOT simulator	

Unit-5 IOT SECURITY AND CASE STUDIES	9 Periods
Securing IOT – modbus, DNP3, IoT Applications – Home Automation – Smart Agriculture – Smart Cities – Smart Healthcare – Smart retailing and Smart fleet management – Intelligent transport management system.	
	Total Theory: 45 Periods

List of Indicative Experiments	Total Practical: 30 Periods

1. Using any simulator, program 8051 Microcontroller in assembly language
   a. To test data transfer between registers and memory with different addressing modes.
   b. Perform basic ALU operations
2. Write Basic and arithmetic Programs Using Embedded C.
3. Write Embedded C program to test interrupt and timers.
4. Introduction to Raspberry PI platform and python programming
5. Develop a program to control an LED using Raspberry Pi/Arduino
6. Interfacing sensors and actuators with Raspberry PI/Arduino
7. Implement web based IOT.
8. Use wifi module on the board for any simple experiment.
9. Implement application layer protocols using any simulator
10. Design an IOT based system using any recent controllers, for a specific usecase / application scenario as a team.

	Text Books	References
Learning Resources	1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, Pearson Education, Second Edition, 2014. 2. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, 2017. 3. Muhammad Azhar Iqbal, Sajjad Hussain, Huanlai Xing, Muhammad Ali Imran, Enabling the Internet of Things, Fundamentals, Design and Applications, Wiley, 2021. 4. Michael J. Pont, “Embedded C”, Pearson Education, 2007.	1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands–on Approach”, VPT, 2014. 2. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, John Wiley & Sons, 2014. 3. Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, WebSockets, and Python 3, Packt Publishing, 2020. 4. Samuel Greengard, Internet of Things, The MIT Press, 2021. 5. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 1st Edition, Wiley Publications, 2019. 6. Wayne Wolf, "Computers as Components – Principles of Embedded Computing System “Third Edition, Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		End Semester Examination (60% weightage)
Average of Internal Test (20%)	Critical Thinking Assessment (20%)	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24SD611	Course Name	TECHNICAL PROFICIENCY I	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Engineering Mathematics I, Programming in C	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Code Standards**	Nil		

Course Objectives: ***The purpose of learning this course is to:***

- Provide knowledge of fundamental mathematical concepts such as matrices, eigenvalues, differentiation, and integration required for engineering problem solving.
- Introduce the principles of digital logic design, Boolean algebra, combinational and sequential circuits, and computer arithmetic.
- Familiarize students with the basic organization and architecture of computer systems including processor operations, memory hierarchy, and input/output interfaces.
- Develop programming skills in C and understanding of fundamental data structures for efficient data organization and manipulation.
- Impart knowledge of algorithm design techniques, complexity analysis, and graph algorithms for solving computational problems efficiently.

			Program Outcomes (PO)												Program Specific Outcome (PSO		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply concepts of linear algebra and calculus to solve engineering mathematics problems involving matrices, eigenvalues, differentiation, and integration.	AP	3	2	–	–	–	–	–	–	–	–	–	–	2	–	–
CO-2:	Analyze and design digital logic circuits using Boolean algebra, minimization techniques, sequential circuits, and computer arithmetic concepts	AN	3	3	–	–	–	–	–	–	–	–	–	–	2	–	–
CO-3:	Explain the organization and functioning of computer systems including processor architecture, pipelining, memory hierarchy, and I/O mechanisms.	UN	–	–	–	–	–	–	–	–	2	3	–	–	–	2	–
CO-4:	Develop programs in C using appropriate data structures such as stacks, queues, linked lists, trees, heaps, and graphs to solve computational problems	AP	3	2	–	–	–	–	–	–	–	–	–	–	3	–	–
CO-5:	Apply algorithm design techniques and analyze the complexity of algorithms for searching, sorting, graph traversal, shortest path, and optimization problems	AP	–	–	–	–	–	–	–	–	3	3	–	–	–	2	–

Section-1	**Engineering Mathematics**	**6 Periods**
Linear Algebra: Matrices – determinants - system of linear equations- eigenvalues and eigenvectors- LU decomposition **Calculus:** Limits- continuity and differentiability- Maxima and minima- Mean value theorem - Integration		
Section-2	**Digital Logic**	**6 Periods**
Boolean algebra - Combinational and sequential circuits – Minimization - Number representations and computer arithmetic (fixed and floating point).		
Section-3	**Computer Organization and Architecture**	**6 Periods**
Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).		
Section-4	**Programming and Data Structures**	**6 Periods**
Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.		
Section-5	**Algorithms**	**6 Periods**
Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph traversals, minimum spanning trees, shortest paths.		
		Total: 30 Periods

	Text Books	References
Learning Resources	1. Higher Engineering Mathematics,B. S. Grewal, *Higher Engineering Mathematics*, 44th Edition, Khanna Publishers, New Delhi, 2018. 2. Digital Design, M. Morris Mano and Michael D. Ciletti, *Digital Design*, 6th Edition, Pearson Education, 2018. 3. Computer Organization and Architecture: Designing for Performance,William Stallings, *Computer Organization and Architecture: Designing for Performance*, 11th Edition, Pearson Education, 2019. 4. Data Structures Using C,Reema Thareja, *Data Structures Using C*, 2nd Edition, Oxford University Press, 2014. 5. Introduction to Algorithms,Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, 4th Edition, MIT Press, 2022.	1. Advanced Engineering Mathematics,Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley India Pvt. Ltd., New Delhi, 2015. 2. Digital Fundamentals,Thomas L. Floyd, *Digital Fundamentals*, 11th Edition, Pearson Education, 2015. 3. Computer System Architecture,M. Morris Mano, *Computer System Architecture*, 3rd Edition, Pearson Education, 2017. 4. Data Structures and Algorithm Analysis in C, Mark Allen Weiss, *Data Structures and Algorithm Analysis in C*, 2nd Edition, Pearson Education, 2013. 5. Algorithm Design,Jon Kleinberg and Éva Tardos, *Algorithm Design*, 1st Edition, Pearson Education, 2006.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		
Critical Thinking Assessment (20%)	**Tutorial(40%)**	**Proctored Exam (40%)**

Course Code	24SD612	Course Name	Advanced Aptitude and Coding Skills – 2	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering (Common to all branches)	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To build high-order analytical aptitude Skills
- To develop advanced programming skills through Java, focusing on performance optimization, design patterns, functional programming, and database-driven application logic.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyze and solve complex quantitative reasoning and data sufficiency problems	AN															
CO-2:	Apply analytical and logical interpretation to multi-source data problems	AN															
CO-3:	Implement advanced Java concepts including generics, collections, and lambda expressions	AN															
CO-4:	Design modular, scalable solutions using Java design patterns and file/database integration	C															
CO-5:	Develop optimized and maintainable code suitable for competitive programming and real-world scenarios	C															

List of Exercises **30 Periods**

1. Data Sufficiency and Analytical Decision-Making
2. Advanced Arithmetic and Number Theory (remainders, modular arithmetic, series patterns)
3. Probability Distributions (binomial, Poisson – concept-based questions)
4. Geometry with Coordinates and Trigonometric Applications
5. Case-based Reasoning, Data Interpretation Charts (DI sets, logical charts, table-based analysis)

6. Java Collections Revisited – Streams API, Lambda Expressions, Functional Interfaces, and method references
7. Exception Handling and Multithreading – Thread creation, synchronization, inter-thread communication
8. File Handling and Serialization – Reading/writing files, object streams, CSV/JSON/XML parsing
9. Database Connectivity (JDBC) – CRUD operations using MySQL/SQLite, handling exceptions and transactions
10. Design Patterns in Java – Singleton, Factory, Strategy, Observer, and MVC pattern introduction
11. Event-Driven and Modular Programming – Console-based mini-project integrating multiple OOP principles
12. Performance Optimization – Algorithmic complexity review, code refactoring, and memory management
13. Competitive Coding Techniques – Sliding window, two-pointer, bitwise, and recursion optimization problems in Java

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		
Written Test (20%)	Proctored Test (Two test during assessment schedule) (40%)	Performance (Daily Challenge + Daily Tracks + Coding test) (40%)

Course Code	26SD613	Course Name	CORPORATE COMMUNICATION SKILLS	Course Category	P	HSMC	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	SCIENCE & HUMANITIES	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To familiarize students with corporate structures, workplace expectations, and professional conduct required in industry environments.
- To develop effective professional communication skills, including verbal, written, and digital communication for corporate settings.
- To equip students with the ability to create industry-ready resumes, professional online profiles, and personal branding strategies.
- To enhance students' problem-solving, teamwork, and decision-making skills for recruitment processes.
- To prepare students for campus placements and early career roles by strengthening interview skills, ethical awareness, adaptability, and career planning capabilities.

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO-1:	Understand campus vs. corporate life, workplace structure, and professional ethics.	U								3	2	3	1			
CO-2:	Apply effective professional communication in workplace situations.	AP								2	2	3	1			
CO-3:	Develop resumes and professional online profiles (LinkedIn/GitHub).	AP								2	2	2	1			
CO-4:	Apply logical thinking and problem-solving for aptitude tests and group discussions.	AP								2	2	2	1			
CO-5:	Demonstrate interview readiness and career development skills.	AP								3	3	3	1			

Unit-1 – Difference between Campus life vs Corporate life **(12 periods)**

Corporate structure, hierarchy, and roles-Expectations of employers from fresh graduates-Professional behaviour and accountability-Understanding job roles: IT, Core, Analytics, Consulting, Product, etc. Work ethics, discipline-and professionalism

Unit-2 – Professional Communication Skills **(12 periods)**

Verbal and non-verbal communication-Email writing and corporate communication etiquette-Presentation skills for meetings and reviews-Active listening and interpersonal communication-Telephone, virtual meeting, and online professionalism-Cross-cultural communication basics

Unit-3 – Resume, LinkedIn & Personal Branding **(12 periods)**

Resume types (Fresher / Internship / Core / IT)-Resume do's and don'ts for campus recruitment-Quantifying achievements and projects-LinkedIn profile creation and optimization GitHub / Portfolio basics (for technical roles)-Professional online presence and digital footprint

Unit-4 Structured Thinking & Clear Expression - Problem-Solving Frameworks **(12 periods)**

Structured Thinking & Clear Expression (Foundation)- Problem-Solving Frameworks for Interviews-Logical Reasoning Communication-Time Management during aptitude tests-Group discussion skills and evaluation criteria

Unit-5 - Interview Skills, Corporate Ethics & Career Readiness **(12 periods)**

Types of interviews: HR, Technical, Managerial, Behavioral-STAR technique for answering questions-Common HR & behavioral interview questions-Corporate ethics, integrity, and compliance-Workplace adaptability and continuous learning-Career planning, goal setting, and growth mindset

Total Periods: 60

Learning Resources	**Textbooks** 1. A Text Book of Employability Skills, written by Dr. Yasir Rashid and Mrs. Najmu Nissa, was published by Shashwat Publication in 2022 (ISBN: 978-93-95125-22-2). 2. Soft Skills: Enhancing Employability – Connecting Campus with Corporate, written by Dr. M. S. Rao, was published by I.K. International Publishing House in 2010 (ISBN: 978-9380578385). 3. Employability Skills, written by the Editorial Board, was published by the National Council of Educational Research and Training (NCERT), New Delhi, in 2019 (ISBN: 978-93-5292-126-3).	**References:** 1. Bolles, Richard N. What Color Is Your Parachute? A Practical Manual for Job-Hunters and Career-Changers. Ten Speed Press, Penguin Random House LLC, 2024 Edition, United States. 2. Harvard Business Review: Career & Communication Articles. Harvard Business Publishing, Boston, Massachusetts, USA. 3. NPTEL – Soft Skills and Employability Courses. Developed by IITs and IISc under the National Programme on Technology Enhanced Learning (NPTEL), Ministry of Education, Government of India.

Learning Assessment		
Continuous Learning Assessment (100% weightage)	**Model Lab Exam 25%**	**End Semester Examination (0% weightage)**
Evaluation of Laboratory Observation, Record 75%		

Course Code	24EL611	**Course Name**	INNOVATION AND PRODUCT DEVELOPMENT - 4 (Patent Filing & Startup Registration)	**Course Category**	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	24EL511 INNOVATION AND PRODUCT DEVELOPMENT (Prototype development and Testing)	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Mechanical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To analyze invention novelty, assess patentability, and draft IP claims.
- To develop and document intellectual property in compliance with applicable technical and legal standards, and maintain readiness for patent filing.
- To evaluate and establish an appropriate startup legal structure and prepare documentation for DPIIT recognition.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Evaluate the novelty, uniqueness, and patentability of an invention through prior-art search and feasibility assessment.	E	2	3		3	2					2		2			
CO-2:	Develop complete patent documentation, including description, claims, diagrams, and technical specifications, in accordance with IP standards.	C	2	2	3		2			3		3		2			
CO-3:	Validate patent claims through prototype alignment, incorporate expert feedback, and finalize documents for patent filing.	E	2	3	2	3	2			3		2		2			
CO-4:	Assess and select an appropriate startup legal structure based on business requirements.	AP			2	2	2			2		3	3	2			
CO-5:	Prepare and organize documentation required for DPIIT recognition readiness.	C	2	2	3							3	3	2			

List of Activity: **30 Periods**

Week 1: Assess novelty and uniqueness of the invention; perform prior art search and evaluate patentability.
Week 2: Prepare detailed technical documentation including description, drawings, and specifications.
Week 3: Draft complete specification with claims; consult IP experts for refinement.
Week 4: Align prototype with documented claims; validate technical feasibility and consistency.
Week 5: Finalize patent draft (claims, drawings, abstract) and keep documents ready for filing.
Week 6: Decide legal structure (LLP, Pvt. Ltd., Partnership) and outline business model.
Week 7: Prepare incorporation-related documents (founder details, PAN, MOA/AOA draft, etc.).
Week 8: Compile DPIIT recognition requirements; document business activities, innovation details, and scalability aspects.
Week 9: Organize and verify all supporting documents; complete internal review and readiness check.
Week 10: Finalize complete set of documents for DPIIT recognition and submission.
Key deliverables: Prior Art Search Report, Patentability Assessment, Draft Patent Specification Document, Final Patent Draft, DPIIT registration documents

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		
Review 1 (30%)	Review 2 (30%)	Report (40%)

Semester VII

Course Code	24CS701	Course Name	IMAGE AND VIDEO ANALYTICS	Course Category	TP	Professional Core Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- understand the basics of image processing techniques for computer vision.
- learn the techniques used for image pre-processing.
- Know about the various object detection techniques.
- understand the various object recognition mechanisms.
- acquire the knowledge on the video analytics techniques

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Understand the basics of image processing techniques for computer vision and video analysis.	U	3	2	2	3	3	-	-	-	1	2	2	2	3	1	2
CO-2:	Apply the techniques used for image pre-processing.	AP	3	3	3	3	3	-	-	-	1	2	2	2	3	1	2
CO-3:	Develop various object detection techniques.	AP	3	3	2	3	3	-	-	-	1	2	2	2	3	1	2
CO-4:	Apply and analyze the various face recognition mechanisms.	AN	3	3	3	3	3	-	-	-	1	2	2	2	3	1	2
CO-5:	Elaborate on deep learning-based video analytics.	AN	3	3	3	3	3	-	-	-	1	1	2	2	3	1	3

Unit-1 INTRODUCTION **6 Periods**

Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.

Unit-2 IMAGE PRE-PROCESSING **6 Periods**

Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi- spectral images - Local pre-processing in the frequency domain - Line detection by local pre- processing operators - Image restoration. Introduction to Gradient-based Operators (Sobel, Prewitt, Roberts)

Unit-3 OBJECT DETECTION USING MACHINE LEARNING **6 Periods**

Object detection– Object detection methods — Data Augmentation (Flip, Rotation, MixUp, Mosaic)-Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) –Deep Learning Architectures-R-CNN-Faster R-CNN-You Only Look Once (YOLO)-Salient features-Loss Functions-YOLO architectures.

Unit-4 FACE RECOGNITION AND GESTURE RECOGNITION **6 Periods**

Face Recognition-Introduction-— Applications of Face Recognition-Process of Face Recognition- Introduction to Vision Transformers (ViT): Patch embeddings, Self-Attention in images DeepFace solution by Facebook-FaceNet for Face Recognition- Implementation using FaceNet- Gesture Recognition.

Unit-5 VIDEO ANALYTICS	6 Periods
Video Processing — use cases of video analytics-Vanishing Gradient and exploding gradient problem- RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture- Improvement in Inception v2-Video analytics-RestNet and Inception v3.	
	Total Theory: 30 Periods

Suggested List of Experiments **Total Practical: 30 Periods**

1. Implement a program that computes the T-pyramid of an image.
2. Implement a program that derives the quad tree representation of an image using the homogeneity criterion of equal intensity
3. Develop programs for the following geometric transforms: (a) Rotation (b) Change of scale
   (c) Skewing (d) Affine transform calculated from three pairs of corresponding points (e) Bilinear transform calculated from four pairs of corresponding points.
4. A smart security system must automatically identify and classify objects appearing in surveillance footage. Develop an application for object detection and recognition in images and videos.
5. A transportation analytics company needs to study vehicle movement patterns from continuous video feeds to detect unusual motion activities. Develop a program for motion analysis using moving-edge information on image sequences.
6. An automated attendance and access management system requires accurate identification of individuals entering the premises. Develop a program for facial detection and recognition system using camera-captured images.
7. A modern surveillance center aims to monitor public places and automatically recognize abnormal activities such as intrusion, abandoned objects, or crowd gathering. Create a video surveillance application for automatic event detection from live video streams.
8. Develop a Generative AI-assisted program to create a quadtree representation of a medical image by dividing the image into regions with the same intensity values.

	Text Books	References
Learning Resources	1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4nd edition, Thomson Learning, 2013. 2. Vaibhav Verdhan, (2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras, Apress 2021(UNIT-III, IV and V)	1. Richard Szeliski "Computer Vision: Algorithms and Applications", 2nd Edition, Springer, 2022. 2. Mohamed Elgendy" Deep Learning for Vision Systems", Manning Publications, 2020. 3. Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012. 4. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003. 5. E. R. Davies, (2012), "Computer & Machine Vision", Fourth Edition, Academic Press.

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CS711	Course Name	MINI PROJECT	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering		**Data Book / Codes Standards**	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Enable students to identify a simple real-time problem related to their area of study.-AI,Cybersecurity,Quantum,IOT
- Apply basic engineering and programming concepts to develop a working solution.
- Develop teamwork and project planning skills through guided project execution.
- Train students in preparing a mini project report using standard technical format.
- Provide students with exposure to systematic project methodology, including analysis, design, implementation, and evaluation.

Course Outcomes (CO): ***At the end of this course, learners will be able to:***

CO-1:	Identify and analyze a simple real-time problem and define basic requirements.
CO-2:	Design and implement a small-scale solution using appropriate tools and techniques.
CO-3:	Function effectively as an individual and as a member of a team.
CO-4:	Prepare and present a structured technical report and project demonstration.
CO-5:	Apply systematic project methodology for analysis, design, implementation, and evaluation of solutions

Learning Assessment

Continuous Learning Assessment (CLA) (60 Marks)			End Semester Examination (40 Marks)			
Review I	Review II	Review III	Project Report		Viva-Voce Examination	
			Supervisor	External	Internal	External
10	20	30	10	10	10	10

Course Code	24SD711	Course Name	TECHNICAL PROFICIENCY II	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Engineering Mathematics I, Engineering Mathematics II, Programming in C, Data Structures	Co- requisite Courses	Theory of Computation,Operating Systems,Database Management Systems	Progressive Courses	Design and Analysis of Algorithms, Compiler Design, Computer Networks, Distributed Systems, Advanced Data Structures.
Course Offering Department	Computer Science and Engineering	**Data Book / Code Standards**	Nil		

Course Objectives: ***The purpose of learning this course is to:***

- Develop logical reasoning and analytical skills required for competitive exams.
- Strengthen quantitative aptitude essential for technical placements.
- Enhance verbal and communication skills for interviews.
- Improve technical problem-solving skills through practice.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply concepts of discrete mathematics and probability theory to solve computational and analytical problems involving logic, sets, graphs, and random variables.	AP	3	3	–	–	–	–	–	–	–	–	–	–	3	–	–
CO-2:	Analyze problems related to formal languages and automata, and determine the computational limits of problems using concepts of Turing machines and undecidability.	AN	3	3	–	–	–	–	–	–	–	–	–	–	3	–	–
CO-3:	Design and analyze compiler components such as lexical analyzers, parsers, intermediate code generators, and apply basic optimization techniques.	AN	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–
CO-4:	Explain and apply operating system principles including process management, memory management, scheduling, synchronization, and deadlock handling.	AP	3	2	–	–	–	–	–	–	–	–	–	–	2	–	–
CO-5:	Design and manage database systems using ER modeling, relational algebra, SQL queries, normalization, indexing, and transaction control mechanisms.	AN	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–
CO-6:	Demonstrate understanding of computer networking concepts, including protocol layering, routing, congestion control, transport and application layer protocols, and network services.	AP	3	2	–	–	–	–	–	–	–	–	–	–	2	–	–

Section-1	Engineering Mathematics II	6 Periods
Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Monoids, Groups. Graphs: connectivity, matching, colouring. Combinatorics: counting, recurrence relations, generating functions. Probability and Statistics: Random variables, Uniform, normal, exponential, Poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.		
Section-2	**Theory of Computation**	**6 Periods**
Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.		
Section-3	**Compiler Design**	**6 Periods**
Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. Local optimization, Data flow analyses: constant propagation, liveness analysis, common sub expression elimination.		
Section-4	**Operating System and Database**	**6 Periods**
System calls, processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems. ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.		
Section-5	**Computer Networks**	**6 Periods**
Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit- switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email.		
		Total: 30 Periods

	Text Books	References
Learning Resources	1. **Discrete Mathematics and Its Applications**, Kenneth H. Rosen, McGraw-Hill 2. **Introduction to the Theory of Computation**, Michael Sipser, Cengage Learning 3. **Compilers: Principles, Techniques, and Tools**, Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Pearson 4. **Operating System Concepts**, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Wiley 5. **Database System Concepts**, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill	• **Probability and Statistics for Engineers**, Jay L. Devore, Cengage Learning • **Introduction to Automata Theory, Languages, and Computation**, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson • **Modern Operating Systems**, Andrew S. Tanenbaum, Pearson • **Fundamentals of Database Systems**, Ramez Elmasri, Shamkant B. Navathe, Pearson • **Computer Networks**, Andrew S. Tanenbaum, David J. Wetherall, Pearson

	6. **Computer Networking: A Top-Down Approach**, James F. Kurose, Keith W. Ross, Pearson	

Learning Assessment

Continuous Learning Assessment (CLA) (100% weightage)		
Critical Thinking Assessment (20%)	**Tutorial(40%)**	**Proctored Exam (40%)**

Semester VIII

Course Code	24CS811	Course Name	PROJECT WORK	Course Category	P	Employability Enhancement Courses	L	T	P	C
							0	0	20	10

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

Course Outcomes (CO): ***At the end of this course, learners will be able to:***

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

Description

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Learning Assessment

Continuous Learning Assessment (CLA) (60 Marks)			End Semester Examination (40 Marks)			
Review I	Review II	Review III	Project Report		Viva-Voce Examination	
			Supervisor	External	Internal	External
10	20	30	10	10	10	10

Professional Elective Courses - Vertical-1 (Data Science)

Course Code	24CSE01	Course Name	DATA VISUALIZATION	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Foundations of Data Science	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering		Data Book / Codes Standards	Nil	

Course Objective: *The purpose of learning this course is to:*

- To outline an overview of data visualization.
- To implement data visualization using Matplotlib.
- To perform univariate data exploration and analysis.
- To apply bivariate data exploration and analysis.
- To outline an overview of security in data visualization.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): *At the end of this course, learners will be able to:*		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamentals of data visualization	U	3	1	3	3	-	-	-	-	2	3	3	3	2	2	2
CO-2:	Implement the data visualization using Matplotlib	AP	2	2	2	1	1	-	-	-	3	2	3	1	3	1	3
CO-3:	Perform univariate data exploration and analysis	AP	2	1	2	1	-	-	-	-	3	2	1	2	2	2	1
CO-4:	Apply bivariate data exploration and analysis	AP	2	2	2	1	-	-	-	-	1	2	1	-	1	-	2
CO-5:	Implement the security in data visualization	AP	3	1	-	2	1	-	-	-	3	2	1	2	2	2	3

Unit-1 INTRODUCTION TO DATA VISUALIZATION **9 Periods**

Context of data visualization – Definition, Methodology, Visualization design objectives. Key Factors – Purpose, visualization function - visualization design options – Data representation, Data Presentation, Seven stages of data visualization - widgets and data visualization tools.

Activities:

1. Install the data Analysis and Visualization tool: R/ Python /Tableau Public/ Power BI.
2. Perform exploratory data analysis (EDA) on with datasets like email data set. Export all your emails as a dataset, import them inside a pandas data frame, visualize them and get different insights from the data.

Unit-2 VISUALIZING USING MATPLOTLIB **9 Periods**

Importing Matplotlib — Simple line plots — Simple scatter plots — visualizing errors — density and contour plots — Histograms — legends — colors — subplots — text and annotation — customization — three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

Activities:

1. Working with Numpy arrays, Pandas data frames , Basic plots using Matplotlib
2. Explore various variable and row filters in R for cleaning data. Apply various plot features in R on sample data sets and visualize

Unit-3 UNIVARIATE ANALYSIS	9 Periods
Introduction to Single variable: Distributions and Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing –– Inequality - Smoothing Time Series. **Activities:** 1. Perform Time Series Analysis and apply the various visualization techniques 2. Perform Data Analysis and representation on a Map using various Map data sets with Mouse Rollover effect, user interaction.	
Unit-4 BIVARIATE ANALYSIS	**9 Periods**
Relationships between Two Variables - Percentage Tables - Analyzing Contingency Tables Handling Several Batches - Scatterplots and Resistant Lines –– Transformations. **Activities:** 1. Build cartographic visualization for multiple datasets involving various countries of the world; states and districts in India etc. 2. Perform EDA on Wine Quality Data Set.	

Unit-5 SECURITY IN DATA VISUALIZATION	9 Periods
Port scan visualization - Vulnerability assessment and exploitation - Firewall log visualization - Intrusion detection log visualization -Attacking and defending visualization systems – Creating secured visualization system. **Activities:** 1. Use a case study on a data set and apply the various EDA and visualization techniques and present an analysis report	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Claus O. Wilke, “Fundamentals of Data Visualization", O'reilly publications, 2019 2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", Oreilly, 1st Edition, 2016. 3. Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008	1. Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017. 2. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC press, 2015.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE15	Course Name	DEEP LEARNING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	nil	**Co- requisite Courses**	nil	**Progressive Courses**	nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand and need and principles of deep neural networks
- To understand CNN architectures of deep neural networks
- To understand RNN architectures of deep neural networks
- To comprehend advanced deep learning models
- To learn the evaluation metrics for deep learning models

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the basics in deep neural networks	U	3	2	2	3	1	-	-	-	2	3	1	2	3	3	3
CO-2:	Apply Convolution Neural Network for image processing	AP	2	2	2	3	3	-	-	-	1	2	2	3	1	1	3
CO-3:	Apply Recurrent Neural Network and its variants for text analysis	AP	3	3	3	3	3	-	-	-	2	1	1	2	2	1	3
CO-4:	Apply model evaluation for various applications	AP	3	3	1	1	1	-	-	-	1	3	1	3	2	1	1
CO-5:	Apply autoencoders and generative models for suitable applications	AP	3	2	2	2	3	-	-	-	2	3	2	2	2	3	3

Unit-1 DEEP NETWORKS BASICS **9 Periods**

Linear Algebra: Scalars -- Vectors -- Matrices and tensors; Probability Distributions -- Gradient- based Optimization – Machine Learning Basics: Capacity -- Overfitting and underfitting -- Hyperparameters and validation sets -- Estimators -- Bias and variance -- Stochastic gradient descent -- Challenges motivating deep learning; Deep Networks: Deep feedforward networks; Regularization -- Optimization.

Activities:

1. Solving XOR problem using DNN
2. Character recognition using CNN

Unit-2 CONVOLUTIONAL NEURAL NETWORKS **9 Periods**

Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers --Gradient Computation.

Activities:

1. Face recognition using CNN
2. Language modeling using RNN

Unit-3 RECURRENT NEURAL NETWORKS **9 Periods**

Unfolding Graphs -- RNN Design Patterns: Acceptor -- Encoder --Transducer; Gradient Computation -- Sequence Modeling Conditioned on Contexts -- Bidirectional RNN -- Sequence to Sequence RNN – Deep Recurrent Networks -- Recursive Neural Networks -- Long Term Dependencies; Leaky Units: Skip connections and dropouts; Gated Architecture: LSTM.

Activities:

1. Sentiment analysis using LSTM		
Unit-4 MODEL EVALUATION		**9 Periods**
Performance metrics -- Baseline Models - Hyperparameters: Manual Hyperparameter -- Automatic Hyperparameter -- Grid search -- Random search -- Debugging strategies. **Activities:** 1. Parts of speech tagging using Sequence to Sequence architecture 2. Machine Translation using Encoder-Decoder model		
Unit-5 AUTOENCODERS AND GENERATIVE MODELS		**9 Periods**
Autoencoders: Undercomplete autoencoders -- Regularized autoencoders -- Stochastic encoders and decoders -- Learning with autoencoders; Deep Generative Models: Variational autoencoders – Generative adversarial networks. **Activities:** 1. Image augmentation using GANs 2. Mini-project on real world applications		
		Total Theory: 45 Periods
	Text Books	**References**
Learning Resources	Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning'', MIT Press, 2016. Andrew Glassner, “Deep Learning: A Visual Approach”, No Starch Press, 2021.	Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, ``A Guide to Convolutional Neural Networks for Computer Vision'', Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018. Yoav Goldberg, ``Neural Network Methods for Natural Language Processing'', Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017. Francois Chollet, ``Deep Learning with Python'', Manning Publications Co, 2018. Charu C. Aggarwal, ``Neural Networks and Deep Learning: A Textbook'', Springer International Publishing, 2018. Josh Patterson, Adam Gibson, ``Deep Learning: A Practitioner's Approach'', O'Reilly Media, 2017.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE16	Course Name	TEXT AND SPEECH ANALYTICS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand natural language processing basics
- Apply classification algorithms to text documents
- Build question-answering and dialogue systems
- Develop a speech recognition system
- Develop a speech synthesizer

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain existing and emerging deep learning architectures for text and speech processing	U	3	2	3	1	3	-	-	-	1	2	1	2	1	1	1
CO-2:	Apply deep learning techniques for NLP tasks, language modelling and machine translation	AP	3	1	2	1	3	-	-	-	2	2	1	3	3	2	1
CO-3:	Explain coreference and coherence for text processing	U	2	2	1	3	1	-	-	-	3	3	1	2	3	3	1
CO-4:	:Build question-answering systems, chatbots and dialogue systems	C	2	1	1	1	2	-	-	-	2	1	2	2	3	1	1
CO-5:	Apply deep learning models for building speech recognition and text-to-speech systems	AP	1	3	2	2	1	-	-	-	3	2	1	1	2	3	1

Unit-1 NATURAL LANGUAGE BASICS **9 Periods**

Foundations of natural language processing – Language Syntax and Structure- Text Preprocessing and Wrangling – Text tokenization – Stemming – Lemmatization – Removing stop- words – Feature Engineering for Text representation – Bag of Words model- Bag of N-Grams model – TF-IDF model **Activities:**

1. Create Regular expressions in Python for detecting word patterns and tokenizing text
2. Getting started with Python and NLTK - Searching Text, Counting Vocabulary, Frequency Distribution, Collocations, Bigrams

Unit-2 TEXT CLASSIFICATION **9 Periods**

Vector Semantics and Embeddings -Word Embeddings - Word2Vec model – Glove model – Fast Text model – Overview of Deep Learning models – RNN – Transformers – Overview of Text summarization and Topic Models

Activities:

1. Accessing Text Corpora using NLTK in Python
2. Write a function that finds the 50 most frequently occurring words of a text that are not stop words.

Unit-3 QUESTION ANSWERING AND DIALOGUE SYSTEMS **9 Periods**

Information retrieval – IR-based question answering – knowledge-based question answering – language models for QA – classic QA models – chatbots – Design of dialogue systems –evaluating dialogue systems **Activities:** 1. Implement the Word2Vec model

Unit-4	**TEXT-TO-SPEECH SYNTHESIS**	**9 Periods**
Overview. Text normalization. Letter-to-sound. Prosody, Evaluation. Signal processing - Concatenative and parametric approaches, Wave Net and other deep learning-based TTS systems **Activities:** 1. Use a transformer for implementing classification 2. Design a chatbot with a simple dialog system		

Unit-5	**AUTOMATIC SPEECH RECOGNITION**	**9 Periods**
Speech recognition: Acoustic modelling – Feature Extraction - HMM, HMM-DNN systems **Activities:** 1. Convert text to speech and find accuracy 2. Design a speech recognition system and find the error rate		
		Total Theory: 45Periods

	Text Books	**References**
Learning Resources	Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Third Edition, 2022.	Dipanjan Sarkar, "Text Analytics with Python: A Practical Real-World approach to Gaining Actionable insights from your data", APress,2018. Tanveer Siddiqui, Tiwary U S, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, "Fundamentals of Speech Recognition" 1st Edition, Pearson, 2009. Steven Bird, Ewan Klein, and Edward Loper, "Natural language processing with Python", O'REILLY.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

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Course Code	24ITE21	Course Name	EXPLORATORY DATA ANALYSIS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**			

Course Objective: ***The purpose of learning this course is to:***

- To outline an overview of exploratory data analysis.
- To implement data visualization using Matplotlib
- To perform univariate data exploration and analysis.
- To apply bivariate data exploration and analysis.
- To use Data exploration and visualization techniques for multivariate and time series data.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamentals of exploratory data analysis.	U	3	2	3	3	3	-	-	-	2	2	3	2	3	3	2
CO-2:	Implement the data visualization using Matplotlib.	AP	2	2	2	3	3	-	-	-	3	2	2	2	1	2	3
CO-3:	Perform univariate data exploration and analysis.	AP	2	3	2	2	3	-	-	-	2	2	2	1	2	3	1
CO-4:	Apply bivariate data exploration and analysis	AP	2	2	2	2	3	-	-	-	3	2	2	1	2	2	2
CO-5:	Use Data exploration and visualization techniques for multivariate and time series data.	AP	2	2	3	2	1	-	-	-	1	2	2	1	2	2	3

Unit-1 EXPLORATORY DATA ANALYSIS **9 Periods**

EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data –Comparing EDA with classical and Bayesian analysis – Software tools for EDA - Visual Aids for EDA- Data transformation techniques-merging database, reshaping and pivoting, Transformation techniques.

Activities:

1. Install the data Analysis and Visualization tool: Python /Tableau Public/ Power BI.
2. Perform exploratory data analysis (EDA) with datasets like email data set. Export all your emails as a dataset, import them inside a pandas data frame, visualize them and get different insights from the data.

Unit-2 EDA USING PYTHON **9 Periods**

Data Manipulation using Pandas – Pandas Objects – Data Indexing and Selection – Operating on Data – Handling Missing Data – Hierarchical Indexing – Combining datasets – Concat, Append, Merge and Join – Aggregation and grouping – Pivot Tables – Vectorized String Operations.

Activities:

1. Working with Numpy arrays, Pandas data frames , Basic plots using Matplotlib.
2. Explore various variable and row filters in Python for cleaning data. Apply various plot features using Pandas and Matplotlib on sample datasets and visualize the results.

Unit-3 UNIVARIATE ANALYSIS **9 Periods**

Introduction to Single variable: Distribution Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality.

Activities: 1. Perform Time Series Analysis and apply the various visualization techniques. 2. Perform Data Analysis and representation on a Map using various Map data sets with Mouse Rollover effect, user interaction, etc..
Unit-4 BIVARIATE ANALYSIS **9 Periods**
Relationships between Two Variables - Percentage Tables - Analysing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines. **Activities:** 1. Build cartographic visualization for multiple datasets involving various countries of the world; states and districts in India etc.
Unit-5 MULTIVARIATE AND TIME SERIES ANALYSIS **9 Periods**
Introducing a Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Timebased indexing – Visualizing – Grouping – Resampling. **Activities:** 1. Perform EDA on Wine Quality Data Set. 2. Use a case study on a data set and apply the various EDA and visualization techniques and present an analysis report.
Total Theory: 45 Periods

	Text Books	References
Learning Resources	1.Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”, Packt Publishing, 2020. (Unit 1) 2.Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017. (Unit 2) 3.Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008. (Unit 3,4,5)	Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017. Claus O. Wilke, “Fundamentals of Data Visualization”, O’reilly publications, 2019. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, 2nd Edition, CRC press, 2015.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE22	Course Name	RECOMMENDER SYSTEMS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	-		

Course Objective: ***The purpose of learning this course is to:***

- To understand the foundations of the recommender system.
- To learn the significance of machine learning and data mining algorithms for Recommender systems
- To learn about collaborative filtering
- To make students design and implement a recommender system.
- To learn collaborative filtering.

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basic concepts of recommender systems.	U	2	2	1	2	1	-	-	-	1	-	-	1	-	-	-
CO-2:	Implement machine-learning and data-mining algorithms in recommender systems data sets.	AP	1	2	-	-	1	-	-	-	-	-	-	1	-	-	-
CO-3:	Implementation of Collaborative Filtering in carrying out performance evaluation of recommender systems based on various metrics.	AP	2	3	1	-	1	-	-	-	2	-	-	-	-	-	-
CO-4:	Design and implement a simple recommender system.	AN	3	2	2	2	1	-	-	-	2	-	-	2	-	-	-
CO-5:	Learn about advanced topics of recommender systems	AP	1	1	-	2	1	-	-	-	-	-	-	1	-	-	-
CO-6:	Learn about advanced topics of recommender systems applications	AP	2	2	1	1	1	-	-	-	-	-	-	1	-	-	-

Unit-1 INTRODUCTION **9 Periods**

Introduction and basic taxonomy of recommender systems - Traditional and non-personalized Recommender Systems - Overview of data mining methods for recommender systems- similarity measures- Dimensionality reduction – Singular Value Decomposition (SVD) Suggested Activities: Practical learning – Implement Data similarity measures. External Learning – Singular Value Decomposition (SVD) applications Suggested Evaluation Methods: Quiz on Recommender systems. Quiz of python tools available for implementing Recommender systems

Activities:

1. Implement Data similarity measures using Python
2. Implement dimension reduction techniques for recommender systems

Unit-2 CONTENT-BASED RECOMMENDATION SYSTEMS **9 Periods**

High-level architecture of content-based systems - Item profiles, Representing item profiles, Methods for learning user profiles, Similarity-based retrieval, and Classification algorithms. Suggested Activities:Assignment on content-based recommendation systems, Assignment of learning user profiles, Suggested Evaluation Methods: Quiz on similarity-based retrieval. Quiz of content-based filtering

Activities:

1. Implement user profile learning

Unit-3 COLLABORATIVE FILTERING	9 Periods
A systematic approach, Nearest-neighbor collaborative filtering (CF), user-based and item-based CF, components of neighborhood methods (rating normalization, similarity weight computation, and neighborhood selection Suggested Activities:Practical learning – Implement collaborative filtering concepts Assignment of security aspects of recommender systems Suggested Evaluation Methods:Quiz on collaborative filtering Seminar on security measures of recommender systems **Activities:** 1. Implement collaborative filter techniques.	
Unit-4 ATTACK-RESISTANT RECOMMENDER SYSTEMS	**9 Periods**
Introduction - Types of Attacks - Detecting attacks on recommender systems - Individual attack - Group attack - Strategies for robust recommender design - Robust recommendation algorithms.Suggested Activities: Group Discussion on attacks and their mitigation Study of the impact of group attacks External Learning - Use of CAPTCHAs Suggested Evaluation Methods:Quiz on attacks on recommender systems Seminar on preventing attacks using the CAPTCHAs **Activities:** 1. Implement content-based recommendation systems	
Unit-5 EVALUATING RECOMMENDER SYSTEMS	**9 Periods**
Evaluating Paradigms - User Studies - Online and Offline evaluation - Goals of evaluation design - Design Issues - Accuracy metrics - Limitations of Evaluation measures Suggested Activities: Group Discussion on goals of evaluation design Study of accuracy metrics Suggested Evaluation Methods: Quiz on evaluation design Problems on accuracy measures **Activities:** 1. Create an attack for tampering with recommender systems 2. Implement accuracy metrics like Receiver Operated Characteristic curves	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1.Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016. Dietmar Jannach , Markus Zanker , Alexander Felfernig and Gerhard Friedrich ,Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed. 2.Francesco Ricci , Lior Rokach , Bracha Shapira , Recommender Sytems Handbook, 1st ed, Springer (2011), 3.Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, 3rd edition, Cambridge University Press, 2020.	

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE20	Course Name	BUSINESS ANALYTICS	Course Category	T	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Data Science	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the Analytics Life Cycle.
- To comprehend the process of acquiring Business Intelligence
- To understand various types of analytics for Business Forecasting
- To model the supply chain management for Analytics.
- To apply analytics for different functions of a business

			Program Outcomes (PO)												Program Specific Outcome (PSO		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Explain the real world business problems and model with analytical solutions.	AP	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-2:	Identify the business processes for extracting Business Intelligence	U	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-3:	Apply predictive analytics for business fore-casting	U	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-4:	Apply analytics for supply chain and logistics management	AP	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-5:	Use analytics for marketing and sales.	AN	3	2	2	2	3	-	-	-	-	2	-	-	3	3	3

Unit-1 INTRODUCTION TO BUSINESS ANALYTICS **9 Periods**

Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration.

Activities:

1. Perform statistical operations - Mean, Median, Mode and Standard deviation, Variance, Skewness, Kurtosis
2. Perform Z-test, T-test & ANOVA
3. Perform bivariate and multivariate analysis on the dataset

Unit-2 BUSINESS INTELLIGENCE **9 Periods**

Data Warehouses and Data Mart - Knowledge Management –Types of Decisions - Decision Making Process - Decision Support Systems — Business Intelligence – OLAP — Analytic functions.

Activities:

1. Perform data pre-processing operations i) Handling Missing data ii) Normalization

2. Perform dimensionality reduction operation using PCA, KPCA & SVD

Unit-3	**BUSINESS FORECASTING**	**9 Periods**
Introduction to Business Forecasting and Predictive analytics - Logic and Data Driven Models –Data Mining and Predictive Analysis Modelling –Machine Learning for Predictive analytics. **Activities:** 1. Create a dashboard and perform data analysis		
Unit-4	**HR & SUPPLY CHAIN ANALYTICS**	**9 Periods**
Human Resources – Planning and Recruitment – Training and Development - Supply chain network-Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR & Supply Chain -Applying HR Analytics to make a prediction of the demand for hourly employees for a year.		

Unit-5	**MARKETING & SALES ANALYTICS**	**9 Periods**
Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process – Sales Planning – Analytics applications in Marketing and Sales - Predictive analytics for customers' behaviour in marketing and sales. **Activities:** 1. Develop the data model 2. Presentation of a case study		
		Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. R. Evans James, Business Analytics, 2nd Edition, Pearson, 2017 2. R N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2nd Edition, Wiley, 2016 3. Philip Kotler and Kevin Keller, Marketing Management, 15th edition, PHI, 2016 4. VSP RAO, Human Resource Management, 3rd Edition, Excel Books, 2010. 5. Mahadevan B, "Operations Management -Theory and Practice",3rd Edition, Pearson Education,2018	1. Foster Provost & Tom Fawcett , *Data Science for Business,*1st Edition,O'Reilly Media, 2013 2. U. Dinesh Kumar ,*Business Analytics: The Science of Data-Driven Decision Making,* 2nd Edition, Wiley India, 2021. 3. Wes McKinney ,*Python for Data Analysis,* 3rd Edition, O'Reilly Media, 2022.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE02	Course Name	BIG DATA ANALYTICS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	NIL
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand big data.
- To learn and use NoSQL big data management.
- To learn map reduce analytics using Hadoop and related tools.
- To work with map reduce applications
- To understand the usage of Hadoop related tools for Big Data Analytics

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Describe big data and use cases from selected business domains.	U	3	3	3	3	3	-	-	-	2	2	3	1	3	3	3
CO-2:	Explain NoSQL big data management.	U	3	3	2	3	2	-	-	-	2	2	3	3	3	3	2
CO-3:	Install, configure, and run Hadoop and HDFS.	U	3	3	3	2	3	-	-	-	2	2	1	2	3	3	3
CO-4:	Perform map-reduce analytics using Hadoop.	AP	2	3	3	3	3	-	-	-	2	2	3	2	2	3	3
CO-5:	Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.	AP	3	3	3	3	3	-	-	-	3	1	3	2	3	3	3

Unit-1 UNDERSTANDING BIG DATA **9 Periods**

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications- big data technologies – introduction to Hadoop – open-source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

Activities:

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files

Unit-2 NOSQL DATA MANAGEMENT **9 Periods**

Introduction to NoSQL – aggregate data models – key-value and document data models –relationships – graph databases – schema less databases – materialized views – distribution models– master-slave replication – consistency – Cassandra – Cassandra data model – Cassandra examples – Cassandra clients

Unit-3 MAP REDUCE APPLICATIONS **9 Periods**

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

Activities:

1. Implement of Matrix Multiplication with Hadoop Map Reduce

2. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	
Unit-4 BASICS OF HADOOP	**9 Periods**
Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes –design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow –Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures –Cassandra – Hadoop integration.	
Unit-5 HADOOP RELATED TOOLS	**9 Periods**
Hbase – data model and implementations – Hbase clients – Hbase examples – praxis- Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts- Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries. **Activities:** 1. Installation of Hive along with practice examples. 2. Installation of HBase, Installing thrift along with Practice examples	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013. 2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012. 3. Sadalage, Pramod J. “NoSQL distilled”, 2013.	1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012. 2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011. 3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010. 4. Alan Gates, "Programming Pig", O'Reilley, 2011.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Professional Elective Courses - Vertical-2 (Full Stack Web Development)

Course Code	24CSE03	Course Name	SOFTWARE TESTING AND AUTOMATION	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	JAVA, C++	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the basics of software testing
- To learn how to do the testing and planning effectively
- To build test cases and execute them
- To focus on wide aspects of testing and understanding multiple facets of testing
- To get an insight about test automation and the tools used for test automation

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basic concepts of software testing and the need for software testing.	**1**	3	3	2	1	2	-	-	-	1	1	3	2	3	2	3
CO-2:	Design Test planning and different activities involved in test planning.	**2**	2	3	1	1	1	-	-	-	2	2	1	2	1	2	3
CO-3:	Design effective test cases that can uncover critical defects in the application	**3**	2	2	1	3	1	-	-	-	1	3	1	2	2	3	2
CO-4:	Carry out advanced types of testing.	**4**	2	1	3	2	1	-	-	-	1	1	1	2	3	1	2
CO-5:	Automate the software testing using Selenium and TestNG.	**5**	2	2	1	3	1	-	-	-	1	3	2	1	2	1	3

Unit-1 FOUNDATIONS OF SOFTWARE TESTING **9 Periods**

Why do we test Software?, Black-Box Testing and White-Box Testing, Software Testing Life Cycle, V- model of Software Testing, Program Correctness and Verification, Reliability versus Safety, Failures, Errors and Faults (Defects), Software Testing Principles, Program Inspections, Stages of Testing: Unit Testing, Integration Testing, System Testing

Activities:

1. Develop the test plan for testing an e-commerce web/mobile application
2. Design the test cases for testing the e-commerce application

Unit-2 TEST PLANNING **9 Periods**

The Goal of Test Planning, High Level Expectations,Intergroup Responsibilities, Test Phases, Test Strategy, Resource Requirements, Tester Assignments, Test Schedule, Test Cases, Bug Reporting, Metrics and Statistics.

Activities:

1. Test the e-commerce application and report the defects in it. 2. Develop the test plan and design the test cases for an inventory control system	
Unit-3 TEST DESIGN AND EXECUTION	**9 Periods**
Test Objective Identification, Test Design Factors, Requirement identification, Testable Requirements, Modeling a Test Design Process, Modeling Test Results, Boundary Value Testing, Equivalence Class Testing, Path Testing, Data Flow Testing, Test Design Preparedness Metrics, Test Case Design Effectiveness,Model-Driven Test Design, Test Procedures, Test Case Organization and Tracking, Bug Reporting, Bug LifeCycle. **Activities:** 1. Execute the test cases against a client server or desktop application and identify the defects. 2. Test the performance of the e-commerce application.	
Unit-4 ADVANCED TESTING CONCEPTS	**9 Periods**
Performance Testing: Load Testing, Stress Testing, Volume Testing, Fail-Over Testing, Recovery Testing, Configuration Testing, Compatibility Testing, Usability Testing, Testing the Documentation, Security testing,Testing in the Agile Environment, Testing Web and Mobile Applications	
Unit-5 TEST AUTOMATION AND TOOLS	**9 Periods**
Automated Software Testing, Automate Testing of Web Applications, Selenium: Introducing Web Driver andWeb Elements, Locating Web Elements, Actions on Web Elements, Different Web Drivers, Understanding Web Driver Events, Testing: Understanding Testing.xml, Adding Classes, Packages, Methods to Test, Test Reports. **Activities:** 1. Mini Project: a) Build a data-driven framework using Selenium and TestNG. b) Build Page object Model using Selenium and TestNG c) Build BDD framework with Selenium, TestNG and Cucumber 2. Automatic the testing of e-commerce application using selenium. 3. Integrate TestNG with the above test automation.	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1.Yogesh Singh, "Software Testing", Cambridge University Press, 2012. 2.Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" – Second Edition 2018.	1. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3rd Edition,2012, JohnWiley & Sons, Inc. 2. Ron Patton, Software testing, 2nd Edition, 2006, Sams Publishing.Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Fourth Edition, 2014, Taylor & Francis Group 3. Carl Cocchiaro, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing. 4. Elfriede Dustin, Thom Garrett, Bernie Gaurf, Implementing Automated Software Testing, 2009, PearsonEducation, Inc. 5. Satya Avasarala, Selenium WebDriver Practical Guide, 2014, Packt Publishing. 6. Varun Menon, TestNg Beginner's Guide, 2013, Packt Publishing.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		End Semester Examination (60% weightage)
Average of Internal Test (20%)	Critical Thinking Assessment (20%)	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE04	Course Name	DEVOPS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Introduction to Operating Systems	**Co-requisite Courses**	Nil	**Progressive Courses**	Cloud Computing
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce DevOps terminology, definition & concepts
- To understand the different Version control tools like Git, Mercurial
- To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous
- To understand Configuration management using Ansible
- Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand different actions performed through Version control tools like Git.	U	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO-2:	Understand Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle	U	1	1	1	1	-	-	-	-	-	-	-	-	1	1	1
CO-3:	Ability to Perform Automated Continuous Deployment	AP	1	1	1	1	-	-	-	-	-	-	-	-	1	1	1
CO-4:	Ability to do configuration management using Ansible	AP	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO-5:	Understand to leverage Cloud-based DevOps tools using Azure DevOps	U	3	2	2	2	3	-	-	-	-	-	-	-	3	3	3

Unit-1 INTRODUCTION TO DEVOPS **9 Periods**

Devops Essentials – DevOps vs Agile - DevOps Principles and Life Cycle – Introduction to CI / CD & DevOps Tools -Version control systems: Git and Github.

Unit-2 COMPILE AND BUILD USING MAVEN & GRADLE **9 Periods**

Introduction, Installation of Maven, POM files, Maven Build lifecycle, Build phases(compile build, test, package) Maven Profiles, Maven repositories(local, central, global),Maven plugins, Maven create and build Artificats, Dependency management, Installation of Gradle, Understand build using Gradle

Activities:

1. Build a simple application using Gradle

Unit-3 CONTINUOUS INTEGRATION USING JENKINS **9 Periods**

Install & Configure Jenkins, Jenkins Architecture Overview, Creating a Jenkins Job, Configuring a Jenkins job, Introduction to Plugins, Adding Plugins to Jenkins, Commonly used plugins (Git Plugin, Parameter Plugin, HTML Publisher, Copy Artifact and Extended choice parameters). Configuring Jenkins to work with java, Git and Maven, Creating a Jenkins Build and Jenkins workspace, Kubernetes – Cluster Architecture.

Activities:

1. Install Jenkins in Cloud
2. Create CI pipeline using Jenkins
3. Create a CD pipeline in Jenkins and deploy in Cloud

Unit-4 CONFIGURATION MANAGEMENT USING ANSIBLE **9 Periods**

Ansible Introduction, Installation, Ansible master/slave configuration, YAML basics, Ansible modules, Ansible Inventory files, Ansible playbooks, Ansible Roles, adhoc commands in ansible **Activities:** 1. Create an Ansible playbook for a simple web application infrastructure 2. Install Ansible and configure ansible roles and to write playbooks	
Unit-5 BUILDING DEVOPS PIPELINES USING AZURE	**9 Periods**
Create Github Account -Different Git tools - Git Installation and Configuration - Setting up Git Bash and Git UI -GIT commands, Create Azure Organization, Create a new pipeline, Build a sample code, Modify azure-pipelines.yaml file **Activities:** 1. Create Maven Build pipeline in Azure 2. Run regression tests using Maven Build pipeline in Azure	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Roberto Vormittag, "A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises", Second Edition, Kindle Edition, 2016. 2. Jaokim Verona, Practical DevOps, 2 nd Edition, Packt. Publication, 2018.	1. Mitesh Soni,"Hands-On Azure Devops: Cicd Implementation For Mobile, Hybrid, And Web Applications Using Azure DevOps And Microsoft Azure: CICD Implementation for DevOps and Microsoft Azur" Paperback – 1 January 2020. 2. Jeff Geerling, "Ansible for DevOps: Server and configuration management for humans", First Edition, 2015. 3. David Johnson, "Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps", Second Edition, 2016. 4. Alistair Cockburn, "Agile Software Development", 2nd ed, Pearson Education, 2007.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE05	Course Name	PRINCIPLES OF PROGRAMMING LANGUAGES	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Theory of Computation , Object Oriented Programming	**Co- requisite Courses**	Nil	**Progressive Courses**	-
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand and describe syntax and semantics of programming languages
- To understand data, data types, and basic statements
- To understand call-return architecture and ways of implementing them
- To understand object-orientation, concurrency, and event handling in programming languages
- To develop programs in non-procedural programming paradigms

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Describe syntax and semantics of programming language	U	2	2	3	2	1	-	-	-	-	-	-	3	2	3	-
CO-2:	Explain data, data types, and basic statements of programming languages	U	3	3	3	2	2	-	-	-	-	-	-	3	2	3	-
CO-3:	Design and implement subprogram constructs	U	3	3	3	2	2	-	-	-	-	-	-	3	2	3	-
CO-4:	Apply object-oriented, concurrency, and event handling programming constructs and Develop programs in Scheme, ML, and Prolog	AP	3	3	3	3	2	2		-	-	-	-	-	3	2	-
CO-5:	Understand and adopt new programming languages	U	3	3	3	3	3	3	2	2	1	3	1	3	3	3	-

Unit-1	**SYNTAX AND SEMANTICS**	**9 Periods**
Evolution of programming languages – describing syntax – context-free grammars, variants of CFG – attribute grammars – describing semantics – lexical analysis – parsing – recursive-descent – bottom-up parsing.		
Unit-2	**DATA, DATA TYPES, AND BASIC STATEMENTS**	**9 Periods**
Primitive data types –**Derived datatypes**- strings – array types – associative arrays – record types –– pointers and references –User defined data type- union types -Structure type-Enumeartion type**-** Expression:Arithmetic expressions – overloaded operators – type conversions – relational and Boolean expressions – assignment statements – mixed mode assignments **–**Scope and Scope rules-control structures – selection – iterations – branching – guarded statements.		
Unit-3	**SUBPROGRAMS AND IMPLEMENTATIONS**	**9 Periods**
Subprograms – design issues – local referencing – parameter passing – overloaded methods – generic methods – design issues for functions – semantics of call and return – implementing simple subprograms – stack and dynamic local variables – nested subprograms – blocks – dynamic scoping		

Unit-4	**OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING**	**9 Periods**
Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency – semaphores – monitors – message passing – threads – statement level concurrency – exception handling – event handling		
Unit-5	**FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES**	**9 Periods**
Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog – multi-paradigm languages.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Robert W. Sebesta, "Concepts of Programming Languages", Twelfth Edition (Global Edition), Pearson, 2022. 2. Michael L. Scott, "Programming Language Pragmatics", Fourth Edition, Elsevier, 2018. 3. R. Kent Dybvig, "The Scheme programming language", Fourth Edition, Prentice Hall, 2011.	1. Jeffrey D. Ullman, "Elements of ML programming", Second Edition, Pearson, 1997. 2. W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth Edition, Springer, 2003.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE02	Course Name	APP DEVELOPMENT	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To learn development of native applications with basic GUI Components
- To develop cross-platform applications with event handling
- To develop applications with location and data storage capabilities
- To develop web applications with database access

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Develop Native applications with GUI Components.	U	2	2	1	2	3	-	-	-	1	1	2	1	2	3	3
CO-2:	Develop hybrid applications with basic event handling.	AP	2	1	3	2	2	-	-	-	3	2	2	3	3	2	1
CO-3:	Implement cross-platform applications with location and data storage capabilities.	AN	2	2	2	1	2	-	-	-	1	1	1	1	1	1	2
CO-4:	Implement cross platform applications with basic GUI and event handling.	AN	1	3	1	1	3	-	-	-	1	1	3	2	1	3	1
CO-5:	Develop web applications with cloud database access.	E	1	1	3	1	3	-	-	-	1	1	2	1	3	2	1

Unit-1 UNIT I FUNDAMENTALS OF MOBILE & WEB APPLICATION DEVELOPMENT 9 Periods

Basics of Web and Mobile application development, Native App, Hybrid App, Cross-platform App, What is Progressive Web App, Responsive Web design.

Activities:

1. Using react native, build a cross platform application for a BMI calculator.
2. Build a cross platform application for a simple expense manager which allows entering expenses and income on each day and displays category wise weekly income and expense.

Unit-2 UNIT II NATIVE APP DEVELOPMENT USING JAVA 9 Periods

Native Web App, Benefits of Native App, Scenarios to create Native App, Tools for creating Native App, Cons of Native App, Popular Native App Development Frameworks, Java & Kotlin for Android, Swift & Objective-C for iOS, Basics of React Native, Native Components, JSX, State, Props.

Activities:

1. Develop a cross platform application to convert units from imperial system to metric system (km to miles, kg to pounds etc.,)

Unit-3 UNIT III HYBRID APP DEVELOPMENT 9 Periods

Hybrid Web App, Benefits of Hybrid App, Criteria for creating Native App, Tools for creating Hybrid App, Cons of Hybrid App, Popular Hybrid App Development Frameworks, Ionic, Apache Cordova.

Activities:

1. Design and develop a cross platform application for day to day task (to-do) management

Unit-4	**UNIT IV CROSS-PLATFORM APP DEVELOPMENT USING REACT-NATIVE**	**9 Periods**
What is Cross-platform App, Benefits of Cross-platform App, Criteria for creating Cross-platform App, Tools for creating Cross-platform App, Cons of Cross-platform App, Popular Cross platform App Development Frameworks, Flutter, Xamarin, React-Native, Basics of React Native, Native Components, JSX, State, Props. **Activities:** 1. Design an android application using Cordova for a user login screen with username, password, reset button and a submit button. Also, include header image and a label. Use layout manager.		
Unit-5	**UNIT V NON-FUNCTIONAL CHARACTERISTICS OF APP FRAMEWORKS**	**9 Periods**
Comparison of different App frameworks, Build Performance, App Performance, Debugging capabilities, Time to Market, Maintainability, Ease of Development, UI/UX, Reusability **Activities:** 1. Design and develop an android application using Apache Cordova to find and display the current location of the user 2. Write programs using Java to create Android application having Databases • For a simple library application • For displaying books available, books lend, book reservation. Assume that student information is available in a database which has been stored in a database server.		
		Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. Head First Android Development, Dawn Griffiths, O'Reilly, 1st edition 2. Apache Cordova in Action, Raymond K. Camden, Manning. 2015 Full Stack React Native: Create beautiful mobile apps with JavaScript and React Native, 3. Head First Android Development, 3rd Edition – Dawn Griffiths, O'Reilly (latest full edition, updated for modern Android, Jetpack, Jetpack Compose,2021	1. Android Programming for Beginners, John Horton, Packt Publishing, 2nd Edition 2. Native Mobile Development by Shaun Lewis, Mike Dunn 3. Building Cross-Platform Mobile and Web Apps for Engineers and Scientists: An Active Learning Approach, Pawan Lingras, Matt Triff, Rucha Lingras 4. Apache Cordova 4 Programming, John M Wargo, 2015 5. React Native Cookbook, Daniel Ward, Packt Publishing, 2nd Edition

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE03	Course Name	CLOUD SERVICES MANAGEMENT	Course Category	TP	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce Cloud Service Management terminology, definition & concepts
- Compare and contrast cloud service management with traditional IT service management
- Identify strategies to reduce risk and eliminate issues associated with adoption of cloud services
- Select appropriate structures for designing, deploying and running cloud-based services in a business environment
- Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Exhibit cloud-design skills to build and automate business solutions using cloud technologies.	AP	3	3	1	1	1	-	-	-	2	1	3	2	2	1	3
CO-2:	Possess Strong theoretical foundation leading to excellence and excitement towards adoption of cloud-based services	U	3	1	2	3	2	-	-	-	1	2	3	1	2	2	2
CO-3:	Solve the real world problems using Cloud services and technologies	AN	1	1	3	1	3	-	-	-	3	3	1	1	3	2	1
CO-4:	Apply cloud cost models to estimate and manage cloud expenditure effectively.	AP	3	1	2	1	3	-	-	-	3	1	3	1	3	2	1
CO-5:	Apply governance models to ensure effective management, compliance, and value realization in cloud environments	AP	3	3	1	2	2	-	-	-	2	1	2	1	2	3	1

Unit-1	UNIT I CLOUD SERVICE MANAGEMENT FUNDAMENTALS	6 Periods
Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models		
Unit-2	**UNIT II CLOUD SERVICES STRATEGY**	**6 Periods**
Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture		
Unit-3	**UNIT III CLOUD SERVICE MANAGEMENT**	**6 Periods**
Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management.		
Unit-4	**UNIT IV CLOUD SERVICE ECONOMICS**	**6 Periods**
Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models.		
Unit-5	**UNIT V CLOUD SERVICE GOVERNANCE & VALUE**	**6 Periods**

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership
Total Theory: 30 Periods

List of Experiments	**Total Practical: 30 Periods**
1. Create a Cloud Organization in AWS/Google Cloud/or any equivalent Open Source cloud softwares like Openstack, Eucalyptus, OpenNebula with Role-based access control 2. Create a Cost-model for a web application using various services and do Cost-benefit analysis 3. Create alerts for usage of Cloud resources 4. Create Billing alerts for your Cloud Organization 5. Compare Cloud cost for a simple web application across AWS, Azure and GCP and suggest the best one	

	Text Books	**References**
Learning Resources	1. Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications 2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2013 3. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour. 4. “Cloud Service Management and Governance: Smart Service Management in Cloud Era, 2023 paperback edition” – Enamul Haque, Lulu Press Inc,2023	1. Economics of Cloud Computing by Praveen Ayyappa, LAP Lambert Academic Publishing 2. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vechhiola, S. Thamarai Selvi

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24ITE04	Course Name	UI AND UX DESIGN	Course Category	TP	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology		**Data Book / Codes Standards**	nil	

Course Objective: ***The purpose of learning this course is to:***

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- To understand the various Research Methods used in Design
- To explore the various Tools used in UI & UX
- Creating a wireframe and prototype

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Build UI for user Applications	U	3	1	1	3	1	-	-	-	3	3	2	1	3	3	1
CO-2:	Evaluate UX design of any product or application	AN	2	3	1	3	2	-	-	-	1	2	2	2	1	2	2
CO-3:	Demonstrate UX Skills in product development	AP	1	3	3	2	2	-	-	-	2	3	1	2	1	3	3
CO-4:	Implement Sketching principles	AP	1	2	3	3	1	-	-	-	3	2	1	3	3	3	3
CO-5:	Create Wireframe and Prototype	AP	1	2	3	2	1	-	-	-	2	1	1	1	3	2	2

Unit-1	**FOUNDATIONS OF DESIGN**	**6 Periods**
UI vs. UX Design - Core Stages of Design Thinking - Divergent and Convergent Thinking - Brainstorming and Game storming - Observational Empathy		
Unit-2	**FOUNDATIONS OF UI DESIGN**	**6 Periods**
Visual and UI Principles - UI Elements and Patterns - Interaction Behaviors and Principles – Branding - Style Guides		
Unit-3	**FOUNDATIONS OF UX DESIGN**	**6 Periods**
Introduction to User Experience - Why You Should Care about User Experience - Understanding User Experience - Defining the UX Design Process and its Methodology - Research in User Experience Design - Tools and Method used for Research - User Needs and its Goals - Know about Business Goals		
Unit-4	**WIREFRAMING, PROTOTYPING AND TESTING**	**6 Periods**
Sketching Principles - Sketching Red Routes - Responsive Design – Wireframing - Creating Wire flows - Building a Prototype - Building High-Fidelity Mockups - Designing Efficiently with Tools - Interaction Patterns - Conducting Usability Tests - Other Evaluative User Research Methods - Synthesizing Test Findings - Prototype Iteration		
Unit-5	**RESEARCH, DESIGNING, IDEATING, & INFORMATION ARCHITECTURE**	**6 Periods**
Identifying and Writing Problem Statements - Identifying Appropriate Research Methods - Creating Personas - Solution Ideation - Creating User Stories - Creating Scenarios - Flow Diagrams - Flow Mapping - Information Architecture		
		Total Theory: 30 Periods

List of Experiments	Total Practical: 30 Periods

1. Designing a Responsive layout for an societal application
2. Exploring various UI Interaction Patterns
3. Developing an interface with proper UI Style Guides
4. Developing Wireflow diagram for application using open source software
5. Exploring various open source collaborative interface Platform
6. . Hands on Design Thinking Process for a new product
7. Brainstorming feature for proposed product
8. Defining the Look and Feel of the new Project
9. Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
10. Identify a customer problem to solve
11. Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping
12. . Sketch, design with popular tool and build a prototype and perform usability testing and identify improvements

	Text Books	References
Learning Resources	1. Joel Marsh, "UX for Beginners", O'Reilly , 2022 2. Jon Yablonski, "Laws of UX using Psychology to Design Better Product & Services" O'Reilly 2021	1. Jenifer Tidwell, Charles Brewer, Aynne Valencia, "Designing Interface" 3 rd Edition , O'Reilly 2020 2. Steve Schoger, Adam Wathan "Refactoring UI", 2018 3. Steve Krug, "Don't Make Me Think, Revisited: A Commonsense Approach to Web & Mobile", Third Edition, 2015 4. https://www.nngroup.com/articles/ 5. https://www.interaction-design.org/literature.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24ITE05	Course Name	WEB APPLICATION SECURITY	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	nil	Co- requisite Courses	nil	Progressive Courses	nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamentals of web application security
- To focus on wide aspects of secure development and deployment of web applications
- To learn how to build secure APIs
- To learn the basics of vulnerability assessment and penetration testing
- To get an insight about Hacking techniques and Tools

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understanding the basic concepts of web application security and the need for it	U	3	2	-	-	-	2	-	3	-	-	-	2	2	1	1
CO-2:	Be acquainted with the process for secure development and deployment of web applications	AN	3	2	2	-	2	2	-	2	1	-	-	2	3	2	1
CO-3:	Acquire the skill to design and develop Secure Web Applications that use Secure APIs	AP	3	3	3	--	3	-	-	2	2	1	1	2	3	3	1
CO-4:	Be able to get the importance of carrying out vulnerability assessment and penetration testing	U	2	3	-	2	2	2	-	3	-	-	-	2	2	2	3
CO-5:	Acquire the skill to think like a hacker and to use hackers tool sets	AP	2	3	-	3	3	1	-	2	2	-	-	3	2	3	2

Unit-1 FUNDAMENTALS OF WEB APPLICATION SECURITY **9 Periods**

The history of Software Security-Recognizing Web Application Security Threats, Web Application Security, Authentication and Authorization, Secure Socket layer, Transport layer Security, Session Management-Input Validation.

Activities:

1. Install wireshark and explore the various protocols
   a. Analyze the difference between HTTP vs HTTPS
   b. Analyze the various security mechanisms embedded with different protocols.

Unit-2 SECURE DEVELOPMENT **9 Periods**

Web Applications Security - Security Testing, Security Incident Response Planning, The Microsoft Security Development Lifecycle (SDL), OWASP Comprehensive Lightweight Application Security Process (CLASP), The Software Assurance Maturity Model (SAMM).

Activities:

1. Identify the vulnerabilities using OWASP ZAP tool

Unit-3 SECURE API DEVELOPMENT **9 Periods**

API Security- Session Cookies, Token Based Authentication, Securing Natter APIs: Addressing threats with Security Controls, Rate Limiting for Availability, Encryption, Audit logging, Securing service-to-service APIs: API Keys , OAuth2, Securing Microservice APIs: Service Mesh, Locking Down Network Connections, Securing Incoming Requests.

Activities: 1. Create simple REST API using python for following operation. a.GET b.PUSH c.POST d.DELETE		
Unit-4	**VULNERABILITY ASSESSMENT AND PENETRATION TESTING**	**9 Periods**
Vulnerability Assessment Lifecycle, Vulnerability Assessment Tools: Cloud-based vulnerability scanners, Host-based vulnerability scanners, Network-based vulnerability scanners, Database- based vulnerability scanners, Types of Penetration Tests: External Testing, Web Application Testing, Internal Penetration Testing, SSID or Wireless Testing, Mobile Application Testing. **Activities::** 1. Install Burp Suite to do following vulnerabilities: a.SQL injection b.cross-site scripting (XSS)		
Unit-5	**HACKING TECHNIQUES AND TOOLS**	**9 Periods**
Social Engineering, Injection, Cross-Site Scripting(XSS), Broken Authentication and Session Management, Cross-Site Request Forgery, Security Misconfiguration, Insecure Cryptographic Storage, Failure to Restrict URL Access, Tools: Comodo, OpenVAS, Nexpose, Nikto, Burp Suite, etc. **Activities:** 1. Attack the website using Social Engineering method.		
		Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. Andrew Hoffman, Web Application Security: Exploitation and Countermeasures for Modern Web Applications, First Edition, 2020, O'Reilly Media, Inc. 2. Bryan Sullivan, Vincent Liu, Web Application Security: A Beginners Guide, 2012, The McGraw-Hill Companies. 3. Neil Madden, API Security in Action, 2020, Manning Publications Co., NY, USA.	1. Michael Cross, Developer's Guide to Web Application Security, 2007, Syngress Publishing, Inc. 2. Ravi Das and Greg Johnson, Testing and Securing Web Applications, 2021, Taylor & Francis Group, LLC. 3. Prabath Siriwardena, Advanced API Security, 2020, Apress Media LLC, USA. 4. Malcom McDonald, Web Security for Developers, 2020, No Starch Press, Inc. 5. Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, Gideon Lenkey, and Terron Williams Grey Hat Hacking: The Ethical Hacker's Handbook, Third Edition, 2011, The McGraw-Hill Companies.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADE05	Course Name	WEB TECHNOLOGIES	Course Category	TP	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Database Management Systems	Co- requisite Courses	Nil	Progressive Courses	Full Stack Development Essentials
Course Offering Department	Artificial Intelligence and Data Science	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand web basics and build pages using HTML5, CSS3, and Bootstrap.
- Use JavaScript for client-side scripting and validation.
- Develop server-side programs using Servlets and JDBC.
- Create dynamic web solutions using PHP and XML.
- Explore modern web frameworks like Angular, React, Node.js, and Django.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Construct a basic website using HTML and Cascading Style Sheets.	AP	3	3	3	3	3	-	-	-	1	3	3	1	3	2	3
CO-2:	Build dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms.	AP	2	3	2	1	2	-	-	-	2	2	1	3	2	2	2
CO-3:	Develop server side programs using Servlets and JSP.	AP	1	1	3	2	3	-	-	-	1	2	1	1	1	2	1
CO-4:	Construct simple web pages in PHP and to represent data in XML format.	AP	2	3	3	1	2	-	-	-	3	1	2	2	2	2	2
CO-5:	Develop interactive web applications.	AP	1	2	3	2	2	-	-	-	2	1	3	1	1	1	2

Unit-1	WEBSITE BASICS, HTML 5, CSS 3, WEB 2.0	7 Periods
Web Essentials: Clients, Servers and Communication - The Internet - World wide web - HTTP Request Message - HTTP Response Message - Web Clients - Web Servers - HTML5 - Tables - Lists - Image - HTML5 control elements - Drag and Drop - Audio - Video controls - CSS3 - Inline, embedded and external style sheets - Rule cascading - Inheritance - Backgrounds - Border Images - Colors - Shadows - Text - Transformations - Transitions - Animations. Bootstrap Framework.		
Unit-2	**CLIENT SIDE PROGRAMMING**	**6 Periods**
Java Script: An introduction to JavaScript-JavaScript DOM Model-Exception Handling-Validation- Built-in objects - Event Handling- DHTML with JavaScript- JSON introduction - Syntax - Function Files - JavaScript ES6 Features.		
Unit-3	**SERVER SIDE PROGRAMMING**	**5 Periods**
Servlets: Java Servlet Architecture- Servlet Life Cycle- Form GET and POST actions- Session Handling- Understanding Cookies- Database con: JDBC - AI API Integration.		
Unit-4	**PHP and XML**	**6 Periods**
An introduction to PHP: PHP- Using PHP- Variables- Program control- Built-in functions- Form Validation. XML: Basic XML- Document Type Definition- XML Schema, XML Parsers and Validation, XSL – AI Spam Detection.		
Unit-5	**INTRODUCTION TO ANGULAR and WEB APPLICATIONS FRAMEWORKS**	**6 Periods**
Introduction to AngularJS, MVC Architecture, Understanding ng attributes, Expressions and data binding, Conditional Directives, Style Directives, Controllers, Filters, Forms, Routers, Modules, Services; Web Applications Frameworks and Tools - Firebase- Docker- Node JS- React- Django- UI & UX - REST API - Generative AI Web Apps		
		Total Theory: 30 Periods

List of Experiments	Total Practical: 30 Periods

1. Create a web page with the following using HTML.
    - To embed an image map in a web page.
    - To fix the hot spots.
    - Show all the related information when the hot spots are clicked.
2. Create a web page with all types of Cascading style sheets.
3. Client Side Scripts for Validating Web Form Controls using DHTML.
4. Installation of Apache Tomcat web server.
5. Write programs in Java using Servlets:
    - To invoke servlets from HTML forms.
    - Session Tracking.
6. Write programs in Java to create three-tier applications using JSP and Databases.
    - For conducting on-line examinations.
    - For displaying student mark list. Assume that student information is available in a database which has been stored in a database server.
7. Programs using XML – Schema – XSLT/XSL.

	Text Books	References
Learning Resources	1. Deitel and Deitel and Nieto, Internet and World Wide Web - How to Program, Prentice Hall, 5th Edition, 2011. 2. Jeffrey C and Jackson, Web Technologies A Computer Science Perspective, Pearson Education, 2011. 3. Angular 6 for Enterprise-Ready Web Applications, Doguhan Uluca, 1st edition Packt Publishing. 4. *Web Development and Design Foundations with HTML5*, Terry Felke-Morris, Pearson Education, Tenth Edition, 2022.	1. Stephen Wynkoop and John Burke "Running a Perfect Website", QUE, 2nd Edition,1999. 2. Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009. 3. Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011. 4. UttamK.Roy, "Web Technologies", Oxford University Press, 2011. 5. Angular: Up and Running: Learning Angular, Step by Step, Shyam Seshadri, 1st edition, O'Reilly. 6. *CSS: The Definitive Guide*, Eric A. Meyer, Estelle Weyl, O'Reilly Media, Fifth Edition, 2023.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Professional Elective Courses - Vertical-3 (Cloud Computing And Data Center)

Course Code	24CSE06	Course Name	VIRTUALIZATION	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Cloud Services Management
Course Offering Department		Computer Science and Engineering		**Data Book / Codes / Standards**	Nil

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamental concepts of virtualization and its relationship with cloud computing
- To study the concepts of server and desktop virtualization
- To explore the principles of network virtualization
- To analyze the methods of storage and application virtualization
- To examine various industry-standard virtualization tools and platforms

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Analyse the concepts of virtualization, types of hardware virtualization, and hypervisors used in cloud environments.	AN	1	3	1	3	2	-	-	-	1	1	3	1	2	3	2
CO-2:	Apply virtualization principles to real-world scenarios through server and desktop virtualization solutions.	AP	3	2	2	1	2	-	-	-	1	2	2	3	3	2	1
CO-3:	Install and configure different virtual machine platforms and network virtualization components such as SDN and SDDC.	AP	3	2	1	3	1	-	-	-	2	2	1	3	3	3	2
CO-4:	Experiment with virtual machines by integrating storage, application, and network tools for optimized performance.	C	1	1	2	3	3	-	-	-	3	3	1	1	3	2	2
CO-5:	Evaluate and compare various virtualization tools and platforms for optimizing performance, cost, and scalability in real-world environments.	EV	1	3	2	3	1	-	-	-	2	1	3	3	1	1	2

Unit-1 INTRODUCTION TO VIRTUALIZATION **9 Periods**

Virtualization and cloud computing - Need of virtualization – cost, administration, fast deployment, reduce infrastructure cost – limitations- Types of hardware virtualization: Full virtualization - partial virtualization – Paravirtualization – Types of Hypervisors, Recent Trends & technologies in virtualized environments.

Unit-2 SERVER AND DESKTOP VIRTUALIZATION **9 Periods**

Virtual machine basics – Types of virtual machines – hypervisor concepts and types – Understanding Server Virtualization – types of server virtualization– Business Cases for Server Virtualization – Uses of Virtual Server Consolidation – Selecting Server Virtualization Platform – Desktop Virtualization – Types of Desktop Virtualization – Tools.

Activities:

1. Desktop Virtualization using VNC
2. Desktop Virtualization using Chrome Remote Desktop

Unit-3 NETWORK VIRTUALIZATION		9 Periods
Introduction to Network Virtualization - Advantages - Functions - SDN & SDDC - Tools for Network Virtualization - Virtual Switching and Connectivity - VLAN-WAN Architecture - WAN Virtualization - Network Security and Micro-Segmentation.		
Unit-4 STORAGE VIRTUALIZATION		**9 Periods**
Memory Virtualization – Types of Storage Virtualization – Block, File – CDMI – Address space Remapping – Risks of Storage Virtualization – SAN – NAS– RAID– Application Virtualization – Tools for storage and application virtualization **Activities:** 1. Create RAID 5 volume		
Unit-5 VIRTUALIZATION TOOLS		**9 Periods**
VMware – Amazon AWS – Microsoft Hyper – V – Oracle VM Virtual Box – IBM PowerVM – Google Virtualization – Case study. **Activities:** 1. Create Nested Virtual Machine(VM under another VM) 2. Create type 2 virtualization in VMWARE or any equivalent Open Source Tool. Allocate memory and storage space as per requirement. Install Guest OS on that VMWARE		
		Total Theory: 45 Periods
	Text Books	**References**
Learning Resources	1. Chris Wolf, Erick M. Halter, “Virtualization: From the Desktop to the Enterprise”, APress, 2005. 2. James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005. 3. David Marshall, Wade A. Reynolds, “Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center”, Auerbach Publications, 2006.	1. Matthew Portnoy, "Virtualization Essentials." Sybex (Wiley), 3rd ed., 2023. Wiley 2. Vedran Dakic, Humble Devassy Chirammal, Prasad Mukhedkar, Anil Vettathu, "Mastering KVM Virtualization." Packt Publishing, 2nd ed., 2020. O'Reilly Media 3. Humble Devassy Chirammal, Prasad Mukhedkar, Anil Vettathu (alternative/earlier authorship listing), "Mastering KVM Virtualization." Packt Publishing, 1st ed., 2016. 4. Bernard Golden, "Virtualization For Dummies." For Dummies (Wiley), 1st ed. (updated paperback/e-book edition), 2011. Wiley

	4. Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill , New Delhi – 2010 5. Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011 6. Peter von Oven, Mastering VMware Horizon 8: An Advanced Guide to Delivering Virtual Desktops and Virtual Apps, APress, 2021.	

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE03	Course Name	CLOUD SERVICES MANAGEMENT	Course Category	TP	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce Cloud Service Management terminology, definition & concepts
- Compare and contrast cloud service management with traditional IT service management
- Identify strategies to reduce risk and eliminate issues associated with adoption of cloud services
- Select appropriate structures for designing, deploying and running cloud-based services in a business environment
- Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Exhibit cloud-design skills to build and automate business solutions using cloud technologies.	AP	3	3	1	1	1	-	-	-	2	1	3	2	2	1	3
CO-2:	Possess Strong theoretical foundation leading to excellence and excitement towards adoption of cloud-based services	U	3	1	2	3	2	-	-	-	1	2	3	1	2	2	2
CO-3:	Solve the real world problems using Cloud services and technologies	AN	1	1	3	1	3	-	-	-	3	3	1	1	3	2	1
CO-4:	Apply cloud cost models to estimate and manage cloud expenditure effectively.	AP	3	1	2	1	3	-	-	-	3	1	3	1	3	2	1
CO-5:	Apply governance models to ensure effective management, compliance, and value realization in cloud environments	AP	3	3	1	2	2	-	-	-	2	1	2	1	2	3	1

Unit-1	**UNIT I CLOUD SERVICE MANAGEMENT FUNDAMENTALS**	**6 Periods**
Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models		
Unit-2	**UNIT II CLOUD SERVICES STRATEGY**	**6 Periods**
Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture		
Unit-3	**UNIT III CLOUD SERVICE MANAGEMENT**	**6 Periods**
Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management.		
Unit-4	**UNIT IV CLOUD SERVICE ECONOMICS**	**6 Periods**
Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models.		
Unit-5	**UNIT V CLOUD SERVICE GOVERNANCE & VALUE**	**6 Periods**

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership
Total Theory: 30 Periods

List of Experiments	**Total Practical: 30 Periods**
1. Create a Cloud Organization in AWS/Google Cloud/or any equivalent Open Source cloud softwares like Openstack, Eucalyptus, OpenNebula with Role-based access control 2. Create a Cost-model for a web application using various services and do Cost-benefit analysis 3. Create alerts for usage of Cloud resources 4. Create Billing alerts for your Cloud Organization 5. Compare Cloud cost for a simple web application across AWS, Azure and GCP and suggest the best one	

	Text Books	**References**
Learning Resources	1. Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications 2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2013 3. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour. 4. “Cloud Service Management and Governance: Smart Service Management in Cloud Era, 2023 paperback edition” – Enamul Haque, Lulu Press Inc,2023	1. Economics of Cloud Computing by Praveen Ayyappa, LAP Lambert Academic Publishing 2. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vechhiola, S. Thamarai Selvi

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom’s Taxonomy should be:
  - Lower-order thinking skills: not more than 40%
  - Higher-order thinking skills: not less than 60%

Course Code	24CSE07	Course Name	DATA WAREHOUSING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is :***

- To know the details of data warehouse Architecture
- To understand OLAP Technology
- To understand the partitioning strategy
- To differentiate various schema
- To understand the roles of process manager & system manager

CO			PO												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Design data warehouse architecture for various problems	E	3	3	3	2	2	-	-	-	3	-	-	3	2	2	2
CO-2:	Apply the OLAP Technology	AP	3	2	2	2	3	-	-	-	2	-	2	2	1	1	1
CO-3:	Analyse the partitioning strategy	AN	3	3	3	3	-	-	-	-	-	-	-	3	1	1	1
CO-4:	Critically analyse the differentiation of various schema for given problem	AN	3	3	3	3	-	-	-	-	-	-	-	3	2	2	2
CO-5:	Frame roles of process manager and system manager	E	3	2	2	2	-	2	-	-	-	-	2	2	3	3	3

Unit-1 INTRODUCTION TO DATA WAREHOUSE **9 Periods**

Data warehouse Introduction – Data warehouse components – operational database Vs. data warehouse – Data warehouse Architecture – Three-tier Data Warehouse Architecture – Autonomous Data Warehouse Vs. Snowflake – Modern Data Warehouse.

Unit-2 ETL AND OLAP TECHNOLOGY **9 Periods**

What is ETL? – ETL vs ELT – Types of Data warehouses – Data warehouse Design and Modelling -Delivery Process – Online Analytical Processing (OLAP) – Characteristics of OLAP – Online Transaction Processing (OLTP) vs OLAP – OLAP operations – Types of OLAP – ROLAP vs MOLAP vs HOLAP.

Activities:

1. Case study using OLAP
2. Case study using OLTP.

Unit-3 META DATA, DATA MART AND PARTITION STRATEGY **9 Periods**

Meta Data – Categories of Metadata – Role of Metadata – Metadata Repository – Challenges for Meta Management – Data Mart – Need of Data Mart – Cost Effective Data Mart -Designing Data Marts – Partitioning Strategy – Vertical Partition - Normalization – Row Splitting – Horizontal Partition.

Activities:

1. Data exploration and introduction with WEKA.
2. Apply WEKA tool for data validation.

Unit-4 DIMENSIONAL MODELING AND SCHEMA	9 Periods
Dimensional Modelling – Multi-Dimensional Modelling – Data Cube – Star schema – Snowflake schema – Star vs Snowflake schema – Fact constellation schema – Schema Definition – Process Architecture – Types of Data Base Parallelism – Datawarehouse Tools. **Activities:** 1. Design star,snowflake and constellation schema for a real world. 2. Write the query for schema definition.	
Unit-5 SYSTEM AND PROCESS MANAGERS	**9 Periods**
Data Warehousing System Mangers: System Configuration Manager – System Scheduling Manager – System Event Manager – System Database Manager – System Backup Recovery Manager – Data Warehousing Process Managers: Load Manager – Warehouse Manager – Query Manager – Tuning – Testing .	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Alex Berson and Stephen Smith, “Data Warehousing, Data Mining &OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008. 2. Ralph Kimball,” The Data Warehouse Toolkit: The Complete Guide to Dimensional Modelling”, Third Edition, 2003.	1.Paul Raj Ponniah,” Data warehousing fundamentals for IT Professionals”,2012. 2. K.P.Soman, Shyam Diwakar and V.Ajay “Insight into Data mining Theory and Practice”, Eastern Economy Edition, Prentice Hall of India, 2006.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE08	Course Name	STORAGE TECHNOLOGIES	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering		**Data Book / Codes Standards**	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Characterize the functionalities of logical and physical components of storage
- Describe various storage networking technologies
- Identify different storage virtualization technologies
- Discuss the different backup and recovery strategies
- Understand common storage management activities and solutions

CO			PO												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Demonstrate the fundamentals of information storage management and various models of Cloud infrastructure services and deployment	AN	3	3	3	2	2	-	-	-	3	-	-	3	2	2	2
CO-2:	Illustrate the usage of advanced intelligent storage systems and RAID	AN	3	2	2	2	3	-	-	-	2	-	2	2	1	1	1
CO-3:	Interpret various storage networking architectures – SAN, including storage subsystems and virtualization.	AN	3	3	3	3	-	-	-	-	-	-	-	3	1	1	1
CO-4:	Examine the different role in disaster recovery and remote replication technologies	AP	3	3	3	3	-	-	-	-	-	-	-	3	2	2	2
CO-5:	Infer the security needs and security measures to be employed in information storage management	AP	3	2	2	2	-	2	-	-	-	-	2	2	3	3	3

Unit-1 STORAGE SYSTEMS **9 Periods**

Introduction to Information Storage: digital data and its types, information storage, Key characteristics of data centre and Evolution of computing platforms. Information Lifecycle Management. Third Platform Technologies: Cloud computing and its essential characteristics, Cloud services and cloud deployment models, Big Data analytics, Social networking and mobile computing, Characteristics of third platform infrastructure and Imperatives for third platform transformation.

Unit-2 INTELLIGENT STORAGE SYSTEMS AND RAID **9 Periods**

Components of an intelligent storage system, Components, addressing and performance of hard disk drives and solid-state drives, RAID, Types of intelligent storage systems, Scale-up and scale-out storage architecture.

Unit-3 STORAGE NETWORKING TECHNOLOGIES AND VIRTUALIZATION **9 Periods**

Block-based Storage System, File-Based Storage System, Object-Based and Unified Storage. Fibre Channel SA: Software-defined networking, FC SAN components and architecture, FC SAN topologies, link aggregation and zoning, Virtualization in FC SAN environment. Internet Protocol SAN: iSCSI protocol, network components and connectivity, Link aggregation, switch aggregation and VLAN, FCIP protocol, connectivity and configuration.

Unit-4	**BACKUP, ARCHIVE AND REPLICATION**	**9 Periods**
Introduction to Business Continuity, Backup architecture, Data deduplication, Cloud-based and mobile device backup, Data archive, Uses of replication and its characteristics, Compute based, storage-based and network-based replication, Disaster Recovery as a Service (DRaaS).		
Unit-5	**SECURING STORAGE INFRASTRUCTURE**	**9 Periods**
Information security goals, Storage security domains, Threats to a storage infrastructure, Security controls to protect a storage infrastructure, Governance, risk and compliance, Storage management functions, Storage infrastructure management processes.		
		Total Theory: 45 Periods

	Text Books
Learning Resources	1.EMC Corporation, Information Storage and Management, Wiley, India. 2. Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel and Libor Miklas, Introduction to Storage Area Networks, Ninth Edition, IBM – Redbooks, December 2017. 3. Ulf Troppens, Rainer Erkens, Wolfgang Mueller- Friedt, Rainer Wolafka, Nils Haustein, Storage Networks Explained, Second Edition, Wiley, 2009.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE09	Course Name	SOFTWARE DEFINED NETWORKS AND APPLICATIONS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Cloud Computing, Virtualization	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: *The purpose of learning this course is to:*

- To understand the need for SDN and its data plane operations.
- To understand the functions of control plane
- To comprehend the migration of networking functions to SDN environment
- To explore various techniques of network function virtualization
- To comprehend the concepts behind network virtualization

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Describe the motivation behind SDN	U	1	2	3	1	3	-	-	-	2	3	1	3	1	2	1
CO-2:	Identify the functions of the data plane and control plane	AN	2	1	2	2	3	-	-	-	2	2	2	2	1	3	2
CO-3:	Design and develop network applications using SDN	AP	2	2	2	3	3	-	-	-	3	1	1	2	1	3	3
CO-4:	Orchestrate network services using NFV	U	2	2	2	3	1	-	-	-	1	3	1	2	2	2	2
CO-5:	Explain various use cases of SDN and NFV	U	3	3	1	1	3	-	-	-	1	2	1	2	1	3	3

Unit-1 SDN: INTRODUCTION **9 Periods**

Evolution of SDN – Need for SDN – The SDN Approach – SDN architecture - SDN Planes-Data Plane, Control plane and Application Plane

Activities:

1. Setup your own virtual SDN lab
i) Virtualbox/Mininet Environment for SDN - http://mininet.org
ii) https://www.kathara.org
iii) GNS3

Unit-2 SDN DATA PLANE AND CONTROL PLANE **9 Periods**

Data Plane functions and protocols - OpenFLow Protocol - Flow Table - Control Plane Functions - Southbound Interface, Northbound Interface – SDN Controllers - Ryu, OpenDaylight, ONOS - Distributed Controllers

Activities:

1. Create a SDN application that uses the Northbound API to program flow table rules on the switch for various use cases like L2 learning switch, Traffic Engineering, Firewall etc.
2. Create a simple mininet topology with SDN controller and use Wireshark to capture and visualize the OpenFlow messages such as OpenFlow FLOW MOD, PACKET IN, PACKET OUT etc.

Unit-3	**SDN APPLICATIONS**	**9 Periods**
SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Measurement and Monitoring – Security – Data Center Networking		
Unit-4	**NETWORK FUNCTION VIRTUALIZATION**	**9 Periods**
Network Virtualization - Virtual LANs – OpenFlow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture		
Unit-5	**NFV FUNCTIONALITY**	**9 Periods**
NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV **Activities:** 1. Create a simple end-to-end network service with two VNFs using vim-emu https://github.com/containernet/vim-emu 2. Install OSM and onboard and orchestrate network service.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. William Stallings, “Foundations of Modern Networking: SDN, SNFV, QoE, IoT and Cloud”, Pearson Education, 1st Edition, 2015.	1. Ken Gray, Thomas D. Nadeau, “Network Function Virtualization”, Morgan Kauffman, 2016. 2. Thomas D Nadeau, Ken Gray, “SDN: Software Defined Networks”, O’Reilly Media, 2013. 3. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, 1st Edition, CRC Press, 2014. 4. Paul Goransson, Chuck Black Timothy Culver, “Software Defined Networks: A Comprehensive Approach”, 2nd Edition, Morgan Kaufmann Press, 2016. 5. Oswald Coker, Siamak Azodolmolky, “Software-Defined Networking with OpenFlow”, 2nd Edition, O’Reilly Media, 2017.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE10	Course Name	STREAM PROCESSING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Stream Processing	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce Data Processing terminology, definition & concepts
- Define different types of Data Processing
- Explain the concepts of Real-time Data processing
- Select appropriate structures for designing and running real-time data services in a business environment
- Illustrate the benefits and drive the adoption of real-time data services to solve real-world problems

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the applicability and utility of different streaming algorithms.	AP	2	2	2	2	2	-	-	1	1	1	1	2	2	2	2
CO-2:	Describe and apply current research trends in data-stream processing.	U	1	1	1	1	-	-	-	1	1	1	1	2	1	1	1
CO-3:	Analyze the suitability of stream mining algorithms for data stream systems.	U	1	1	1	1	-	-	-	1	1	1	1	2	1	1	1
CO-4:	Program and build stream processing systems, services and applications.	AP	2	2	2	2	2	-	-	1	1	1	1	2	2	2	2
CO-5:	Solve problems in real-world applications that process data streams.	AN	3	2	2	2	3	-	-	1	1	1	1	2	3	3	3

Unit-1 FOUNDATIONS OF DATA SYSTEMS **9 Periods**

Introduction to Data Processing - Stages of Data processing - Data Analytics - Batch Processing - Stream Processing - Data Migration - Transactional Data processing - Data Mining - Data Management Strategy – Storage – Processing – Integration – Analytics - Benefits of Data as a Service - Challenges

Unit-2 REAL-TIME DATA PROCESSING **9 Periods**

Introduction to Big data - Big data infrastructure - Real-time Analytics - Near real-time solution - Lambda architecture - Kappa Architecture - Stream Processing - Understanding Data Streams - Message Broker - Stream Processor - Batch & Real-time ETL tools - Streaming Data Storage

Unit-3 DATAMODELS AND QUERY LANGUAGES **9 Periods**

Relational Model - Document Model - Key-Value Pairs - NoSQL - Object-Relational Mismatch - Many-to-One and Many-to-Many Relationships - Network data models - Schema Flexibility - Structured Query Language - Data Locality for Queries - Declarative Queries - Graph Data models - Cypher Query Language - Graph Queries in SQL- The Semantic Web – CODASYL – SPARQL

Unit-4 EVENT PROCESSING WITH APACHE KAFKA **9 Periods**

Apache Kafka - Kafka as Event Streaming platform - Events - Producers - Consumers - Topics – Partitions – Brokers - Kafka APIs - Admin API - Producer API - Consumer API - Kafka Streams API - Kafka Connect API **Activities:** 1. Create a Event Stream with Apache Kafka 2. Create a Real-time Stream processing application using Spark Streaming 3. Build a Micro-batch application 4. Real-time Fraud and Anomaly Detection, 5. Real-time personalization, Marketing, Advertising	
Unit-5 REAL-TIME PROCESSING USING SPARK STREAMING	**9 Periods**
Structured Streaming - Basic Concepts - Handling Event-time and Late Data - Fault-tolerant Semantics - Exactly-once Semantics - Creating Streaming Datasets - Schema Inference - Partitioning of Streaming datasets - Operations on Streaming Data – Selection - Aggregation – Projection – Watermarking - Window operations - Types of Time windows - Join Operations, Deduplication	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Streaming Systems: The What, Where, When and How of Large-Scale Data Processing by Tyler Akidau, Slava Chemyak, Reuven Lax, O'Reilly publication 2. Designing Data-Intensive Applications by Martin Kleppmann, O'Reilly Media 3. Practical Real-time Data Processing and Analytics: Distributed Computing and Event Processing using Apache Spark, Flink, Storm and Kafka, Packt Publishing	1. https://spark.apache.org/docs/latest/streaming-programming-guide.html 2. Kafka.apache.org

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE13	Course Name	SECURITY AND PRIVACY IN CLOUD	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To Introduce Cloud Computing terminology, definition & concepts
- To understand the security design and architectural considerations for Cloud
- To understand the Identity, Access control in Cloud
- To follow best practices for Cloud security using various design patterns
- To be able to monitor and audit cloud applications for security

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the cloud concepts and fundamentals.	U	3	3	3	1	2	-	-	-	1	1	1	3	3	1	2
CO-2:	Explain the security challenges in the cloud.	U	1	3	2	3	1	-	-	-	2	2	3	2	3	1	2
CO-3:	Define cloud policy and Identity and Access Management	R	3	2	2	3	2	–	-	-	3	1	1	2	2	3	1
CO-4:	Understand various risks and audit and monitoring mechanisms in the cloud.	U	2	1	2	3	3	-	-	-	3	2	3	3	1	1	2
CO-5:	Define the various architectural and design considerations for security in the cloud.	R	1	3	3	1	1	-	-	-	2	3	3	2	2	3	2

Unit-1 FUNDAMENTALS OF CLOUD SECURITY CONCEPTS **9 Periods**

Overview of cloud security- Security Services - Confidentiality, Integrity, Authentication, Nonrepudiation, Access Control - Basic of cryptography - Conventional and public-key cryptography, hash functions, authentication, and digital signatures.

Activities:

1. Simulate a cloud scenario using Cloud Sim and run a scheduling algorithm not present in Cloud Sim
2. simulate resource management using cloud sim

Unit-2 SECURITY DESIGN AND ARCHITECTURE FOR CLOUD **9 Periods**

Security design principles for Cloud Computing - Comprehensive data protection - End-to-end access control - Common attack vectors and threats - Network and Storage - Secure Isolation Strategies - Virtualization strategies - Inter-tenant network segmentation strategies - Data Protection strategies: Data retention, deletion and archiving procedures for tenant data, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key

Activities:

1. simulate log forensics using cloud sim
2. simulate a secure file sharing using a cloud sim

Unit-3 ACCESS CONTROL AND IDENTITY MANAGEMENT **9 Periods**

Access control requirements for Cloud infrastructure - User Identification - Authentication and Authorization - Roles-based Access Control - Multi-factor authentication - Single Sign-on, Identity Federation - Identity providers and service consumers - Storage and network access control options - OS Hardening and minimization - Verified and measured boot - Intruder Detection and prevention

Activities: 1. Implement data anonymization techniques over the simple dataset (masking, k-anonymization, etc) 2. Implement any encryption algorithm to protect the images		
Unit-4	**CLOUD SECURITY DESIGN PATTERNS**	**9 Periods**
Introduction to Design Patterns, Cloud bursting, Geo-tagging, Secure Cloud Interfaces, Cloud Resource Access Control, Secure On-Premise Internet Access, Secure External Cloud **Activities:** 1. Implement any image obfuscation mechanism 2. Implement a role-based access control mechanism in a specific scenario		
Unit-5	**MONITORING, AUDITING AND MANAGEMENT**	**9 Periods**
Proactive activity monitoring - Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges - Events and alerts - Auditing – Record generation, Reporting and Management, Tamper-proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information and Event Management **Activities:** 1. Implement any image obfuscation mechanism 2. Implement a role-based access control mechanism in a specific scenario		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Raj Kumar Buyya , James Broberg, andrzejGoscinski, —Cloud Computing:‖, Wiley 2013 2. Dave shackleford, —Virtualization Security‖, SYBEX a wiley Brand 2013. 3. Mather, Kumaraswamy and Latif, —Cloud Security and Privacy‖, OREILLY 2011 4. Security and Privacy in Cloud-Based AI, Samarth Shah, Vikhyat Singhal.2025	1. Mark C. Chu-Carroll —Code in the Cloud‖,CRC Press, 2011

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Professional Elective Courses - Vertical-4 (Cyber Security And Data Privacy)

Course Code	24ITE06	Course Name	ETHICAL HACKING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards			

Course Objective: ***The purpose of learning this course is to:***

- To understand the basics of computer based vulnerabilities.
- To explore different foot printing, reconnaissance and scanning methods.
- To expose the enumeration and vulnerability analysis methods
- To understand hacking options available in Web and wireless applications.
- To explore the options for network protection.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	To express knowledge on basics of computer based vulnerabilities	U	2	2	3	2	1	-	-	-	1	2	2	1	1	2	3
CO-2:	To gain understanding on different foot printing, reconnaissance and scanning methods.	U	1	2	1	2	1	-	-	-	2	2	1	1	1	2	2
CO-3:	To demonstrate the enumeration and vulnerability analysis methods	AP	2	2	3	3	1	-	-	-	1	2	1	2	2	3	1
CO-4:	Analyze common vulnerabilities in web and wireless applications and associated hacking methods.	AN	2	1	1	2	1	-	-	-	1	3	3	3	3	2	1
CO-5:	Analyze different network security options to safeguard against threats and attacks.	AN	2	3	1	1	2	-	-	-	2	1	1	1	1	1	3

Unit-1 INTRODUCTION **9 Periods**

Ethical Hacking Overview - Role of Security and Penetration Testers .- Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing .- Network and Computer Attacks - Malware -Protecting Against Malware Attacks.- Intruder Attacks - Addressing Physical Security

Activities:

1. Install Kali or Backtrack Linux / Metasploitable/ Windows XP
2. Practice the basics of reconnaissance.

Unit-2 FOOT PRINTING, RECONNAISSANCE AND SCANNING NETWORKS **9 Periods**

Footprinting Concepts - Footprinting through Search Engines, Web Services, Social Networking Sites, Website, Email - Competitive Intelligence - Footprinting through Social Engineering -Footprinting Tools - Network Scanning Concepts - Port-Scanning Tools - Scanning Techniques -Scanning Beyond IDS and Firewall

Activities:

1. Using FOCA / Search Diggity tools, extract metadata and expanding the target list
2. Aggregates information from public databases using online free tools like Paterva’s Maltego

Unit-3 ENUMERATION AND VULNERABILITY ANALYSIS **9 Periods**

Enumeration Concepts - NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration - Vulnerability Assessment Concepts - Desktop and Server OS Vulnerabilities - Windows OS Vulnerabilities - Tools for Identifying Vulnerabilities in Windows- Linux OS -Vulnerabilities- Vulnerabilities of Embedded Oss

Activities: 1. Information gathering using tools like Robtex. **2.** Scan the target using tools like Nessus		
Unit-4	**SYSTEM HACKING**	**9 Periods**
Hacking Web Servers - Web Application Components- Vulnerabilities - Tools for Web Attackers and Security Testers Hacking Wireless Networks - Components of a Wireless Network –Wardriving- Wireless Hacking - Tools of the Trade **Activities:** **1.** View and capture network traffic using Wireshark.		
Unit-5	**NETWORK PROTECTION SYSTEMS**	**9 Periods**
Access Control Lists. - Cisco Adaptive Security Appliance Firewall - Configuration and Risk Analysis Tools for Firewalls and Routers - Intrusion Detection and Prevention Systems - NetworkBased and Host-Based IDSs and IPSs - Web Filtering - Security Incident Response Teams – Honeypots. **Activities:** Automate dig for vulnerabilities and match exploits using Armitage FOCA		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Michael T. Simpson, Kent Backman, and James E. Corley, Hands-On Ethical Hacking and Network Defense, Course Technology, Delmar Cengage Learning, 2010. 2. The Basics of Hacking and Penetration Testing - Patrick Engebretson, SYNGRESS, Elsevier, 2013. 3. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, Dafydd Stuttard and Marcus Pinto, 2011. 4.Kali Linux Ethical Hacking , Diego Rodrigues 2025	1. Black Hat Python: Python Programming for Hackers and Pentesters, Justin Seitz , 2014

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24ITE07	Course Name	DIGITAL AND MOBILE FORENSICS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards			

Course Objective: *The purpose of learning this course is to:*

- To understand basic digital forensics and techniques.
- To understand digital crime and investigation
- To understand how to be prepared for digital forensic readiness.
- To understand and use forensics tools for iOS devices.
- To understand and use forensics tools for Android devices.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): *At the end of this course, learners will be able to:*		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Have knowledge on digital forensics.	R	3	1	3	2	1	-	-	-	1	1	3	3	1	3	1
CO-2:	Know about digital crime and investigations	R	3	3	3	3	3	-	-	-	2	2	1	2	1	3	1
CO-3:	Be forensic ready.	AP	3	3	2	3	1	-	-	-	3	2	1	1	3	2	3
CO-4:	Investigate, identify and extract digital evidence from iOS devices.	AN	3	1	2	2	3	-	-	-	1	3	3	2	1	3	3
CO-5:	Investigate, identify and extract digital evidence from Android devices.	AN	1	3	2	3	2	-	-	-	2	3	2	3	1	2	1

Unit-1 INTRODUCTION TO DIGITAL FORENSICS **9 Periods**

Forensic Science – Digital Forensics – Digital Evidence – The Digital Forensics Process – Introduction – The Identification Phase – The Collection Phase – The Examination Phase – The Analysis Phase – The Presentation Phase

Activities:

1. Installation of Sleuth Kit on Linux. List all data blocks. Analyze allocated as well as unallocated blocks of a disk image.
2. Data extraction from call logs using Sleuth Kit

Unit-2 DIGITAL CRIME AND INVESTIGATION **9 Periods**

Digital Crime – Substantive Criminal Law – General Conditions – Offenses – Investigation Methods for Collecting Digital Evidence – International Cooperation to Collect Digital Evidence

Activities:

1. Data extraction from SMS and contacts using Sleuth Kit.
2. Install Mobile Verification Toolkit or MVT and decrypt encrypted iOS backups.

Unit-3 DIGITAL FORENSIC READINESS **9 Periods**

Introduction – Law Enforcement versus Enterprise Digital Forensic Readiness – Rationale for Digital Forensic Readiness – Frameworks, Standards and Methodologies – Enterprise Digital Forensic Readiness – Challenges in Digital Forensics

Activities:

1. Process and parse records from the iOS system.
2. Extract installed applications from Android devices

Unit-4 iOS FORENSICS **9 Periods**

Mobile Hardware and Operating Systems - iOS Fundamentals – Jailbreaking – File System – Hardware – iPhone Security – iOS Forensics – Procedures and Processes – Tools – Oxygen Forensics – MobilEdit – iCloud **Activities:** 1. Extract diagnostic information from Android devices through the adb protocol.
Unit-5 **ANDROID FORENSICS** **9 Periods**
Android basics – Key Codes – ADB – Rooting Android – Boot Process – File Systems – Security –Tools – Android Forensics – Forensic Procedures – ADB – Android Only Tools –Dual Use Tools –Oxygen Forensics – MobilEdit – Android App Decompiling **Activities:** 1. Generate a unified chronological timeline of extracted records
Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. Andre Arnes, "Digital Forensics", Wiley, 2018. 2. Chuck Easttom, "An In-depth Guide to Mobile Device Forensics", First Edition, CRC Press, 2022.	1. Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE08	Course Name	SOCIAL NETWORK SECURITY	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	-		

Course Objective: ***The purpose of learning this course is to:***

- To develop semantic web related simple applications
- To explain Privacy and Security issues in Social Networking
- To explain the data extraction and mining of social networks
- To discuss the prediction of human behaviour in social communities
- To describe the Access Control, Privacy and Security management of social networks

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Develop semantic web related simple applications	AP	3	1	2	3	2	-	-	-	3	2	1	2	3	3	2
CO-2:	Develop an address Privacy and Security issues in Social Networking	AN	2	2	2	3	3	-	-	-	1	2	2	3	3	3	2
CO-3:	Apply the data extraction and mining of social networks	U	2	1	1	3	2	-	-	-	1	2	1	1	1	3	3
CO-4:	Apply the prediction of human behaviour in social communities	U	3	3	3	3	2	-	-	-	1	1	1	1	2	1	3
CO-5:	Develop the applications of social networks	U	1	3	2	2	2	-	-	-	1	1	3	1	2	3	3

Unit-1 FUNDAMENTALS OF SOCIAL NETWORKING **9 Periods**

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, Historical overview of privacy and security, Major paradigms, for understanding privacy and security **Activities:**
1. Design own social media application

Unit-2 SECURITY ISSUES IN SOCIAL NETWORKS **9 Periods**

The evolution of privacy and security concerns with networked technologies, Contextual influences on privacy attitudes and behaviors, Anonymity in a networked world
Activities:
1. Create a Network model using Neo4j

Unit-3 EXTRACTION AND MINING IN SOCIAL NETWORKING DATA **9 Periods**

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, Big data and Privacy
Activities:
1. Read and write Data from Graph Database
2. Find “Friend of Friends” using Neo4j

Unit-4 PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES **9 Periods**

Understanding and predicting human behavior for social communities, User dataManagement, Inference and Distribution, Enabling new human experiences, Realitymining, Context, Awareness, Privacy in online social networks, Trust in online environment, What is Neo4j, Nodes, Relationships, Properties

Activities: 1.Implement secure search in social media	
Unit-5 ACCESS CONTROL, PRIVACY AND IDENTITY MANAGEMENT	**9 Periods**
Understand the access control requirements for Social Network, Enforcing AccessControl Strategies, Authentication and Authorization, Roles-based Access Control,Host, storage and network access control options, Firewalls, Authentication, andAuthorization in S ocial Network, Identity & Access Management, Single Sign-on,Identity Federation, Identity providers and service consumers, The role of Identity provisioning **Activities:** 1.Create a simple Security & Privacy detector	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Peter Mika, “Social Networks and the Semantic Web, First Edition, Springer 2007. 2. BorkoFurht, “Handbook of Social Network Technologies and Application, First Edition, Springer, 2010.3. Learning Neo4j 3. x – Second Edition By Jérôme Baton, Rik Van Bruggen, Packt publishing 4. David Easley, Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning abouta Highly Connected World‖, First Edition, Cambridge University Press, 2010 5.Social NetworK N. Karthick, R. Nithya, A. Ajeeth 2025 Security and Digital Risk Management,N. Arunkumar,	1. Easley D. Kleinberg J., “Networks, Crowds, and Markets – Reasoning about aHighly Connected World‖, Cambridge University Press, 2010. 2. Jackson, Matthew O., “Social and Economic Networks”, Princeton University Press, 2008. 3. GuandongXu ,Yanchun Zhang and Lin Li, “Web Mining and Social Networking –Techniques and applications”, First Edition, Springer, 2011. 4. Dion Goh and Schubert Foo, “Social information Retrieval Systems: EmergingTechnologies and Applications for Searching the Web Effectively”, IGI GlobalSnippet, 2008. 5. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, “Collaborative andSocial Information Retrieval and Access: Techniques for Improved userModeling”, IGI Global Snippet, 2009

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE09	Course Name	MODERN CRYPTOGRAPHY	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamental concepts of symmetric and asymmetric cryptography, semantic security, and modern encryption techniques.
- To analyse various cryptographic attack models including IND-CPA, IND-CCA, replay, side-channel, and non-malleability attacks.
- To study randomness, cryptographic primitives, hash functions, pseudo-random generators/functions, and their role in secure communication.
- To gain knowledge of public key cryptography, digital signatures, authenticated key exchange, PKI, and emerging post-quantum cryptographic techniques.
  To understand message authentication, authenticated encryption, secret sharing, zero-knowledge proofs, blockchain security, and secure multi-party computation.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the fundamentals of symmetric and asymmetric cryptography, semantic security, hash functions, and post-quantum cryptography concepts.	U	3	2	1	1	2	-	-	1	-	-	-	2	3	2	1
CO-2:	Analyze various cryptographic attack models including IND-CPA, IND-CCA, replay attacks, side-channel attacks, and authenticated encryption security.	AN	3	3	2	2	2	1	-	2	-	-	-	2	3	3	2
CO-3:	Apply cryptographic primitives such as PRG, PRF, stream ciphers, key derivation functions, and randomness techniques in secure communication systems.	AP	2	3	3	2	3	-	-	1	1	-	-	2	2	3	3
CO-4:	Design and implement secure public key cryptographic mechanisms including RSA, ECC, digital signatures, PKI, authenticated key exchange, and lattice-based cryptography.	C	3	3	3	2	3	1	-	2	1	1	-	2	3	3	3
CO-5:	Develop secure authentication and advanced cryptographic solutions using MAC, HMAC, secret sharing, zero-knowledge proofs, blockchain cryptography, and secure multiparty computation.	U	2	3	3	3	3	2	-	2	1	1	-	3	2	3	3

Unit-1 INTRODUCTION — 9 Periods

Basics of Symmetric Key Cryptography, Basics of Asymmetric Key Cryptography, Hardness of Functions, Notions of Semantic Security (SS) and Message Indistinguishability (MI), Chosen Plaintext Security, Modern Public Key Encryption Concepts, Hash Functions and Applications, Trapdoor Functions, Introduction to Post-Quantum Cryptography.

Activities:

1. Implement Feige–Fiat–Shamir identification protocol.
2. Implement GQ identification protocol.

Unit-2 FORMAL NOTIONS OF ATTACKS — 9 Periods

Attacks under Message Indistinguishability: Chosen Plaintext Attack (IND-CPA), Chosen Ciphertext Attacks (IND-CCA), Non-malleability Attacks, Replay and Side-Channel Attacks, Security Models for Modern Cryptographic Systems, Security in Authenticated Encryption Schemes.

Activities:

1.Implement Schnorr identification protocol

Unit-3 RANDOMNESS AND CRYPTOGRAPHIC PRIMITIVES — 9 Periods

Provable Security Concepts, Cryptographic Hash Functions, One-way Functions, Pseudo-random Generators (PRG), Pseudo-random Functions (PRF), Stream Ciphers, Key Derivation Functions, Randomness in Cryptographic Applications. **Activities:** **1.** Implement a one-time signature scheme.

Unit-4	**BUILDING A PSEUDORANDOM PERMUTATION**	**9 Periods**
Digital Signature Schemes, Signing and Verification Algorithms, RSA and Elliptic Curve Cryptography (ECC), Authenticated Key Exchange, Public Key Infrastructure (PKI), Introduction to Lattice-based Cryptography, Cryptographic Protocol Design. **Activities:** 1. Implement RSA/ECC-based digital signature scheme. 2. Implement secure key exchange protocol.		
Unit-5	**MESSAGE AUTHENTICATION CODES**	**Periods**
Message Authentication Codes (MAC), HMAC, Authenticated Encryption, Variable Length MACs, Secret Sharing Schemes, Zero Knowledge Proofs, Blockchain and Cryptographic Applications, Secure Multi-party Computation, Cryptographic Protocol Analysis. **Activities:** 1. Implement Authentication trees and one-time signatures. 2. Implement HMAC-based authentication.		
		Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1.Hans Delfs and Helmut Knebl, Introduction to Cryptography: Principles and Applications, Springer Verlag. 2.Wenbo Mao, Modern Cryptography, Theory and Practice, Pearson Education (Low Priced Edition) 3. Introduction to Modern Cryptography, 3rd edition, 2020, Jonathan Katz, Yehuda Lindell	1. Shaffi Goldwasser and Mihir Bellare, Lecture Notes on Cryptography, Available at http://citeseerx.ist.psu.edu/. 2. OdedGoldreich, Foundations of Cryptography, CRC Press (Low Priced Edition Available), Part 1 and Part 23 3. William Stallings, "Cryptography and Network Security: Principles and Practice", PHI 3rd Edition, 2006.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE10	Course Name	ENGINEERING SECURE SOFTWARE SYSTEMS	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Know the importance and need for software security.
- Know about various attacks.
- Learn about secure software design.
- Understand risk management in secure software development.
- Know the working of tools related to software security.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Identify various vulnerabilities related to memory attacks.	R	2	3	2	3	2	-	-	-	2	1	2	2	2	2	1
CO-2:	Apply security principles in software development.	AP	2	2	2	3	3	-	-	-	2	1	2	2	1	2	1
CO-3:	Evaluate the extent of risks.	E	1	2	2	2	1	-	-	-	1	1	2	1	2	2	1
CO-4:	Involve selection of testing techniques related to software security in the testing phase of software development.	AN	2	3	2	2	2	-	-	-	2	1	2	2	2	2	1
CO-5:	Use tools for securing software.	AP	2	1	2	2	3	-	-	-	2	1	1	2	2	1	2

Unit-1 NEED OF SOFTWARE SECURITY AND LOW-LEVEL ATTACKS **9 Periods**

Software Assurance and Software Security - Threats to software security - Sources of software insecurity - Benefits of Detecting Software Security - Properties of Secure Software – Memory Based Attacks: Low-Level Attacks Against Heap and Stack - Defense Against Memory-Based Attacks

Activities:

1. Implement the SQL injection attack.
2. Implement the Buffer Overflow attack.

Unit-2 SECURE SOFTWARE DESIGN **9 Periods**

Requirements Engineering for secure software - SQUARE process Model - Requirements elicitation and prioritization- Isolating The Effects of Untrusted Executable Content - Stack Inspection – Policy Specification Languages – Vulnerability Trends – Buffer Overflow – Code Injection - Session Hijacking. Secure Design - Threat Modeling and Security Design Principles

Activities:

1. Implement Cross Site Scripting and Prevent XSS.

Unit-3 SECURITY RISK MANAGEMENT **9 Periods**

Risk Management Life Cycle – Risk Profiling – Risk Exposure Factors – Risk Evaluation and Mitigation – Risk Assessment Techniques – Threat and Vulnerability Management.

Activities:

1. Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools like Kali Linux.

Unit-4	**SECURITY TESTING**	**9 Periods**
Traditional Software Testing – Comparison - Secure Software Development Life Cycle - Risk Based Security Testing – Prioritizing Security Testing With Threat Modeling – Penetration Testing – Planning and Scoping - Enumeration – Remote Exploitation – Web Application Exploitation - Exploits and Client Side Attacks – Post Exploitation – Bypassing Firewalls and Avoiding Detection - Tools for Penetration Testing **Activities:** Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools like Kali Linux.		
Unit-5	**SECURE PROJECT MANAGEMENT**	**9 Periods**
Governance and security - Adopting an enterprise software security framework - Security and project management - Maturity of Practice **Activities:** Penetration test using kali Linux		
		Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. Julia H. Allen, “Software Security Engineering”, Pearson Education, 2008 2. Evan Wheeler, “Security Risk Management: Building an Information Security Risk Management Program from the Ground Up”, First edition, Syngress Publishing, 2011 3. Chris Wysopal, Lucas Nelson, Dino Dai Zovi, and Elfriede Dustin, “The Art of Software Security Testing: Identifying Software Security Flaws (Symantec Press)”, Addison-Wesley Professional, 2006 4. Security Engineering: A Guide to Building Dependable Distributed Systems Ross J. Anderson ,2024 Edition 5. Platform Engineering and Security: Security and Compliance Integration in SDLC Kuldeep Singh Tomar, Govindarajan Vishnu chithan 2025	1. Robert C. Seacord, “Secure Coding in C and C++ (SEI Series in Software Engineering)”, Addison-Wesley Professional, 2005. 2. Jon Erickson, “Hacking: The Art of Exploitation”, 2nd Edition, No Starch Press, 2008. 3. Mike Shema, “Hacking Web Apps: Detecting and Preventing Web Application Security Problems”, First edition, Syngress Publishing, 2012 4. Bryan Sullivan and Vincent Liu, “Web Application Security, A Beginner's Guide”, Kindle Edition, McGraw Hill, 2012 5. Lee Allen, “Advanced Penetration Testing for Highly-Secured Environments: The Ultimate Security Guide (Open Source: Community Experience Distilled)”, Kindle Edition, PacktPublishing,2012 6. Jason Grembi, “Developing Secure Software”

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE11	Course Name	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGIES	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the basics of Blockchain
- To learn Different protocols and consensus algorithms in Blockchain
- To learn the Blockchain implementation frameworks
- To understand the Blockchain Applications
- To experiment the Hyperledger Fabric, Ethereum networks

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand emerging abstract models for Blockchain Technology	U	3	3	2	2	1	-	-	-	1	-	-	2	3	3	1
CO-2:	Identify major research challenges and technical gaps existing between theory and practice in the crypto currency domain	AN	3	3	3	3	1	-	-	-	2	-	-	2	3	3	3
CO-3:	It provides conceptual understanding of the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.	U	3	3	3	3	2	-	-	-	3	-	-	2	3	3	3
CO-4:	Apply hyperledger Fabric and Ethereum platform to implement the Block chain Application.	AP	3	2	3	2	3	-	-	-	3	-	-	2	3	2	3
CO-5:	Apply blockchain technologies including smart contracts, DApps, NFTs, and Truffle framework for real-world applications in supply chain management	AP	3	2	3	2	3	-	-	-	3	-	-	2	3	2	3

Unit-1 INTRODUCTION TO BLOCKCHAIN **9 Periods**

Blockchain- Public Ledgers, Blockchain as Public Ledgers - Block in a Blockchain, Transactions- The Chain and the Longest Chain - Permissioned Model of Blockchain, Cryptographic -Hash Function, Properties of a hash function-Hash pointer and Merkle tree

Activities:

1. Install and understand Docker container, Node.js, Java and Hyperledger Fabric, Ethereum and perform necessary software installation on local machine/create instance on cloud to run.

Unit-2 BITCOIN AND CRYPTOCURRENCY **9 Periods**

A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay

Activities:

1.Create and deploy a blockchain network using Hyperledger Fabric SDK for Java Set up and initialize the channel, install and instantiate chain code, and perform invoke and query on your blockchain network

Unit-3 BITCOIN CONSENSUS	9 Periods
Bitcoin Consensus, Proof of Work (PoW)- Hash cash PoW , Bitcoin PoW, Attacks on PoW , monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases. **Activities:** **1.** Interact with a blockchain network. Execute transactions and requests against a blockchain network by creating an app to test the network and its rules	
Unit-4 HYPERLEDGER FABRIC & ETHEREUM	**9 Periods**
Architecture of Hyperledger fabric v1.1- chain code- Ethereum: Ethereum network, EVM, Transaction fee, Mist Browser, Ether, Gas, Solidity. **Activities:** 1. Deploy an asset-transfer app using blockchain. Learn app development within a Hyperledger Fabric network	
Unit-5 BLOCKCHAIN APPLICATIONS	**9 Periods**
Smart contracts, Truffle Design and issue- DApps- NFT. Blockchain Applications in Supply Chain Management, Logistics, Smart Cities, Finance and Banking, Insurance, etc- Case Study. **Activities:** 1. Use blockchain to track fitness club rewards. Build a web app that uses Hyperledger Fabric to track and trace member rewards 2. Car auction network: A Hello World example with Hyperledger Fabric Node SDK and IBM Blockchain Starter Plan. Use Hyperledger Fabric to invoke chain code while storing results and data in the starter plan.	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Bashir and Imran, Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks, 2017. 2. 2.Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly, 2014.	1. Daniel Drescher, “Blockchain Basics”, First Edition, Apress, 2017. 2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016. 3. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015 4. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Blockchain”, Packt Publishing 5. Handbook of Research on Blockchain Technology, published by Elsevier Inc. ISBN: 9780128198162, 2020

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE12	Course Name	NETWORK SECURITY	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To learn the fundamentals of cryptography
- To learn the key management techniques and authentication approaches
- To explore the network and transport layer security techniques
- To understand the application layer security standards.
- To learn the real time security practices

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Classify the encryption techniques	U	3	3	2	2	2	-	-	-	2	1	2	1	2	3	1
CO-2:	Illustrate the key management technique and authentication.	U	1	1	3	2	2	-	-	-	2	2	1	1	3	1	2
CO-3:	Evaluate the security techniques applied to network and transport layer	AP	1	2	1	1	2	-	-	-	3	3	1	3	2	1	3
CO-4:	Discuss the application layer security standards	AN	2	2	3	2	2	-	-	-	3	3	2	1	2	1	3
CO-5:	Apply security practices for real time applications	AP	2	1	3	2	2	-	-	-	2	1	1	3	2	1	1

Unit-1 INTRODUCTION **9 Periods**

Basics of cryptography, conventional and public-key cryptography, hash functions, authentication, and digital signatures

Activities:

1. Implement symmetric key algorithms
2. Implement asymmetric key algorithms and key exchange algorithms

Unit-2 KEY MANAGEMENT AND AUTHENTICATION **9 Periods**

Key Management and Distribution: Symmetric Key Distribution, Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure. User Authentication: Remote User-Authentication Principles, Remote User-Authentication Using Symmetric Encryption, Kerberos Systems, Remote User Authentication Using Asymmetric Encryption.

Activities:

1. Implement digital signature schemes
2. Installation of Wire shark, tcpdump and observe data transferred in client-server communication using UDP/TCP and identify the UDP/TCP datagram

Unit-3 ACCESS CONTROL AND SECURITY **9 Periods**

Network Access Control: Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access Control - IP Security - Internet Key Exchange (IKE) -Transport-Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS standard, Secure Shell (SSH) application

Activities:

1. Check message integrity and confidentiality using SSL
2. Experiment Eavesdropping, Dictionary attacks, MITM attacks

Unit-4 **APPLICATION LAYER SECURITY**	**9 Periods**
Electronic Mail Security: Pretty Good Privacy, S/MIME, DomainKeys Identified Mail. Wireless Network Security: Mobile Device Security **Activities:** 1. Experiment with Sniff Traffic using ARP Poisoning 2. Demonstrate intrusion detection system using any tool	
Unit-5 **SECURITY PRACTICES**	**9 Periods**
Firewalls and Intrusion Detection Systems: Intrusion Detection Password Management, Firewall Characteristics Types of Firewalls, Firewall Basing, Firewall Location and Configurations. Blockchains, Cloud Security and IoT security **Activities:** 1. Explore network monitoring tools 2. Study to configure Firewall, VPN	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Cryptography and Network Security: Principles and Practice, 6th Edition, William Stallings, 2014, Pearson, ISBN 13:9780133354690 2. Next-Generation Cybersecurity: AI, ML, and Blockchain, Keshav Kaushik, Ishu Sharma, 2024.	1. Network Security: Private Communications in a Public World, M. Speciner, R. Perlman, C. Kaufman, Prentice Hall, 2002. 2. Linux iptables Pocket Reference, Gregor N. Purdy, O'Reilly, 2004, ISBN-13: 978- 0596005696. 3. Linux Firewalls, by Michael Rash, No Starch Press, October 2007, ISBN: 978-1-59327- 141-1. 4. Network Security, Firewalls And VPNs, J. Michael Stewart, Jones & Bartlett Learning, 2013, ISBN-10: 1284031675, ISBN-13: 978-1284031676. 5. The Network Security Test Lab: A Step-By-Step Guide, Michael Gregg, Dreamtech Press, 2015, ISBN-10:8126558148, ISBN-13: 978-8126558148.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Professional Elective Courses - Vertical-5 (AI&ML)

Course Code	24CSE18	Course Name	KNOWLEDGE ENGINEERING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering		**Data Book / Codes Standards**	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Understand the basics of Knowledge Engineering.
- Discuss methodologies and modeling for Agent Design and Development.
- Design and develop ontologies.
- Apply reasoning with ontologies and rules.
- Understand learning and rule learning.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basics of Knowledge Engineering.	U	3	1	1	1	1	1	-	-	1	2	1	2	1	1	1
CO-2:	Apply methodologies and modelling for Agent Design and Development	AP	3	2	3	2	2	-	-	-	2	1	2	1	3	3	1
CO-3:	Design and develop ontologies.	AP	2	2	3	2	2	-	-	-	3	2	2	2	3	2	3
CO-4:	Apply reasoning with ontologies and rules.	AP	2	2	3	1	1	-	-	-	2	2	2	2	2	1	1
CO-5:	Understand learning and rule learning	U	2	2	2	1	1	-	-	-	2	1	1	1	2	1	1

Unit-1 REASONING UNDER UNCERTAINTY **9 Periods**

Introduction – Abductive reasoning – Probabilistic reasoning: Enumerative Probabilities – Subjective Bayesian view – Belief Functions – Baconian Probability – Fuzzy Probability – Uncertainty methods - Evidence-based reasoning – Intelligent Agent – Mixed-Initiative Reasoning – Knowledge Engineering.

Unit-2 METHODOLOGY AND MODELING **9 Periods**

Conventional Design and Development – Development tools and Reusable Ontologies – Agent Design and Development using Learning Technology – Problem Solving through Analysis and Synthesis – Inquiry-driven Analysis and Synthesis – Evidence-based Assessment – Believability Assessment – Drill-Down Analysis, Assumption-based Reasoning, and What-If Scenarios.

Unit-3 ONTOLOGIES – DESIGN AND DEVELOPMENT **9 Periods**

Concepts and Instances – Generalization Hierarchies – Object Features – Defining Features – Representation – Transitivity – Inheritance – Concepts as Feature Values – Ontology Matching. Design and Development Methodologies – Steps in Ontology Development – Domain Understanding and Concept Elicitation – Modelling-based Ontology Specification.

Unit-4 REASONING WITH ONTOLOGIES AND RULES **9 Periods**

Production System Architecture – Complex Ontology-based Concepts – Reduction and Synthesis rules and the Inference Engine – Evidence-based hypothesis analysis – Rule and Ontology Matching – Partially Learned Knowledge – Reasoning with Partially Learned Knowledge.

Unit-5	**LEARNING AND RULE LEARNING**	**9 Periods**
Machine Learning – Concepts – Generalization and Specialization Rules – Types – Formal definition of Generalization. Modelling, Learning and Problem Solving – Rule learning and Refinement – Overview – Rule Generation and Analysis – Hypothesis Learning.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum, Knowledge Engineering Building Cognitive Assistants for Evidence-based Reasoning, Cambridge University Press, First Edition, 2016. (Unit 1 – Chapter 1 / Unit 2 – Chapter 3,4 / Unit 3 – Chapter 5, 6 / Unit 4 - 7 , Unit 5 – Chapter 8, 9)	**1.** 1 Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004. 2. Ela Kumar, Knowledge Engineering, I K International Publisher House, 2018. 3. John F. Sowa: Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole, Thomson Learning, 2000. 4. King , Knowledge Management and Organizational Learning , Springer, 2009. 5. Jay Liebowitz, Knowledge Management Learning from Knowledge Engineering, 1st Edition,2001.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADE01	Course Name	SOFT COMPUTING	Course Category	TP	Professional Elective Courses	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Data Structures and Algorithms	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Artificial Intelligence and Data Science	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
- Provide the mathematical background for carrying out the optimization associated with neural network learning
- Learn various evolutionary algorithms.
- Become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
- Introduce case studies utilizing the above and illustrate the Intelligent behaviour of programs based on soft computing

			Program Outcomes (PO)												Program Specifi Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamentals of fuzzy logic operators and inference mechanisms	U	3	2	3	3	3	-	-	-	3	1	3	2	3	1	2
CO-2:	Understand neural network architecture for AI applications such as classification and clustering	U	2	3	3	2	3	-	-	-	3	2	3	2	2	1	3
CO-3:	Learn the functionality of Genetic Algorithms in Optimization problems	U	1	3	2	2	1	-	-	-	3	1	1	2	1	3	2
CO-4:	Use hybrid techniques involving Neural networks and Fuzzy logic	AP	1	2	1	3	2	-	-	-	3	3	1	1	2	1	1
CO-5:	Apply soft computing techniques in real world applications	AP	2	3	1	2	1	-	-	-	3	3	3	2	1	2	3

Unit	Title	Periods
Unit-1	**INTRODUCTION TO SOFT COMPUTING AND FUZZY LOGIC**	**6 Periods**
Introduction - Fuzzy Logic - Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Operations on Fuzzy Relations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems-AI-Based Fuzzy Expert Systems .		
Unit-2	**NEURAL NETWORKS**	**6 Periods**
Supervised Learning Neural Networks – Perceptron - Backpropagation -Multilayer Perceptrons – Unsupervised Learning Neural Networks – Kohonen Self-Organizing Networks-Artificial Neural Networks in AI .		
Unit-3	**GENETIC ALGORITHMS**	**6 Periods**
Chromosome Encoding Schemes -Population initialization and selection methods - Evaluation function - Genetic operators- Cross over – Mutation - Fitness Function – Maximizing function-Convergence of Genetic Algorithm- Intelligent Systems using Genetic Algorithms .		
Unit-4	**NEURO FUZZY MODELING**	**6 Periods**
ANFIS architecture – hybrid learning – ANFIS as universal approximator – Coactive Neuro fuzzy modelling – Framework – Neuron functions for adaptive networks – Neuro fuzzy spectrum - Analysis of Adaptive Learning Capability-AI-Based Adaptive Learning Systems		
Unit-5	**APPLICATIONS**	**6 Periods**
Modelling a two input sine function - Printed Character Recognition – Fuzzy filtered neural networks – Plasma Spectrum Analysis – Hand written neural recognition - Soft Computing for Color Recipe Prediction-AI-Based Signal and Spectrum Analysis .		
		Total Theory: 30 Periods

List of Experiments	Total Practical: 30 Periods
1. Implementation of fuzzy control/ inference system 2. Programming exercise on classification with a discrete perceptron 3. Implementation of XOR with backpropagation algorithm 4. Implementation of self organizing maps for a specific application 5. Programming exercises on maximizing a function using Genetic algorithm 6. Implementation of two input sine function 7. Implementation of three input non linear function	

	Text Books	References
Learning Resources	1. SaJANG, J.-S. R., SUN, C.-T., & MIZUTANI, E. (1997). Neuro-fuzzy and soft computing: A computational approach to learning and machine intelligence. Upper Saddle River, NJ, Prentice Hall,1997 2. Himanshu Singh, Yunis Ahmad Lone, Deep Neuro-Fuzzy Systems with Python With Case Studies and Applications from the Industry, A press, 2020 3. Jyh- Shing Roger Jang, Chris T. Sun, Eiji Mizutani, *“Neuro- Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence”*, Pearson, Revised Edition (2025).	1. Roj Kaushik and Sunita Tiwari, Soft Computing-Fundamentals Techniques and Applications, 1st Edition, McGraw Hill, 2018. 2. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003. 3. Samir Roy, Udit Chakraborthy, Introduction to Soft Computing, Neuro Fuzzy and Genetic Algorithms, Pearson Education, 2013. 4. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Third Edition, Wiley India Pvt Ltd, 2019. 5. R.Eberhart, P.Simpson and R.Dobbins, “Computational Intelligence - PC Tools”, AP Professional, Boston, 1996 6. Snehashish Chakraverty, Arup Kumar Sahoo, Dhabaleswar Mohapatra, *“Artificial Neural Networks and Type- 2 Fuzzy Set”*, Elsevier, 1st Edition, 2025.

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24ITE17	Course Name	OPTIMIZATION TECHNIQUES	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Formulate and solve linear programming problems (LPP)
- Evaluate Integer Programming Problems, Transportation and Assignment Problems
- Obtain a solution to network problems using CPM and PERT techniques
- Able to optimize the function subject to the constraints
- Identify and solve problems under Markovian queuing models

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Formulate and solve linear programming problems (LPP)	AP	3	3	2	1	1	-	-	-	2	1	1	2	3	3	3
CO-2:	Evaluate Integer Programming Problems, Transportation and Assignment Problems.	AN	3	1	2	2	3	-	-	-	3	2	3	1	2	1	1
CO-3:	Obtain a solution to network problems using CPM and PERT techniques	AP	2	3	3	2	2	-	-	-	3	3	1	3	1	3	1
CO-4:	Able to optimize the function subject to the constraints	AN	2	2	1	1	3	-	-	-	2	1	3	1	2	1	2
CO-5:	Identify and solve problems under Markovian queuing models	AP	2	1	1	3	2	-	-	-	3	3	1	3	3	2	1

Unit-1 LINEAR MODELS **9 Periods**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Two-Phase method

Activities:

1. Solving simplex maximization problems using R programming
2. Solving simplex minimization problems using R programming
3. Solving mixed constraints problems Big M & Two phase method using TORA

Unit-2 INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS **9 Periods**

Integer programming: Branch and bound method- Transportation and Assignment problems - Traveling salesman problem

Activities:

1. Solving transportation problems using R
2. Solving assignment problems using R

Unit-3 PROJECT SCHEDULING **9 Periods**

Project network -Diagram representation Floats - Critical path method (CPM) PERT- Cost considerations in PERT and CPM

Activities:

1. Solving optimization problems using LINGO
2. Studying Primal-Dual relationships in LP using TORA
3. Solving LP problems using dual simplex method using TORA
4. Sensitivity & post optimality analysis using LINGO

Unit-4 CLASSICAL OPTIMIZATION THEORY **9 Periods**

Unconstrained problems necessary and sufficient conditions - Newton-Raphson method, Constrained problems equality constraints inequality constraints - Kuhn-Tucker conditions **Activities:** 1. Solving shortest route problems using optimization software 2. Solving Project Management problems using optimization software 3. Testing random numbers and random variates for their uniformity
Unit-5 QUEUING MODELS 9 Periods
Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models, multiple service channels **Activities:** 1. Testing random numbers and random variates for their independence 2. Solve single server queuing model using simulation software package 3. Solve multi server queuing model using simulation software package
Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017	1. ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4th Edition, 2011. 2. J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5th Edition, 2012. 3. Hiller F.S, Liberman G.J, Introduction to Operations Research, 10th Edition McGraw Hill, 2017. 4. Jit. S. Chandran, Mahendran P. Kawatra, KiHoKim, Essentials of Linear Programming, Vikas Publishing House Pvt.Ltd. New Delhi, 1994. 5. Ravindran A., Philip D.T., and Solberg J.J., Operations Research, John Wiley, 2nd Edition, 2007.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE19	Course Name	GAME THEORY	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Discrete Mathematics, Probability Theory	**Co- requisite Courses**	Operations Research	**Progressive Courses**	Mechanism Design, Algorithmic Game Theory
Course Offering Department	Computer Science and Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce the student to the notion of a game, its solutions concepts, and other basic notions and tools of game theory, and the main applications for which they are appropriate, including electronic trading markets.
- To formalize the notion of strategic thinking and rational choice by using the tools of game theory, and to provide insights into using game theory in 41odelling applications.
- To draw the connections between game theory, computer science, and economics, especially emphasizing the computational issues.
- To introduce contemporary topics in the intersection of game theory, computer science, and economics.
- To apply game theory in searching, auctioning and trading.

				Program Outcomes (PO)											Program Specific Outcome (PSO		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**CO**	**PO1**	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CO-1:	Discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts	**CO1**	1	3	3	2	3	3	-	-	-	-	-	-	1	1	3
CO-2:	Discuss the use of Nash Equilibrium for other problems.	**CO2**	2	3	3	3	2	3	-	-	-	-	-	-	1	1	1
CO-3:	Identify key strategic aspects and based on these be able to connect them to appropriate game theoretic concepts given a real world situation	**CO3**	3	1	1	3	3	3	-	-	-	-	-	-	1	1	2
CO-4:	Identify some applications that need aspects of Bayesian Games.	**CO4**	4	2	1	1	1	1	-	-	-	-	-	-	1	1	2
CO-5:	Implement a typical Virtual Business scenario using Game theory.	**CO5**	5	2	2	3	2	1	-	-	-	-	-	-	1	1	2

Unit-1	**INTRODUCTION**	**9 Periods**
Introduction — Making rational choices: basics of Games — strategy — preferences — payoffs — Mathematical basics — Game theory — Rational Choice — Basic solution concepts-non- cooperative versus cooperative games — Basic computational issues — finding equilibria and learning in games- Typical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets).		
Unit-2	**GAMES WITH PERFECT INFORMATION**	**9 Periods**
Games with Perfect Information — Strategic games — prisoner's dilemma, matching pennies - Nash equilibria —mixed strategy equilibrium — zero-sum games		
Unit-3	**GAMES WITH IMPERFECT INFORMATION**	**9 Periods**
Games with Imperfect Information — Bayesian Games — Motivational Examples — General Definitions — Information aspects — Illustrations — Extensive Games with Imperfect — Information — Strategies — Nash Equilibrium —Repeated Games — The Prisoner's Dilemma — Bargaining		
Unit-4	**NON-COOPERATIVE GAME THEORY**	**9 Periods**

Non-cooperative Game Theory — Self-interested agents — Games in normal form — Analyzing games: from optimality to equilibrium — Computing Solution Concepts of Normal — Form Games—Computing Nash equilibria of two-player, zero-sum games —Computing Nash equilibria of two- player, general- sum games — Identifying dominated strategies
Unit-5 **MECHANISM DESIGN** 9 **Periods**
Aggregating Preferences — Social Choice — Formal Model — Voting — Existence of social functions — Ranking systems — Protocols for Strategic Agents: Mechanism Design — Mechanism design with unrestricted preferences
Total Theory: 45 Periods

	Text Books	References
Learning Resources	**Primary textbooks** 1. M. J. Osborne, An Introduction to Game Theory. Oxford University Press, 2012. 2. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013. 3. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani, Algorithmic Game Theory. Cambridge University Press, 2007. 4. A.Dixit and S. Skeath, Games of Strategy, Second Edition. W W Norton & Co Inc, 2004. 5. YoavShoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.	1. *Theory of Games and Economic Behavior – John von Neumann & Oskar Morgenstern* 2. *An Introduction to Game Theory – Martin J. Osborne*

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE19	Course Name	COGNITIVE SCIENCE	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology		Data Book / Codes Standards		

Course Objective: ***The purpose of learning this course is to:***

- To know the theoretical background of cognition.
- To understand the link between cognition and computational intelligence.
- To explore probabilistic programming language.
- To study the computational inference models of cognition.
- To study the computational learning models of cognition.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the underlying theory behind cognition	U	3	1	3	2	2	-	-	-	1	1	2	2	1	2	2
CO-2:	Connect to the cognition elements computationally.	AP	2	2	1	1	2	-	-	-	3	2	3	1	2	3	2
CO-3:	Implement mathematical functions through Web PPL.	AP	1	3	1	3	3	-	-	-	1	3	1	3	3	1	2
CO-4:	Develop applications using cognitive inference model.	AP	2	1	1	2	3	-	-	-	1	2	3	1	3	3	1
CO-5:	Develop applications using cognitive learning model.	AP	1	2	3	2	2	-	-	-	1	2	2	2	2	2	1

Unit-1 PHILOSOPHY, PSYCHOLOGY AND NEUROSCIENCE **9 Periods**

Philosophy: Mental-physical Relation – From Materialism to Mental Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science – Science of Information Processing –Cognitive Neuroscience – Perception – Decision – Learning and Memory – Language Understanding and Processing.

Activities:

Demonstration of Mathematical functions using WebPPL

Unit-2 COMPUTATIONAL INTELLIGENCE **9 Periods**

Machines and Cognition – Artificial Intelligence – Architectures of Cognition – Knowledge Based Systems – Logical Representation and Reasoning – Logical Decision Making –Learning – Language – Vision.

Activities:

Implementation of reasoning algorithms

Unit-3 PROBABILISTIC PROGRAMMING LANGUAGE **9 Periods**

WebPPL Language – Syntax – Using Javascript Libraries – Manipulating probability types and distributions – Finding Inference – Exploring random computation – Coroutines: Functions that receive continuations –Enumeration

Activities:

Developing an Application system using generative model

Developing an Application using conditional inference learning model

Unit-4	INFERENCE MODELS OF COGNITION	9 Periods
Generative Models – Conditioning – Causal and statistical dependence – Conditional dependence – Data Analysis – Algorithms for Inference. **Activities:** 1. Application development using hierarchical model		
Unit-5	**LEARNING MODELS OF COGNITION**	**9 Periods**
Learning as Conditional Inference – Learning with a Language of Thought – Hierarchical Models– Learning (Deep) Continuous Functions – Mixture Models. **Activities:** Application development using Mixture model		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Vijay V Raghavan,Venkat N.Gudivada, VenuGovindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016 Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015 Robert A. Wilson, Frank C. Keil, “The MIT Encyclopedia of the Cognitive Sciences”,The MIT Press, 1999. Jose Luis Bermúdez, Cognitive Science -An Introduction to the Science of the Mind, Cambridge University Press 2020	1. Noah D. Goodman, Andreas Stuhlmuller, “The Design and Implementation of Probabilistic Programming Languages”, Electronic version of book, https://dippl.org/. 2. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, “Probabilistic Models of Cognition”, Second Edition, 2016, https://probmods.org/.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITE20	Course Name	ETHICS AND AI	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards			

Course Objective: ***The purpose of learning this course is to:***

- Study the morality and ethics in AI
- Learn ae Ethical initiatives in the field of artificial intelligence
- Study about AI standards and Regulations
- Study about social and ethical issues of Robot Ethics
- Study about AI and Ethics- challenges and opportunities

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Learn about morality and ethics in AI	U	3	2	3	3	1	-	-	-	1	2	1	1	3	1	1
CO-2:	Acquire the knowledge of real time application ethics, issues and its challenges.	AP	2	1	1	2	1	-	-	-	1	2	1	1	3	3	1
CO-3:	Understand the ethical harms and ethical initiatives in AI	U	2	3	1	1	3	-	-	-	2	1	1	2	3	2	2
CO-4:	Learn about AI standards and Regulations like AI Agent, Safe Design of Autonomous and Semi-Autonomous Systems	U	3	1	3	3	2	-	-	-	2	2	3	1	2	1	3
CO-5:	Understand the concepts of Roboethics and Morality with professional responsibilities	U	3	1	1	3	3	-	-	-	2	3	3	3	1	3	3

Unit-1 INTRODUCTION **9 Periods**

Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust

Activities:

1. Recent case study of ethical initiatives in healthcare, autonomous vehicles and defense

Unit-2 ETHICAL INITIATIVES IN AI **9 Periods**

International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles , Warfare and weaponization.

Activities:

1. Exploratory data analysis on a 2 variable linear regression model
2. Experiment the regression model without a bias and with bias

Unit-3 AI STANDARDS AND REGULATION **9 Periods**

Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems-Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems

Activities:

1. Classification of a dataset from UCI repository using a perceptron with and without bias

Unit-4 ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS **9 Periods**

Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility- Roboethics Taxonomy. **Activities:** 1. Case study on ontology where ethics is at stake
Unit-5 AI AND ETHICS- CHALLENGES AND OPPORTUNITIES 9 Periods
Challenges - Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI. **Activities:** 1. Identification on optimization in AI affecting ethics
Total Theory: 45 Periods

	Text Books	References
Learning Resources	1.y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield," The ethics of artificial intelligence: Issues and initiatives", EPRS | European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020 2.Patrick Lin, Keith Abney, George A Bekey," Robot Ethics: The Ethical and Social Implications of Robotics", The MIT Press- January 2014.	Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017 Mark Coeckelbergh," AI Ethics", The MIT Press Essential Knowledge series, April 2020 Web link: https://sci-hub.mksa.top/10.1007/978-3-540-30301-5_65 https://www.scu.edu/ethics/all-about-ethics/artificial-intelligence-and-ethics-sixteenchallenges- and-opportunities/ https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/ https://sci-hub.mksa.top/10.1159/000492428

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Professional Elective Courses - Vertical-6 (Emerging Technologies)

Course Code	24CSE11	Course Name	GAME DEVELOPMENT	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Python	Co- requisite Courses	Nil	Progressive Courses	NIL
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: *The purpose of learning this course is to:*

- To understand the fundamental concepts of 2D and 3D graphics used in game development.
- To gain knowledge of the various stages involved in the game development lifecycle.
- To learn the core principles and components of game engines.
- To explore different game development environments, frameworks, and toolkits.
- To acquire hands-on skills in designing and developing simple games using the Pygame environment.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): *At the end of this course, learners will be able to:*		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Describe the fundamental principles of 2D and 3D graphics used in game development.	U	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
CO-2:	Implement standard game design frameworks to prepare structured and detailed documentation.	U	1	2	2	1	2	-	-	-	-	-	-	-	2	2	1
CO-3:	Apply the core features and functionalities of game engines to build game components.	AP	1	1	1	2	1	-	-	-	-	-	-	-	2	2	2
CO-4:	Analyze and compare various game development environments, frameworks, and toolkits.	AN	3	3	1	3	3	-	-	-	-	-	-	-	2	2	3
CO-5:	Develop and test a basic game using the Pygame framework.	AP	3	3	2	1	3	-	-	-	-	-	-	-	2	2	3

Unit-1 3D GRAPHICS FOR GAME DESIGN 9 Periods

Genres of Games, Basics of 2D and 3D Graphics for Game Avatar, Game Components – 2D and 3D Transformations – Projections – Color Models – Illumination and Shader Models – Animation – Controller Based Animation.

Unit-2 GAME DESIGN PRINCIPLES 9 Periods

Character Development, Storyboard Development for Gaming – Script Design – Script Narration, Game Balancing, Core Mechanics, Principles of Level Design – Proposals – Writing for Preproduction, Production and Post – Production.

Unit-3 GAME ENGINE DESIGN 9 Periods

Rendering Concept – Software Rendering – Hardware Rendering – Spatial Sorting Algorithms – Algorithms for Game Engine– Collision Detection – Game Logic – Game AI – Pathfinding.

Activities:

Install a game engine (e.g., Unity or Unreal) and explore its graphical user interface; conceptualize the theme for a 2D game.

Create character designs, including sprites, animations, movements, and control mechanisms.

Unit-4	OVERVIEW OF GAMING PLATFORMS AND FRAMEWORKS	9 Periods
Pygame Game development – Unity – Unity Scripts –Mobile Gaming, Game Studio, Unity - Single player and Multi-Player games. **Activities:** Build level layouts using tiles and incorporate interactive and collectible objects. Build a multiplayer game using Unity.		
Unit-5	**GAME DEVELOPMENT USING PYGAME**	**9 Periods**
Developing 2D and 3D interactive games using Pygame – Avatar Creation – 2D and 3D Graphics Programming – Incorporating music and sound – Asset Creations – Game Physics algorithms Development – Device Handling in Pygame – Overview of Isometric and Tile Based arcade Games – Puzzle Games. **Activities** : Implement player–environment interactions, optionally integrating a physics engine. Develop a 2D interactive application using Pygame. Create a puzzle-based game. Design menus and user interface elements tailored for mobile platforms. Develop a 3D game using the Unreal Engine.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Sanjay Madhav, "Game Programming Algorithms and Techniques: A Platform Agnostic Approach", Addison Wesley,2013. 2. Will McGugan, "Beginning Game Development with Python and Pygame: From Novice to Professional", Apress,2007. 3. Paul Craven, "Python Arcade games", Apress Publishers,2016. 4. David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, CRC Press,2006. 5. Jung Hyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 2011.	1. Jason Gregory, *Game Engine Architecture*, 3rd Edition, A K Peters/CRC Press, 2018. 2. Eric Lengyel, *Mathematics for 3D Game Programming and Computer Graphics*, 4th Edition, Cengage Learning, 2022. 3. Robert Nystrom, *Game Programming Patterns*, Genever Benning, 2014. 4. Millington & Funge, *Artificial Intelligence for Games*, 2nd Edition, Morgan Kaufmann, 2009.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE12	Course Name	FOG COMPUTING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the fundamentals of Fog Computing
- Analyze Fog Computing architecture
- Explore resource management and virtualization
- Understand data processing in Fog environments
- Study applications of Fog Computing

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	CO	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO-1:	Explain the motivation, definitions and architectures of fog and related edge computing paradigms.	U	3	2	1	1	2	1	1	-	2	-	-	-	2	2	3
CO-2:	Compare fog/edge/cloud architectures and evaluate which tier is suitable for given IoT/real-time applications.	U	2	3	2	2	2	-	1	1	2	-	-	-	2	3	3
CO-3:	Design a multi-tier fog architecture and select appropriate communication and programming models for a target application.	AP	2	2	3	2	3	--	2	2	1	-	-	-	3	3	2
CO-4:	Implement a simple fog pipeline (sensors → fog node → cloud) and measure performance metrics (latency, throughput, energy).	AP	1	2	3	3	3	-	1	2	1	-	-	-	3	3	2
CO-5:	Identify major security and privacy threats in fog environments and propose mitigation strategies.	AN	1	2	2	2	2	2	1	-	1	-	-	-	1	2	3

Unit-1 Foundations & Motivation **9 Periods**

Introduction: limitations of cloud for latency-sensitive IoT, motivation for fog/edge. Definitions: Fog vs Edge vs Cloudlet vs MEC (multi-access edge computing), Fog computing characteristics, application scenarios (smart cities, industrial IoT, vehicular networks)

Unit-2 Fog Architecture & Components **9 Periods**

Multi-tier architecture: device layer, fog layer, cloud layer, Communication and network models, protocols, topology and orchestration, Programming models & APIs for fog nodes; virtualization and containerization at the edge.

Unit-3	Resource Management & Service Placement	9 Periods
Resource discovery, allocation, scheduling in fog environments ,Offloading and computation partitioning (when to offload to fog/cloud),Service placement strategies, QoS/QoE metrics, SLA considerations.		
Unit-4	**Data Management, Security & Privacy**	**9 Periods**
Data aggregation/stream processing at the edge; distributed analytics and lightweight ML ,Security challenges: authentication, secure communication, trust, privacy-preserving edge computation, Reliability, fault tolerance, and survivability in fog systems.		
Unit-5	**Use Cases, Platforms & Practical Work**	**9 Periods**
Case studies: smart grid, smart city, healthcare/remote monitoring, connected vehicles, Platforms and toolchain: fog frameworks, lightweight containers (Docker on Raspberry Pi), NFV/MEC examples,		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya and Satish Narayana Srirama (Editors), John Wiley & Sons, Wiley Series on Parallel and Distributed Computing, First Edition, 2019. 2. Fog Computing: Theory and Practice, Assad Abbas, Samee U. Khan and Albert Y. Zomaya (Editors), John Wiley & Sons, Wiley Series on Parallel and Distributed Computing, First Edition, 2020	1. Yi, S., Li, C. and Li, Q., "A Survey of Fog Computing: Concepts, Applications and Issues," *Proceedings of the ACM Workshop on Mobile Big Data*, ACM, 2015. 2. Yousefpour, A., Fung, C., Nguyen, T., Kadiyala, K., Jalali, F., Niakanlahiji, A., Kong, J. and Jue, J. P.,"All One Needs to Know about Fog Computing and Related Edge Computing Paradigms," *Journal of Systems Architecture*, Elsevier, Vol. 98, 2019, pp. 289–330. 3. 3.Fog, Edge and Pervasive Computing in Intelligent IoT-Driven Applications, Deepak Gupta and Aditya Khamparia (Editors), John Wiley & Sons, First Edition, 2021.

Learning Assessment

Continuous Learning Assessment (CLA) (50% weightage)				End Semester Examination (50% weightage)
Theory (25% weightage)		Practical (25% weightage)		
Average of Internal Test (15%)	Critical Thinking Assessment (10%)	Evaluation of Laboratory Observation, Record (15%)	Model Lab Exam (10%)	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CSE13	Course Name	ROBOTIC PROCESS AUTOMATION	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Intelligent Process Automation (IPA)
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the basic concepts of Robotic Process Automation.
- To expose to the key RPA design and development strategies and methodologies.
- To learn the fundamental RPA logic and structure.
- To explore the Exception Handling, Debugging and Logging operations in RPA.
- To learn to deploy and maintain the software bot.

Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**Program Outcomes (PO)**												**Program Specific Outcome (PSO)**		
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the fundamental concepts, evolution, benefits, and application areas of Robotic Process Automation (RPA), and differentiate RPA from traditional automation methods.	U	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-2:	Design and implement automation workflows using sequencing, flowcharting, control flow techniques, and perform data manipulation and control handling in RPA tools.	U	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-3:	Integrate applications and develop automation scripts using recording, UI automation, data scraping, and process mining features.	U	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-4:	Apply exception handling, logging, debugging, and code management techniques to improve robustness, maintainability, and reusability of automation projects.	AP	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-5:	Deploy and manage bots using orchestration servers, handle licensing, publish updates, and evaluate current RPA tools and their future trends.	AN	3	2	2	2	3	-	-	-	-	2	-	-	3	3	3

UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 9 Periods

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files

UNIT II AUTOMATION PROCESS ACTIVITIES 9 Periods

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events

UNIT III APP INTEGRATION, RECORDING AND SCRAPING 9 Periods

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

UNIT IV EXCEPTION HANDLING AND CODE MANAGEMENT	9 Periods
Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.	
UNIT V DEPLOYMENT AND MAINTENANCE	**9 Periods**
Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. The Robotic Process Automation Handbook — A practical guide to implementing RPA systems; good for understanding RPA architecture, orchestration, and industry practice. 2. Robotic Process Automation with Python & UiPath — Excellent for students: covers technical aspects, scripting, building bots using UiPath, data manipulation, and more. 3. The Simple Implementation Guide to RPA — For understanding how to plan, implement, and manage RPA projects in organizations.	1. **Robotic Process Automation (Wiley)** — More academic; covers the theory, architecture, and cross-disciplinary aspects of RPA. 2. **Robotic Process Automation – Digitization & Automation** — Focuses on how RPA helps in digital transformation, process automation in enterprises. 3. **Robotic Process Automation (General)** — A general / foundational book useful as a reference across different RPA platforms and concepts.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE14	Course Name	EDGE COMPUTING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Computer Networks	Co- requisite Courses	Nil	Progressive Courses	Internet of Things
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the fundamental concepts, evolution, benefits, and challenges of Edge Computing and its growing significance within IoT ecosystems.
- Equip students with knowledge of edge computing architectures, infrastructure components, platforms, and development environments including virtualization and containerization technologies.
- Enable learners to design and develop data processing and analytics solutions at the edge, including machine learning, data synchronization, resource management, and task offloading techniques.
- Familiarize students with fog computing concepts and architectures, and enable comparative analysis between fog, edge, and cloud computing models.
- Provide exposure to real-world applications and case studies of edge computing across sectors such as smart cities, industrial IoT, and healthcare.

			Program Outcomes (PO)												Program Specific Outcome (PSO		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	Understand the fundamentals of edge computing and its role in IoT systems.	U	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO2	Analyze and compare different edge computing architectures, platforms and frameworks.	U	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO3	Analyze and evaluate data processing at the edge and Edge analytics.	AN	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO4	Understand the fundamentals of fog computing and its frameworks.	U	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO5	Demonstrate effective communication and collaboration skills in developing edge computing projects.	AN	3	2	2	2	3	-	-	-	-	2	-	-	3	3	3

Unit-1	INTRODUCTION TO EDGE COMPUTIING AND IoT	9 Periods
Understanding Edge Computing: Evolution, Use cases, advantages, disadvantages, Overview of edge computing and its significance in IoT, Challenges and opportunities in edge computing.		
Unit-2	**EDGE COMPUTING INFRASTRUCTURE**	**10 Periods**
Edge computing architectures and components: Requirements and views for Edge architecture, Edge Computing Reference Architecture, critical elements for Edge architecture, Challenges for Edge application Development. Setting up Edge computing environments: development tools, python libraries.Edge computing platforms and frameworks: AWS IoT Greengrass, Azure IoT Edge, Google Cloud IoT Edge, IBM Edge Application Manager, KubeEdge.		

Unit-3	DATA PROCESSING AT THE EDGE	10 Periods
Data Acquisition and Processing: Data handling, python data handling, data storage and cloud connectivity, Data Aggregation, Data Timestamping and Synchronization, Data Security and Privacy. Edge analytics and machine learning at the edge: Introduction to Edge Analytics. Edge Machine Learning. Model Selection and Optimization. Collaborative Edge Learning. Resource management and task offloading strategies: Task Offloading, Edge-Cloud Collaboration, Dynamic Resource Provisioning.		
Unit-4	**INTRODUCTION TO FOG COMPUTING**	**9 Periods**
Definition and basic concepts, Comparison with cloud computing and IoT, Data Management in Fog Computing. Comparison with cloud computing and edge computing. Fog Computing Architecture. Fog node and infrastructure components. Hierarchical and distributed models. Programming Models and Tools for Fog Computing		
Unit-5	**APPLICATONS AND CASE STUDIES**	**7 Periods**
High-Potential Use cases, Edge computing for smart cities. Industrial IoT and edge computing. Edge computing in Healthcare.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. "Fog and Edge Computing" by Rajkumar Buyya, Satish Narayana Srirama, Wiley Publications 2. "Edge Computing: Models, Technologies, and Applications" by Mung Chiang, Bharath Balasubramanian, and H. Vincent Poor. 3. Edge Computing with Python: End-to-end Edge Applications, Python Tools and Techniques, Edge Architectures, and AI Benefit" by Abhinandan Bhadauria, BPB publications.	1. "Edge Computing for IoT: Architectures and Applications" by Bharat Bhargava, Sudip Misra, Valentina E. Balas, and Raghvendra Kumar 2. "Practical Industrial Internet of Things Security: A practitioner's guide to securing connected industries" by Sravani Bhattacharjee and Rajdeep Chowdhury 3. "Edge Computing: An Introduction to the Next Generation of Networked Systems" by Kiran Chitturi, Bharadwaj Veeravalli, and Satish Narayana Srirama

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE15	Course Name	NATURAL LANGUAGE PROCESSING AND CONVERSATIONAL AI	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Python Programming , Mathematics	Co- requisite Courses	Nil	Progressive Courses	Neuro Linguistic Programming
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Learn the fundamentals of natural language processing.
- Learn the word level analysis methods .
- Explore the syntactic analysis concepts.
- Understand the semantics and pragmatics.
- Understand computational models of dialogue systems.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Tag a given text with basic Language features.	U	2	3	3	2	3	3	-	1	-	-	-	1	3	3	-
CO-2:	Implement a rule based system to tackle morphology/syntax of a language.	AP	2	3	3	2	3	3	-	1	-	-	-	1	3	3	-
CO-3:	Design a tag set to be used for statistical processing for real-time applications.	AP	2	3	3	2	3	3	-	1	-	-	-	1	3	3	-
CO-4:	Compare and contrast the use of different statistical approaches for different types of NLP applications.	UN	2	3	3	2	3	3	-	1	-	-	-	1	3	3	-
CO-5:	Understand computational models of dialogue systems.	UN	2	3	3	2	3	3	-	1	-	-	-	1	3	3	-

Unit-1	**INTRODUCTION**	**9 Periods**
Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.		
Unit-2	**WORD LEVEL ANALYSIS**	**9 Periods**
Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.		
Unit-3	**SYNTACTIC ANALYSIS**	**9 Periods**
Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK,Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.		
Unit-4	**SEMANTICS AND PRAGMATICS**	**9 Periods**
Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.		

Unit-5 CONVERSATIONAL AI	**9 Periods**
Introduction to Conversational AI, Principles of dialogue – common ground, sub dialogues, Gricean principles of conversation, Computational models of dialogue systems, Chatbots architectures – Rule-based and Corpus based, Case study: Sounding board	
	Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1.Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014. 2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, O„Reilly Media, 2009. 3. Seminck, O., Michael McTear."Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots", Computational Linguistics, 2023.	1. Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015. 2. Richard M Reese, —Natural Language Processing with Javall, O„Reilly Media, 2015. 3. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing,Second Edition, Chapman and Hall/CRC Press, 2010. 4. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSE16	Course Name	QUANTUM COMPUTING	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Core Quantum Computing
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Know the background of classical computing and quantum computing.
- Learn the fundamental concepts behind quantum computation.
- Study the details of quantum mechanics and its relation to Computer Science.
- Gain knowledge about the basic hardware and mathematical models of quantum computation.
- Learn the basics of quantum information and the theory behind it.

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basics of quantum computing.	U	3	2	2	2	-	-	-	-	2	-	-	-	2	3	2
CO-2:	Understand the background of Quantum Mechanics.	U	3	2	2	2	-	-	-	-	2	-	-	-	2	3	1
CO-3:	Analyse the computation models.	AN	3	3	3	3	2	-	-	-	3	-	-	-	3	2	2
CO-4:	Model the circuits using quantum computation. environments and frameworks.	AP	3	3	3	3	3	-	-	-	3	-	-	-	1	3	2
CO-5:	Understand the quantum operations such as noise and error–correction.	U	3	3	2	3	-	-	-	-	2	-	-	-	1	3	3

Unit-1 QUANTUM COMPUTING BASIC CONCEPTS	**6 Periods**
Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics – Quantum Bits - Representations of Qubits – Superpositions.	
Unit-2 QUANTUM GATES AND CIRCUITS	**5 Periods**
Universal logic gates-Basic single qubit gates-Multiple qubit gates-Circuit development-Quantum error Correction.	
Unit-3 QUANTUM ALGORITHMS	**7 Periods**
Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm	
Unit-4 QUANTUM INFORMATION THEORY	**6 Periods**
Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels	

Unit-5 QUANTUM CRYPTOGRAPHY	**6 Periods**
Classical cryptography basic concepts - Private key cryptography - Shor’s Factoring Algorithm - Quantum Key Distribution - BB84 - Ekart 91	
	Total Theory: 30 Periods

	Text Books	**References**
Learning Resources	1.Parag K Lala, Mc Graw Hill Education, “Quantum Computing, A Beginners Introduction”, First edition (1 November 2020). 2.Michael A. Nielsen, Issac L. Chuang, “Quantum Computation and Quantum Information”, Tenth Edition, Cambridge University Press, 2010. 3.Chris Bernhardt, The MIT Press; Reprint edition (8 September 2020), “Quantum Computing for Everyone”.	1.Scott Aaronson, “Quantum Computing Since Democritus”, Cambridge University Press, 2013. 2.N. David Mermin, “Quantum Computer Science: An Introduction”, Cambridge University Press, 2007

Learning Assessment				
Continuous Learning Assessment (CLA) (50% weightage)				**End Semester Examination (50% weightage)**
Theory (25% weightage)		**Practical (25% weightage)**		
Average of Internal Test (15%)	**Critical Thinking Assessment (10%)**	**Evaluation of Laboratory Observation, Record (15%)**	**Model Lab Exam (10%)**	

* The expected levels for Bloom’s Taxonomy should be:
  - Lower-order thinking skills: not more than 40%
  - Higher-order thinking skills: not less than 60%

Course Code	24CSE17	Course Name	3D PRINTING AND DESIGN	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To discuss on basics of 3D printing
- To explain the principles of 3D printing technique
- To explain and illustrate inkjet technology
- To explain and illustrate laser technology
- To discuss the applications of 3D printing

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Outline and examine the basic concepts of 3D printing technology	U	1	1	2	2	3	1	-	-	2	-	2	2	3	2	1
CO-2:	Outline 3D printing workflow`	U	3	2	3	3	3	2	-	-	3	-	3	2	3	2	3
CO-3:	Explain and categorise the concepts and working principles of 3D printing using inkjet technique	U	2	2	2	2	2	2	-	-	2	-	2	2	3	2	2
CO-4:	Explain and categorise the working principles of 3D printing using laser technique	U	2	2	2	2	3	2	-	-	2	-	2	2	3	3	2
CO-5:	Explain various method for designing and modeling for industrial applications	U	1	3	3	3	3	3	-	-	3	-	3	3	3	3	1

Unit-1 INTRODUCTION **9 Periods**

Introduction; Design considerations – Material, Size, Resolution, Process; Modelling and viewing - 3D; Scanning; Model preparation – Digital; Slicing; Software; File formats.

Activities:

1. Study the interface and basic tools in the CAD software.
2. Study 3D printer(s) including print heads, build envelope, materials used and related support removal system(s).

Unit-2 PRINCIPLE **9 Periods**

Processes – Extrusion, Wire, Granular, Lamination, Photopolymerisation; Materials - Paper, Plastics, Metals, Ceramics, Glass, Wood, Fiber, Sand, Biological Tissues, Hydrogels, Graphene; Material Selection - Processes, applications, limitations.

Activities:

1. Review of geometry terms of a 3D mesh. Commands for moving from 2D to 3D.
2. Commands for moving from 2D to 3D.
3. Advanced CAD commands to navigate models in 3D space

Unit-3 INKJET TECHNOLOGY **9 Periods**

Printer - Working Principle, Positioning System, Print head, Print bed, Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand; Material Formulation for jetting; Liquid based fabrication – Continous jet, Mulitjet; Powder based fabrication – Colourjet.

Unit-4 LASER TECHNOLOGY **9 Periods**

Light Sources – Types, Characteristics; Optics – Deflection, Modulation; Material feeding and flow – Liquid, powder; Printing machines – Types, Working Principle, Build Platform, Print bed Movement, Support structures;

Unit-5 INDUSTRIAL APPLICATIONS	9 Periods

Product Models, manufacturing – Printed electronics, Biopolymers, Packaging, Healthcare, Food, Medical, Biotechnology, Displays; Future trends.

Activities:

1. Design any four everyday objects
   Refer to web sites like Thingiverse, Shapeways and GitFab to design four everyday objects that utilize the advantages of 3D printing
   Choose four models from a sharing site like Thingiverse, Shapeways or Gitfab.
   a. Improve upon a file and make it your own. Some ideas include:
   b. Redesign it with a specific user in mind
   c. Redesign it for a slightly different purpose
   d. Improve the look of the product
2. Use the CAM software to prepare files for 3D printing.
3. Manipulate machine movement and material layering.
4. Repair a 3D mesh using
   a) Freeware utilities: Autodesk MeshMixer (http://goo.gl/x5nhYc), MeshLab (http://goo.gl/fgztLl) or Netfabb Basic or Cloud Service (http://goo.gl/Q1P47a)
   b) Freeware tool tutorials: Netfabb Basic or Cloud Service (http://goo.gl/Q1P47a), Netfabb and MeshLab (http://goo.gl/WPOVec)
   c) Professional tools: Magics or Netfabb

	Text Books	References
Learning Resources	1. Christopher Barnatt, 3D Printing: The Next Industrial Revolution, CreateSpace Independent Publishing Platform, 2013. 2. Ian M. Hutchings, Graham D. Martin, Inkjet Technology for Digital Fabrication, John Wiley & Sons, 2013.	1. Chua, C.K., Leong K.F. and Lim C.S., Rapid prototyping: Principles and applications, second edition, World Scientific Publishers, 2010. 2. Ibrahim Zeid, Mastering CAD CAM Tata McGraw-Hill Publishing Co., 2007 Joan Horvath, Mastering 3D Printing, APress, 2014.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

OPEN ELECTIVE COURSES(12 Credits)

Course Code	24CEO01	Course Name	ENVIRONMENTAL SCIENCE AND SUSTAINABILITY	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Provide a comprehensive understanding of environmental systems, biodiversity (with emphasis on India), pollution and natural disasters, and natural resources, while developing the ability to apply sustainable development principles including climate change awareness, carbon credit concepts, green materials, energy cycles and sustainable urbanization—for effective environmental management and responsible societal development.

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Classify ecosystem types and biodiversity elements, and plan conservation strategies.	U	2					2	2					2	-	-	1
CO-2:	Assess the causes and consequences of pollution and disasters, and develop measures to minimize their impact.	U	3	2				2	2					2	1	-	1
CO-3:	Plan and adopt sustainable practices for the effective management of natural resources.	AP	3					2	2					2	1	-	2
CO-4:	Assess sustainable development goals and support their application in societal and technological contexts.	U	3	2				2	2					2	1	1	2
CO-5:	Apply knowledge of sustainability to identify eco-friendly materials, energy cycles, and urban development approaches.	U	3	2				2	2						1	-	2

Unit-1 **ENVIRONMENT AND BIODIVERSITY** ***9 Periods***

Definition, scope and importance of environment – need for public awareness. Ecosystem and Energy flow– ecological succession Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

Unit-2 **ENVIRONMENTAL POLLUTION** ***9 Periods***

Causes, Effects and Preventive Measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management System (OHASMS). Environmental protection, Environmental protection acts.

Unit-3 **RENEWABLE SOURCES OF ENERGY** ***9 Periods***

Energy management and conservation, New Energy Sources: Need of new sources. Different types of new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

Unit-4 **SUSTAINABILITY AND MANAGEMENT** ***9 Periods***

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry case study.

Unit-5 **SUSTAINABILITY PRACTICES** ***9 Periods***

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transport. Sustainable energy: Non-conventional Sources, Energy Cyclescarbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change.
Total: 45 Periods

	Text Books	References
Learning Resources	1. Environmental Science and Sustainability: Core Concepts, Ecosystems, and Resource Management — Shweta Patel & Ami Patel, 2025. 2. Sustainable Energy and Environment: An Earth System Approach — Sandeep N. Kundu & Muhammad Nawaz, 2020.	1. Introduction to Environmental Sciences and Sustainability — Emily P. Harris, 2023, OER. 2. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015. 3. Erach Bharucha "Textbook of Environmental Studies for undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013. 4. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . Edition 2010. 5. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007. 6. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition,New Age International Publishers ,2018. 7. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016. 8. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004. 9. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall. 10. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

								L	T	P	C
Course Code	24CEO02	**Course Name**	GREEN BUILDING DESIGN	**Course Category**	T	Open Elective Courses		3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Civil Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the environmental impacts of buildings in terms of energy, water, and material usage.
- Identify and analyze the embodied energy and resource implications of various building technologies.
- Evaluate thermal comfort requirements and the influence of building materials and orientation on energy use.
- Explore solar energy applications and low-energy cooling/heating techniques in buildings.
- Apply the principles of green design, water and waste management, and eco-friendly materials to achieve sustainable built environments.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Assess the influence of construction materials, energy utilization and waste production on environmental sustainability.	U	3	2					2						1	-	2
CO-2:	Analyze the embodied energy and sustainability aspects of different building technologies and materials.	U	3	3					2						1	-	2
CO-3:	Investigate the role of thermal comfort and solar heat control in enhancing building performance.	U	3	3	2				2					2	1	-	2
CO-4:	Design passive solar heating and cooling concepts for sustainable buildings.	U	3	2	2				2					2	1	1	2
CO-5:	Develop sustainable strategies for water utilization, waste management and green composites in buildings.	U	3	2	2				2					2	1	-	2

Unit-1 **ENVIRONMENTAL IMPLICATIONS OF BUILDINGS** ***9 Periods***

Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.

Unit-2 **IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS** ***9 Periods***

Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.

Unit-3 **COMFORTS IN BUILDING** ***9 Periods***

Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations.

Unit-4 **UTILITY OF SOLAR ENERGY IN BUILDINGS** ***9 Periods***

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

Unit-5 **GREEN COMPOSITES FOR BUILDINGS** ***9 Periods***

Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

Total: 45 Periods

	Text Books	References
Learning Resources	1. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007. 2. Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.	1. Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010. 2. Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009. 3. Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke. 4. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:

- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CEO03	Course Name	MUNICIPAL SOLID WASTE MANAGEMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Civil Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To make the students conversant with the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Classify municipal solid waste components and explain the governing rules for waste management.	U	2	2				2	2						-	-	1
CO-2:	Assess waste generation and adopt reduction, reuse, and recycling strategies.	U	2	2	1			2	2					1	1	-	2
CO-3:	Formulate system designs for efficient handling and disposal of municipal solid waste.	U	2	2				2	2						1	1	2
CO-4:	Analyze solid waste management challenges from an integrated, sustainable, and global perspective.	U	2	2	1			2	2					1	1	-	2
CO-5:	Design and evaluate the functional components and operational requirements of a sanitary landfill.	U	2	2		1		2	2					1	1	-	2

Unit-1 **SOURCES AND CHARACTERISTICS** ***9 Periods***

Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management – Requirements and salient features of Solid waste management rules (2016) –- Role of public and NGO‟s- Public Private participation – Elements of Municipal Solid Waste Management Plan.

Unit-2 **SOURCE REDUCTION , WASTE STORAGE AND RECYCLING** ***9 Periods***

Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes.

Unit-3 **COLLECTION AND TRANSFER OF WASTES** ***9 Periods***

Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations – location, operation and maintenance; options under Indian conditions – Field problems- solving.

Unit-4 **PROCESSING OF WASTES** ***9 Periods***

Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio-methanation; Thermal processing options – case studies under Indian conditions.

Unit-5 **WASTE DISPOSAL** ***9 Periods***

Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor – Dumpsite Rehabilitation.

Total: 45 Periods

	Text Books	References
Learning Resources	1. Municipal Solid Waste Management and Landfill Leachate: A Case Study of Hanoi City — S. M. Lee & Nam-Suk Kim (Editors),2023. 2. William A. Worrell, P. Aarne Vesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.	1. Sustainable Solid Waste Management — Policies and Case Studies — Vikram Soni & Rajshree Srivastava (Editors), 2024. 2. CPHEEO (2014), "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi. 3. George Tchobanoglous and FrankKreith (2002).Handbook of Solid waste management, McGraw Hill, New York. 4. John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CEO04	**Course Name**	SUSTAINABLE INFRASTRUCTURE	**Course Category**	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Civil Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Provide a comprehensive understanding of sustainable built environments and development principles, while introducing environmental impact assessment techniques, life cycle and service life evaluation methods, and the social dimensions of sustainability in the construction industry.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explore the relationship between the built environment and societal progress.	U	2	2	1			2	2					2	-	-	1
CO-2:	Investigate how various factors contribute to sustainable development.	U	2	2	1			2	2					2	1	-	2
CO-3:	Apply environmental impact assessment techniques as a tool in design processes.	U	2	2				2	2					2	1	1	2
CO-4:	Construction and management of a sustainable built environment.	U	2	2	1			2	2					2	1	1	2
CO-5:	Comprehend the aspects of social sustainability in the construction industry.	U	2	2	1			2	2					2	-	-	2

1

Unit-1	**INTRODUCTION TO SUSTAINABLE BUILT ENVIRONMENT**	***9 Periods***
Importance of sustainable built environment- Extent and societal values of infrastructure: buildings, structures, utility networks- Role of infrastructure in community well-being and economic development-Relationship between infrastructure and sustainable development-Regulatory frameworks, standards, and global sustainability guidelines-Climate change: impacts, risks, and resilience measures for infrastructure.		
Unit-2	**PRINCIPLES OF SUSTAINABLE DEVELOPMENT AND CONSTRUCTION**	***9 Periods***
Concepts and pillars of sustainability: environmental, economic, social- Sustainability indicators and metrics for infrastructure projects- Green engineering and design principles-Sustainable materials, technologies, and construction practices- Case studies on sustainable construction at national and international levels.		
Unit-3	**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) IN INFRASTRUCTURE**	***9 Periods***
Introduction to Environmental Impact Assessment (EIA)- EIA process: screening, scoping, impact prediction, mitigation, monitoring- Tools and techniques for environmental assessment- Material Flow Analysis (MFA) and its application- Integration of EIA in sustainable design and decision-making.		
Unit-4	**SERVICE LIFE & LIFE CYCLE ASSESSMENT (LCA)**	***9 Periods***
Concepts of service life and durability of infrastructure- Life Cycle Assessment (LCA): principles, methods, and applications-Life Cycle Costing (LCC): cost components and evaluation-Environmental assessment tools for sustainable infrastructure-Sustainable management of infrastructure assets-Case studies on service life performance and LCA from global projects.		
Unit-5	**SOCIAL ASPECTS OF SUSTAINABILITY IN CONSTRUCTION**	***9 Periods***
Social sustainability: definition, principles, and relevance to construction- Community engagement and stakeholder involvement-Ethical considerations, equity, and cultural impacts-Workforce welfare, safety, and inclusiveness in construction-Sustainable development goals (SDGs) related to infrastructure-Applications for sustainable communities and best practice case studies.		
	Total:	**45 Periods**

	Text Books	References
Learning Resources	1. Sustainable Materials in Civil Infrastructure — Thainswemong Choudhury, Raviteja KVNS, Lakhveer Singh, Elisa Bertolesi, 2024. 2. Sustainable Civil Engineering: Principles and Applications — Varinder S. Kanwar, Sanjay K. Shukla, Siby John, Harpreet S. Kandra,2023.	1. Urban Infrastructure and Resilient, Sustainable Buildings — Zhou, Shenghua; Gu, Tiantian; Wong, Mun On (eds.),2025. 2. Horne R. E., Grant T., Verghese K., 'Life Cycle Assessment: Principles, Practice and Prospects', CSIRO, 2009. 3. Liv Haselbach, The Engineering Guide to LEED-New Directions (Green Source): Sustainable construction, McGraw-Hill Professional, 2008. 4. Sarte S. B.,'Sustainable Infrastructure: The Guide to Green Engineering and Design, Wiley; 1st edition, 2010. 5. Karli Verghese, Helen Lewis, Leanne Fitzpatrick, 'Packaging for Sustainability', Springer, 2012. 6. FIB bulletin 88, 'Sustainability of precast structures', 2018.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CEO05	Course Name	DISASTER MANAGEMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Build foundational knowledge of disasters and their interrelationships with vulnerability and risk, while promoting awareness of institutional frameworks and practical response skills.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Classify disasters and explain their causes and impacts on society and the environment.	U	3	1	1			2	2					2	-	-	1
CO-2:	Interpret the disaster management cycle and relate it to community and institutional DRR practices.	U	3	1	1			2	2					2	1	-	1
CO-3:	Investigate the connection between development and disasters, and apply local knowledge and resources to minimize vulnerability.	U	3	1	1			2	2				2	2	1	-	2
CO-4:	Apply knowledge of India's hazards to evaluate disaster management systems and the use of GIS/IT tools in decision-making.	U	3	1	1	2		2	2				2	2	2	1	3
CO-5:	Apply the concepts of disaster management to real-life situations through case studies related to earthquakes, floods, landslides, droughts, forest fires, and man-made disasters.	U	3	1	1	2		2	2				2	2	1	-	2

Unit-1 **INTRODUCTION TO DISASTERS** ***9 Periods***

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

Unit-2 **APPROACHES TO DISASTER RISK REDUCTION (DRR)** ***9 Periods***

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake- holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

Unit-3 **INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT** ***9 Periods***

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

Unit-4 **DISASTER RISK MANAGEMENT IN INDIA** ***9 Periods***

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

Unit-5	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS**	***9 Periods***
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.		
	Total:	**45 Periods**

	Text Books	**References**
Learning Resources	1. Disaster Management — M. Saravana Kumar, 2024. 2. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423.	1. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361. 2. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011. 3. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010. 4. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005. 5. Government of India, National Disaster Management Policy,2009.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CEO06	Course Name	GEOGRAPHICAL INFORMATION SYSTEM	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Civil Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Develop a fundamental understanding of Geographic Information Systems (GIS).	U	3											2	1	1	2
CO-2:	Classify spatial data models and interpret their functions in GIS.	U	3				3								2	1	2
CO-3:	Interpret data acquisition methods and the significance of topology in GIS applications.	U	3		3	3									2	1	2
CO-4:	Apply data quality principles and standards in geographic information systems.	U	3	3	3	3	3								2	2	2
CO-5:	Design data handling procedures and create appropriate GIS outputs.	U	3	3	3	3	3						2		3	2	3

Unit-1 **FUNDAMENTALS OF GIS** ***9 Periods***

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

Unit-2 **SPATIAL DATA MODELS** ***9 Periods***

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

Unit-3 **DATA INPUT AND TOPOLOGY** ***9 Periods***

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration.

Unit-4 **DATA QUALITY AND STANDARDS** ***9 Periods***

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards – Interoperability - OGC - Spatial Data Infrastructure.

Unit-5 **DATA MANAGEMENT AND OUTPUT** ***9 Periods***

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GISdistributed GIS.

Total: 45 Periods

<table>
<tr><td rowspan="2">Learning Resources</td><td>Text Books</td><td>References</td></tr>
<tr><td>1. Introduction to Geographic Information Systems — Ulrike Ingram, Mark Patterson, Allison Bailey, Amber Ignatius & Katayoun Mobasher,2021.
2. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.</td><td>1. Fundamentals of Geographic Information System — Debashis Chakraborty & Rabi N. Sahoo.2020.
2. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems,Prentice-Hall India Publishers, 2006.
3. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.</td></tr>
</table>

<table>
<tr><td colspan="3">Learning Assessment</td></tr>
<tr><td colspan="2">Continuous Learning Assessment (CLA) (40% weightage)</td><td rowspan="2">End Semester Examination
(60% weightage)</td></tr>
<tr><td>Average of Internal Test
(20%)</td><td>Critical Thinking Assessment
(20%)</td></tr>
<tr><td colspan="3">* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%</td></tr>
</table>

Course Code	24CEO07	Course Name	ENVIRONMENT AND AGRICULTURE	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Civil Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To emphasise the importance of environment and agriculture in the changing global scenario and the emerging issues connected to it.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Investigate environmental concerns associated with agriculture and propose suitable mitigation measures.	U	2	2				2	2					2	1	-	2
CO-2:	Determine the environmental consequences of modern farming practices and soil erosion processes.	U	2	1				2	2					2	1	-	1
CO-3:	Assess the relationship between climate change, water cycles and desertification.	U	2	2				2	2					2	1	-	2
CO-4:	Investigate the impact of agricultural biotechnology and GM crops on ecological diversity and environmental health.	U	2	2	1			2	2					2	1	-	2
CO-5:	Develop sustainable solutions by integrating emerging technologies and environmental considerations in agriculture.	U	2	2	1			2	2					2	2	1	3

Unit-1 **ENVIRONMENTAL CONCERNS** ***9 Periods***

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalisation and its impacts – Agro-ecosystems.

Unit-2 **ENVIRONMENTAL IMPACTS** ***9 Periods***

Irrigation development and watersheds – mechanised agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts.

Unit-3 **CLIMATE CHANGE** ***9 Periods***

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

Unit-4 **ECOLOGICAL DIVERSITY AND AGRICULTURE** ***9 Periods***

Ecological diversity, wildlife and agriculture – GM crops and their impacts on the environment – Insects and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

Unit-5 **EMERGING ISSUES** ***9 Periods***

Global environmental governance – alternative culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

Total: 45 Periods

	Text Books	References
Learning Resources	1. Sustainable Agriculture and the Environment — Edited by Muhammad Farooq, Nirmali Gogoi & Michele Pisante, 1st Edition, 2023. 2. Agriculture, Environment and Sustainable Development: Experiences and Case Studies — Edited by Rukhsana & Asraful Alam, 1st Edition, 2022 (Softcover 2023).	1. T.C. Byerly, Environment and Agriculture, United States. Dept. of Agriculture. Economic Research Service, 2006. 2. Robert D. Havener, Steven A. Breth, Environment and agriculture: rethinking development issues for the 21st century: proceedings of a symposium, Winrock International Institute for Agricultural Development, 1994. 3. Environment and agriculture: environmental problems affecting agriculture in Asia and Pacific region; World Food Day Symposium, Bangkok, Thailand. 1989. 4. M.Lakshmi Narasaiah, Environment and Agriculture, Discovery Pub. House, 2006. 5. Arvind Kumar, Environment and Agriculture, ABH Publications, New Delhi, 2005.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CEO08	Course Name	EARTHQUAKE ENGINEERING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Provide a foundational understanding of earthquake engineering, including seismic wave behaviour, measurement techniques, hazard analysis, risk mapping and protection strategies.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Classify the basic elements of earthquake engineering and explain their functions.	U	2	2	1			2	2					2	-	-	1
CO-2:	Investigate the behaviour of seismic waves from their origin to their propagation paths.	U	2	2				2							1	-	1
CO-3:	Classify earthquake measuring scales and explain the operation of seismic devices.	U	2	2		2		2							1	-	2
CO-4:	Apply concepts to quantify and analyse earthquake intensity and ground motion behaviour.	U	2	2		2		2	2						2	1	2
CO-5:	Analyse various methods for safeguarding structures against earthquake forces.	U	2	2	1			2	2						1	-	2

Unit-1	**FUNDAMENTALS OF EARTHQUAKE ENGINEERING**	***9 Periods***
Importance and scope of Earthquake Engineering – Earth's internal structure – Plate tectonics theory and its relevance to earthquakes – Types of faults and seismic sources – Earthquake generation mechanism – Focus, epicentre, seismic gap and recurrence – Basic terminologies used in seismology – Historical earthquakes and their impacts – Introduction to Indian seismicity.		
Unit-2	**EARTHQUAKE WAVE PROPAGATION**	***9 Periods***
Nature of seismic waves – Body waves (P-waves and S-waves): characteristics and behaviour – Surface waves (Love waves and Rayleigh waves): propagation effects – Travel time curves – Earthquake shaking and ground motion – Attenuation of seismic wave amplitudes – Effect of geology on wave propagation – Wave amplification in soil layers.		
Unit-3	**MEASUREMENT AND RECORDING OF EARTHQUAKES**	***9 Periods***
Earthquake measurement principles – Intensity scales (MMI, MSK) – Magnitude scales (Richter magnitude, Moment magnitude) – Seismic moment and seismic energy release – Seismographs and seismograms: types and working – Accelerographs and accelerograms – Instrumentation for strong ground motion studies – Interpretation of recorded data.		
Unit-4	**SEISMIC HAZARD ASSESSMENT AND MICROZONATION**	***9 Periods***
Concept of seismic hazard – Types of hazard assessments – Ground motion intensity estimation at a site – Time interval and probability-based hazard estimation – Probabilistic and semi-probabilistic seismic hazard assessment methods (PSHA & DSHA) – Preparation of seismic zonation maps – Microzonation mapping techniques – Site characterisation for hazard studies – Seismic risk analysis.		
Unit-5	**SEISMIC PROTECTION AND CODAL PROVISIONS**	***9 Periods***
Seismic protection of structures – Base isolation systems: types, principles and applications – Energy dissipation and damping devices – Seismic strengthening and retrofitting methods – Structural configuration for earthquake resistance – Codal provisions for seismic design (IS 1893, IS 13920) – Design philosophy for earthquake-resistant buildings.		
	Total:	**45 Periods**

Learning Resources	Text Books	References
	1. R. Villaverde (2009). Fundamental Concepts of Earthquake Engineering, 1st Edition, CRC Press. 2. S. Elnashai and L. Di Sarno (2008). Fundamentals of Earthquake Engineering, 1st Edition, John Wiley and Sons.	1. Geotechnical Earthquake Engineering (2nd Edition, 2024) by Steven L. Kramer (et al.). 2. Seismic Analysis and Design of Building Structures (2024 Edition) by Yail Jimmy Kim (Editor). 3. Theory and Practice in Earthquake Engineering and Technology (2023) edited by T. G. Sitharam et al. 4. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24EEO01	Course Name	Electrical Safety	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand electrical hazards, types of shocks, their effects, and preventive safety measures in residential and work environments.
- To learn safe installation practices, risks, procedures, and protective measures for electrical plants, machines, and equipment.
- To recognize common electrical faults in homes, buildings, and farms and apply proper safety practices and preventive measures.
- To study hazardous area classifications and grounding/earthing methods essential for preventing electrical accidents.
- To understand safety policies, audits, rules, and statutory regulations governing electrical safety and system operation.

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO)												Program Specific Outcome (PSO)		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Identify electrical hazards, analyse shock mechanisms, and apply methods to prevent electric shocks.	AN	3	2	2	2	2	2	2		2	2		2	2	1	2
CO-2:	Implement safe installation procedures and use appropriate protective equipment for electrical systems.	AP	3	2	2	3	2	2	2	1	2	1		2	2	2	2
CO-3:	Diagnose unsafe conditions in homes, buildings, and agricultural setups and recommend corrective safety actions.	AN	3	2	2	3	2	2	2	1	2	1		2	3	2	2
CO-4:	Classify hazardous areas and design proper earthing and grounding systems for safe electrical operation.	AN	3	2	2	3	2	2	2	1	2	1		2	3	1	2
CO-5:	Interpret safety rules, perform safety audits, and apply statutory electrical safety standards and regulations.	AN	3	2	2	3	2	2	2	1	2	1		2	2	3	2

Unit-1 INTRODUCTION TO ELECTRICAL SAFETY, SHOCKS AND THEIR PREVENTION — 9 Periods

Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

Unit-2 SAFETY DURING INSTALLATION OF PLANT AND EQUIPMENT — 9 Periods

Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

Unit-3	ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS	9 Periods
	Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.	
Unit-4	**ELECTRICAL SAFETY IN HAZARDOUS AREAS AND EARTHING**	**9 Periods**
	Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment's for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations. EQUIPMENT EARTHING AND SYSTEM NEUTRAL EARTHING Introduction, Distinction between system grounding and Equipment Grounding, Equipment Earthing, Functional Requirement of earthing system, description of an earthing system, , neutral grounding(System Grounding), Types of Grounding, Methods of Earthing Generators Neutrals.	
Unit-5	**SAFETY MANAGEMENT OF ELECTRICAL SYSTEMS**	**9 Periods**
	Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees. REVIEW OF IE RULES AND ACTS AND THEIR SIGNIFICANCE Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and firefighting facility. The Electricity Act, 2003, (Part1, 2, 3, 4 & 5)	
		TOTAL: 45 Periods

	Text Books	References
Learning Resources	1. S.Rao, Prof. H.L.Saluja, " Electrical safety, fire safety Engineering and safety management ", 1 st edition Khanna Publishers. New Delhi, 2016 Reprint. 2. Timothy Braun, Lisa Glidden, "Understanding Energy and Energy Policy", Bloomsbury Publishing, first edition, 2014. 3. 2. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, "Electrical Safety Handbook", McGraw-Hill, fourth edition, 2012.	1. Pradeep Chaturvedi, " Energy management policy, planning and utilization ", Concept Publishing company, New Delhi, 1997. 2. Power Engineer's Handbook, TNEB Engineer's Association, sixth edition, 2011. 3. Sanjeev Ahluwalia, "Special report on National Electricity Policy 2021: Making India's Power Sector Future-Ready", 2021.

	Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)			**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**		

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24EEO02	Course Name	Introduction to E-Vehicle	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ELECTRICAL AND ELECTRONICS ENGINEERING	Data Book / Codes / Standards	Nil		

Course Objective: The purpose of learning this course is :

- To understand the fundamentals, evolution, and need for Electric Vehicles (EVs) as an alternative to conventional vehicles.
- To analyze the vehicle dynamics, road load, and tractive force requirements for EV applications.
- To identify and explain the components and power electronic converters used in electric vehicles.
- To compare and select suitable electric motors and drives for electric and hybrid vehicle applications.
- To understand hybrid electric vehicle architectures and various energy storage systems used in EVs.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamentals, need, types, and market scenario of electric vehicles along with basic vehicle dynamics.	U	3	2	-	-	-	2	-	-	-	-	1	2	2	1	3
CO-2:	Explain the main components and power electronic converters used in electric vehicles.	U	3	2	2	-	3	-	-	-	-	-	1	2	3	1	3
CO-3:	Analyze and compare different electric motors and traction drive requirements for electric and hybrid vehicles.	AN	3	3	2	2	3	-	-	-	-	-	1	2	3	2	3
CO-4:	Understand the architectures, operation, advantages, and applications of hybrid electric vehicles.	U	2	2	2	-	-	3	-	-	-	-	1	2	2	2	3
CO-5:	Understand various energy sources, batteries, charging methods, and energy management systems used in electric vehicles.	U	3	2	2	-	2	3	-	-	-	-	2	2	3	2	3

UNIT-1 - INTRODUCTION TO ELECTRIC VEHICLES	9 Periods
Fundamentals of vehicles – Vehicle model – Calculation Road load and tractive force –Components of conventional vehicles – Drawbacks of conventional vehicles – Need for	

electric vehicles– Advantages and applications of Electric Vehicles – History of Electric Vehicles – EV Market in India and outside India –Types of Electric Vehicles.	
UNIT-2 -COMPONENTS OF ELECTRIC VEHICLES	**9 Periods**
Main components of Electric Vehicles – Electric Traction Motor and Controller –Power Converters – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.	
UNIT-3 - MOTORS FOR ELECTRIC VEHICLES	**9 Periods**
Characteristics of traction drive – requirements of electric machines for EVs – Comparison of Different motors for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and working only).	
UNIT-4 - HYBRID ELECTRIC VEHICLES	**9 Periods**
Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs – Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples – Merits and Demerits.	
UNIT-5 - ENERGY SOURCES FOR ELECTRIC VEHICLES	**9 Periods**
Batteries– Types of Batteries – Lithium-ion – Nickel-metal hydride – Lead-acid – Comparison of Batteries – Battery Charging – Fast Charging –Battery Management System – Ultra capacitors – Flywheels – Compressed air energy storage (CAES)– Fuel Cell – it's working.	
Total = 45 Periods	

Learning Resources	1. Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020. 2. Chau - Kwok Tong. Electric vehicle machines and drives: design, analysis and application. John Wiley & Sons - 2015. 3. Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge University Press - 2015.	1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Publication, Second Edition. 2. Seth Leitman arid Bob Brant, Build Your Own Electric Vehicle, McGraw Hill TAB; 3rd edition. 3. WeiLiu, Introduction to Hybrid Vehicle System Modeling and Control, Wiley Publication second edition.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24EEO03	Course Name	Hybrid Energy Technology	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes Standards	Nil		

	Course Objective: ***The purpose of learning this course is to:***
•	• To provide knowledge about different types of hybrid energy systems. • To analyse the various electrical Generators used for the Wind Energy Conversion Systems. • To design the power converters used in SPV Systems. • To analyse the various power converters used in hybrid energy systems and to understand the importance of standalone and grid-connected operation in Hybrid renewable energy systems. • To analyse the performance of the various hybrid energy systems.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyse the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power.	AN	3	3	3	3	3		3					3	2	1	3
CO-2:	Select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system	AN	3	3	3	2	3		2					3	3	2	3
CO-3:	Design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems.	AN	3	3	3	2	3		2		3			3	3	2	3
CO-4:	Analyse the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems.	AN	3	3	3	2	3		1		3			3	3	2	3
CO-5:	Interpret the hybrid renewable energy systems.	AN	3	3	3	2	3		1		3			3	2	1	3

Unit-1	**INTRODUCTION TO HYBRID ENERGY SYSTEMS**	**9 Periods**
	Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind- Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems – Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy – Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics	
Unit-2	**ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS)**	**9 Periods**

	Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG)
Unit-3	**POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS** **9 Periods**
	Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck boost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems – Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems,.
Unit-4	**ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS** **9 Periods**
	Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations
Unit-5	**CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS** **9 Periods**
	Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.
	TOTAL: 45 Periods

	SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation Quiz/ Surprise Test / Solving GATE questions/ etc)
	1. Simulation of Wind energy conversion system 2. Simulation of Power converters 3. Simulations of AC-DC-AC converters, PWM inverters and Matrix Converters with Resistive and dynamic loads

	Text Books	References
Learning Resources	1. Bahman Zohuri, “Hybrid Energy Systems”, Springer, First Edition, 2018. 2. S.M. Muyeen, “Wind Energy Conversion Systems”, Springer First Edition, 2012 3. Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, "Emerging Power Converters for Renewable Energy and Electric Vehicles", CRC Press, First Edison, 2021	1. Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3rd Edition. 2. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 7th Impression, 2005. 3. Rashid.M. H “Power electronics Hand book”, Academic press,4th Edition, 2018. 4. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017. 5. Rai. G.D, “Solar energy utilization”, Khanna publishers, 3rd Edition, 1987. 6. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 2nd Edition, 2006. 7. B.H.Khan "Non-conventional Energy sources", Tata McGraw hill Publishing Company, New Delhi, 2017, 3rd Edition.

Learning Assessment

Continuous Learning Assessment (CLA) (40% weightage)			End Semester Examination (60% weightage)
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**		

* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24EEO04	Course Name	Solar Photo Voltaic System	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamentals of solar radiation, solar thermal systems, and basics of photovoltaic conversion.
- To study the working principles, characteristics, parameters, and configurations of solar cells, modules, and PV arrays
- To learn the methodology, components, economics, and standards involved in designing various types of solar PV systems.
- To gain knowledge of balance-of-system components including charge controllers, converters, inverters, and MPPT techniques.
- To understand battery types, selection, sizing, maintenance, and their role in PV system integration and applications.

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Explain solar radiation principles and different solar thermal applications.	U	3	2				2	3					2	2	1	3
CO-2:	Analyse solar cell parameters and design module/array configurations for required power output.	AN	3	3	2	2	2		2					2	3	1	3
CO-3:	Design standalone, grid-connected, and hybrid PV systems with economic and performance evaluation.	AN	3	3	3	2	2	2	3		2	1	3	2	3	2	3
CO-4:	Select and evaluate power converters, charge controllers, and MPPT methods for PV applications.	AN	3	3	3	2	3		2				2	2	3	2	3
CO-5:	Size, configure, test, and maintain battery banks for various solar PV systems and applications.	AN	3	3	3	3	2		2		2	1	2	2	3	2	3

Unit	Title	Periods
Unit-1	**INTRODUCTION TO SOLAR ENERGY**	**7 Periods**
	Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar pond – Central receiver collector- Solar thermal applications – Fundamentals of solar photo voltaic conversion.	
Unit-2	**SOLAR CELLS, PV MODULES AND ARRAYS**	**10 Periods**
	Solar cells – Parameters of Solar Cells , Factors affecting Electricity generated from a Solar Cell , Photovoltaic effect – I–V characteristics of PV cells Solar PV Modules – Ratings , Module Parameters Factors Affecting Electricity Generated by a Solar PV Module, Measuring Module Parameters, Solar PV Module Arrays - Connection of Modules in Series, in Parallel and in Series and Parallel ((Mixed Combination)	
Unit-3	**SOLAR PV SYSTEM DESIGN**	**10 Periods**
	Types of Solar PV Systems – Standalone, Grid-connected and Hybrid, Design Methodology for SPV System, Grid-connected Solar PV Power Systems – Introduction, Components and Configurations, Grid connected PV System Design for Small Power Applications and for Power Plants. Economics of PV Systems-sample payback period, lifecycle costing, Introduction to Solar Advisory Model (SAM) Software. PV systems in buildings – utility applications for photovoltaics - design issues for central power stations	

	– safety – Economic aspect –standards and guidelines for PV systems, Efficiency and performance - International PV programs.
Unit-4	**CHARGE CONTROLLER, MPPT AND INVERTERS** **9 Periods**
	Need For Balance of System (BoS) , Power Converters and their efficiency , DC to AC Converters (Inverters) , DC to DC Converters , Charge Controllers, Maximum Power Point Tracking (MPPT), Types of Wires and Wire Sizing, Junction Box. Applications - Space - Marine - Telecommunications - Photovoltaic powered transport - Solar Cars - Solar Furnaces - Solar Refrigeration.
Unit-5	**BATTERIES AND THEIR APPLICATIONS TO SOLAR PV SYSTEMS** **9 Periods**
	Types of batteries , Parameters of Batteries, How to select a battery, Connecting Batteries together – Series , Parallel and mixed combination, Estimating Number of Batteries to be Connected in a battery Bank, Testing and Maintenance of Batteries , Fault Detection, Instruments used for Maintenance. System configuration - Water Pumps - Motors - Power conditioning circuitry - Batteries - Array wiring and mounting - PV water pumping system design -Example of a directly coupled system design. Sample Case Study of a Solar PV System, Environmental Considerations of PV Systems.
	TOTAL: 45 Periods

	Text Books	**References**
Learning Resources	1. Chetan Singh Solanki ,Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, PHI Learning Publications, 3rd Edition, 2015 2. SAM Ver. 2.0 User guide - https://www.nrel.gov/docs/fy08osti/43704.pdf 3. Stuart R.Wenham, Martin A.Green, Muriel E. Watt, Richard Corkish and Alistair Sproul, "Applied Photovoltaics", Third Edition, 2011,Earthscan, UK	1. Roger A. Messenger and Jerry Ventre, ‘Photovoltaic Systems Engineering’, Taylor and Francis Group Publications, 3rd Edition, 2010(CRC Press Reprint – 2018) 2. Soteris A. Kalogirou, Solar Energy Engineering: Processes and Systems, Ac Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,1994. 3. Solar & Wind Energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990 4. S.P. Sukhatme , “Solar Energy”, Tata McGraw Hill,1987. ademic Press, (Elsevier)2ndedition ,2014. .

Learning Assessment			
Continuous Learning Assessment (CLA) (40% weightage)			**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**		

* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24EEO05	Course Name	EnergyForecasting,Modeling,andProject Management	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering		Data Book / Codes / Standards	Nil	

Course Objective: ***The purpose of learning this course is to:***

- To impart knowledge about the present status of energy scenario in India.
- To predict the energy demand using various forecasting models.
- To develop an optimization model for the effective utilization of energy sources.
- To understand and learn the procedure to the write the project proposal.
- To learn the present status of energy policies in the country.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Understand the energy scenario and appraise energy availability	UN	1	3	1	1	2	1	2	1	–	1	1	2	2	1	3
CO-2:	Analyse energy demand using various forecasting models	AN	3	3	2	3	2	2	2	1	–	1	2	2	3	2	3
CO-3:	Develop different optimization model for energy planning.	AP	3	2	2	3	3	2	2	1	2	1	2	3	3	3	3
CO-4:	Formulate project proposal and financial evaluation.	AP	2	3	3	3	-	2	2	1	2	3	3	3	2	3	2
CO-5:	Interpret the national and state energy policies.	UN	1	3	2	-	-	2	3	2	–	2	2	3	2	2	3

Unit-1	**ENERGY SCENARIO**	**9 Periods**
Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics – Energy Sources and Overall Energy demand and Availability – Energy Consumption in various sectors and its changing pattern –Status of Nuclear and Renewable Energy: Present Status and future promise.		
Unit-2	**FORECASTING MODEL**	**9 Periods**
Forecasting Techniques – Regression Analysis – Double Moving Average – Double Experimental Smoothing – Triple Exponential Smoothing – ARIMA model- Validation techniques – Qualitative forecasting–Delphi technique.		
Unit-3	**OPTIMIZATION MODEL**	**9 Periods**
Principles of Optimization – Formulation of Objective Function – Constraints – Multi Objective Optimization–Mathematical Optimization Software–Development of Energy Optimization Model Development of Scenarios– Sensitivity Analysis..		
Unit-4	**PROJECT MANAGEMENT**	**9 Periods**
Project Preparation, Feasibility Study, Detailed Project Report, Project Appraisal, Social-cost Benefit analysis, Project Cost Estimation, Project Risk Analysis and management, Project Financing, Financial evaluation and reporting.		

<table>
<tr><td>Unit-5 ENERGY POLICY</td><td>9 Periods</td></tr>
<tr><td colspan="2">Importance and need for energy policy, National & State Level Energy Issues, National and State Energy Policy - Energy Security – National solar mission - state solar energy policy - Framework of Central Electricity Authority (CEA), Central and States Electricity Regulatory Commissions (CERC & ERCs).</td></tr>
<tr><td colspan="2" align="right">Total Theory: 45 Periods</td></tr>
</table>

	Text Books	**References**
Learning Resources		1. Armstrong J.Scott, ‘Principles of forecasting: a hand book for researchers and practitioners’, Norwell, Massachusetts: Kluwer Academic Publishers.2001. 2. Dhandapani Alagiri, ‘Energy Security in India Current Scenario’, The ICFAI University Press,2006. 3. Rob J Hyndman, Forecasting: Principles and Practice, O Texts, 3rd Ed., 2021 4. Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman, ‘Forecasting Methods and applications’, Wiley, 3rd ed., 1998. 5. Sukhvinder Kaur Multani, ‘Energy Security in Asia Current Scenario’, The ICFAI University Press, 2008. 6. Yang X.S., ‘Introduction to mathematical optimization: From linear programming to Metaheuristics’, Cambridge, Int. Science Publishing, 2008. 7. Durai Pravin, Principles of Management, Pearson Education India, 2015

<table>
<tr><td colspan="5">Learning Assessment</td></tr>
<tr><td colspan="4" align="center">Continuous Learning Assessment (CLA) (40% weightage)</td><td rowspan="3" align="center">End Semester Examination
(60% weightage)</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td align="center">Average of Internal Test (20%)</td><td align="center">Critical Thinking Assessment (20%)</td><td></td><td></td></tr>
<tr><td colspan="5">* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%</td></tr>
</table>

Course Code	24EEO06	Course Name	Energy Efficient Buildings Design	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To learn the green buildings concepts applicable to alternate design
- To be familiar with basic terminologies related to buildings
- To learn the building(air)conditioning techniques
- To know the methods to evaluate the performance of buildings
- To incorporate Renewable energy systems in buildings

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the importance of climate-responsive and sustainable building design.	UN	2		3	2	1	1	3	1	–	1	-	2	2	1	3
CO-2:	Analyse various physical properties influencing passive building design	AN	3		2	3	3		3	1	–	1	-	2	3	1	2
CO-3:	Develop passive heating and cooling systems for energy-efficient buildings.	AP	3		3	3	3	2	3	1	–	2	2	3	3	2	3
CO-4:	Interpret the energy performance of buildings	UN	3		3	3	3	1	3	1	–	2	2	3	3	2	3
CO-5:	Analyse the adaptation of renewable energy systems in buildings	AN	3		3	3	3	3	3	2	–	2	3	3	2	2	3

Unit-1	**INTRODUCTION**	**9 Periods**
Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards.		
Unit-2	**LAND SCAPE AND BUILDING ENVELOPES**	**9 Periods**
Energy efficient Landscape design – Microclimate, Shading, Arbors, Windbreaks, Xeriscaping, Building envelope – Thermal comfort, Psychrometry, Comfort indices, Thermal Properties of Building Materials – Thermal Resistance, Thermal Time Constant (TTC), Diurnal Heat Capacity(DHC),Thermal Lag, Decrement Factor, Effect of Solar Radiation –.		
Unit-3	**PASSIVE HEATING AND COOLING**	**9 Periods**
HVAC introduction, Passive Heating – Solar radiation basics, Sun Path Diagram, Direct Heating, Indirect Heating and Isolated heating, Concept of Day lighting, Passive Cooling– Natural Ventilation(Stack and Wind),Evaporative Cooling and Radiative Cooling.		
Unit-4	**THERMAL PERFORMANCE OF BUILDINGS**	**9 Periods**
Heat transfer due to fenestration / infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings		
Unit-5	**RENEWABLE ENERGY IN BUILDINGS**	**9 Periods**
Introduction of renewable sources in buildings, BIPV, Solar water heating, small wind turbines, stand- alone PV systems, Hybrid system–Economics.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources		1. ASHRAEHandbook-2009-Fundamentals. 2. BaruchGivoni:ClimateconsiderationsinbuildingandUrbanDesign,JohnWiley&Sons,1998 3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons,15-Jul-1994 4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley& Sons, 2006. 5. Jan F. Kreider, Peter S.Curtiss, Ari Rabl, Heating and cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press,28-Dec-2009.

Learning Assessment				
Continuous Learning Assessment (CLA) (40% weightage)				**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**			
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24EE007	Course Name	Government Rules, Opportunities, Testing and Certification of Electric Vehicles	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Electrical and Electronics Engineering		**Data Book / Codes / Standards**	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Provide an understanding of the overall electric vehicle (EV) ecosystem, including its components and government initiatives promoting EV adoption.
- Familiarize students with the various government rules, standards, and regulatory frameworks related to EV design, manufacturing, and operation.
- Enable students to apply their knowledge to identify business, research, and employment opportunities in the emerging EV sector.
- Develop analytical skills to evaluate testing methods, certification standards, and safety protocols for EVs and charging systems.
- Encourage analytical thinking in assessing new technologies, policies, and case studies for sustainable and compliant EV system development.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the structure of the electric vehicle ecosystem and various government initiatives promoting EV adoption.	UN	3	1	–	–	–	2	3	1	–	1	-	2	2	1	3
CO-2:	Understand the regulatory framework, standards, and policies governing EV design, manufacturing, and operation.	UN	3	2	–	–	2	3	3	1	–	1	2	2	2	2	3
CO-3:	Apply knowledge of the EV value chain to identify potential business and employment opportunities in the EV sector.	AP	2	2	3	–	2	2	2	1	2	2	3	3	2	2	3
CO-4:	Analyse testing procedures and certification standards for EV components, vehicles, and charging infrastructure.	AN	3	3	2	3	3	2	2	1	–	1	2	2	3	3	2
CO-5:	Analyse emerging technologies, policies, and case studies to propose compliant and sustainable EV solutions.	AN	2	3	2	2	3	3	3	2	2	2	2	3	3	2	3

Unit-1	**INTRODUCTION**	**9 Periods**
Overview of Electric Vehicle (EV) ecosystem – Classification and components of EVs – Overview of Indian and Global EV market – Government initiatives for EV promotion – National Electric Mobility Mission Plan (NEMMP), FAME I & II schemes – State EV policies and incentives – Institutional framework: Ministry of Heavy Industries, NITI Aayog, BIS, ARAI, ICAT – Environmental and socio-economic impacts of EV adoption.		
Unit-2	**GOVERNMENT RULES AND REGULATIONS**	**9 Periods**
EV policies and regulatory structure in India – Central Motor Vehicle Rules (CMVR) – Vehicle registration, licensing, taxation, and insurance for EVs – Battery safety and recycling regulations – Standards for charging infrastructure (AC/DC) – Grid integration norms – Legal framework for EV retrofitting and conversions.		
Unit-3	**OPPORTUNITIES IN EV SECTOR**	**9 Periods**
EV value chain and business opportunities – Battery manufacturing, charging infrastructure, and service sectors – Start-up ecosystem and government funding schemes – Make in India and Production Linked Incentive (PLI) schemes – Skill development and employment potential in EV domain – Case studies on successful EV start-ups – Investment and policy-driven opportunities.		

Unit-4	TESTING AND CERTIFICATION	9 Periods
Testing protocols for EV subsystems – Battery pack testing (performance, safety, abuse tests) – Motor and power electronics testing – Vehicle-level performance tests: range, acceleration, efficiency, safety – Charging station testing and interoperability – Certification standards: AIS, BIS, ISO, IEC – Role of testing agencies: ARAI, ICAT, CIRT – Type approval and conformity of production (COP) processes.		
Unit-5	**FUTURE TRENDS AND CASE STUDIES**	**9 Periods**
Emerging technologies: solid-state batteries, wireless charging, V2G integration – Smart charging and renewable energy coupling – Policy evolution for sustainable EV ecosystem – Case studies: Indian EV implementation and international benchmarks – Challenges and opportunities in rural and urban EV adoption – Mini project: formulation of a testing and certification plan for an EV subsystem or charging station.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley, 2012. 2. M.A. Rashid, Electric Vehicle Systems and Standards, Springer, 2021. 3. Government of India, FAME Scheme and EV Policy Documents, Ministry of Heavy Industries.	1. Electric Vehicle Technology Explained (2nd Edition) by James Larminie & John Lowry – Wiley. A broad and accessible book on EV design, components, batteries, fuel cells and applications. 2. Modern Electric Vehicle Technology by C. C. Chan & K. T. Chau – Oxford University Press. Covers multidisciplinary aspects including propulsion, system-level simulation, energy sources. **3.** Handbook of Power Electronics in Autonomous and Electric Vehicles edited by Muhammad H. Rashid – Elsevier/Academic Press. More advanced; good for power-electronics, charging, and testing of EV/drive systems.

Learning Assessment				
Continuous Learning Assessment (CLA) (40% weightage)				**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**			
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24EEO08	Course Name	PLC and Automation	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering		Data Book / Codes / Standards	Nil	

Course Objective: ***The purpose of learning this course is to:***

- Understand the fundamentals, need, and emerging trends in industrial automation.
- Explain the architecture, programming, and networking of Programmable Logic Controllers (PLC).
- Describe the structure and functionality of Distributed Control Systems (DCS) and SCADA systems.
- Develop Virtual Instrumentation systems for industrial applications.
- Apply Industrial Internet of Things (IIoT) technologies for automation, data management, and connectivity.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Gain the knowledge on fundamentals of automation.	UN	3	2	2	3	2	2	2	1	2	2	1	2	1	1	3
CO-2:	Understand the concepts of PLC.	UN	3	3	3	3	3	3	2	1	2	2	2	2	2	2	3
CO-3:	Understand the concepts of DCS and SCADA	UN	3	3	3	3	3	3	2	1	2	2	2	2	2	2	3
CO-4:	Analyse Virtual Instrumentation for engineering processes.	AN	3	3	3	3	3	3	2	1	2	2	2	2	2	2	3
CO-5:	Apply the concepts of Industrial Internet of Things (IIoT) to develop automation solutions for various industrial systems.	AP	3	3	3	3	3	3	3	2	2	2	3	3	1	3	3

Unit-1	**INTRODUCTION TO AUTOMATION**	**9 Periods**
Sensing and actuation, Communication – Globalization and emerging issues – Cyber Physical systems - Cyber security - Challenges and prospective of AI and 5G enabled technologies – Effect of integrated IT systems on enterprise competitiveness - requirement for automation – Automation system controllers, Industry 4.0 and 5.0 standards.		
Unit-2	**INTRODUCTION TO PLC**	**9 Periods**
PLC –– Hardware – Internal architecture – Ladder and functional block programming – IL, SFC and ST programming methods - Communication Networks for PLC – Case study.		
Unit-3	**DCS AND SCADA**	**9 Periods**
Distributed Control System – Functional components- Diagnostics & IOS – Controllers – Work station – Features of Distributed Control System – Functional Safety – SCADA – RTU – Communication technologies – Operator Interface – Case study		
Unit-4	**VIRTUAL INSTRUMENTATION**	**9 Periods**
Virtual Instrumentation (VI) – Architecture – Programming Techniques – Front Panel and Block diagram – Data flow programming – G programming concepts – Creating and saving VIs – Wiring, Editing and Debugging of Vis – Creating Sub Vis – Control structures – Nodes – Arrays – Cluster controls and indicators – Error handling – Case Study.		
Unit-5	**INDUSTRIAL INTERNET OF THINGS**	**9 Periods**
INDUSTRIAL INTERNET OF THINGS: Introduction – Architecture – Sensing, communication – Big data analytics – Security and Fog computing, cloud computing- Internet for energy – Case Study		

		Total Theory: 45 Periods
	Text Books	**References**
Learning Resources		1. Lamb, Frank, "Industrial Automation: Hands-On", 1st Edition, New York: McGraw-Hill Education, 2013. 2. Mehta B.R and Reddy Y.J, "Industrial Process Automation Systems: Design and Implementation", Waltham MA: Butterworth-Heinemann, 2015. 3. Giacomo Veneri , Antonio Capasso, " Hands on Industrial Internet of things" , Packt, 2018 4. Labview based Advanced Instrumentation systems, S. Sumathi & P. Surekha, Springer Publications, 2018 Edition 5. Dag H. Hanssen, Programmable Logic Controllers, A Practical Approach to IEC 61131-3 using CODESYS, John Wiley & Sons Ltd., 2015 6. David Bailey & Edwin Wright, "Practical SCADA for Industry'', Elsevier 2010.

Learning Assessment				
Continuous Learning Assessment (CLA) (40% weightage)				**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**			
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%				

Course Code	24ECO01	Course Name	MICRO SENSORS& NANO SENSORS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics & Communication Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the fundamental concepts of microsensors and Micro technology
- Provide knowledge of different types of micro sensors and actuators, including their operating principles and performance characteristics.
- Explain various microfabrication techniques used in MEMS device development such as lithography, etching, and deposition processes.
- Develop understanding of MEMS materials and packaging technologies required to ensure device reliability and performance.
- Familiarize students with nanosensors and emerging nanotechnology-based sensing systems used in advanced applications.

			ProgramOutcomes(PO)												ProgramSpecific Outcome(PSO)		
Course Outcomes(CO): ***At the end of this course,learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the principles and role of microsensors in various engineering applications.	U	3	2	-	-	1	-	1	-	-	-	-	-	2	1	3
CO-2:	Classify different types of microsensors and actuators used in MEMS and analyze their characteristics.	AN	3	3	-	2	2	-	-	-	-	-	-	-	3	1	3
CO-3:	Select the appropriate microfabrication techniques for developing MEMS devices.	AP	3	2	3	-	2	-	-	-	-	-	-	-	3	1	3
CO-4:	Choose suitable materials and packaging technologies for MEMS devices.	AP	3	2	3	-	2	-	1	-	-	-	-	-	2	1	3
CO-5:	Categorize various nanosensors and explain their characteristics and applications.	AN	2	3	-	2	2	-	1	-	-	-	-	-	2	1	3

UNIT 1 **INTRODUCTION TO MICROSENSORS** ***9 Periods***

Need for miniaturization, Microsystems versus MEMS, micro fabrication, smart materials, structures and systems, integrated mi crosystems: micromechanical structures, microsensors, microactuators, applications of smart materials and microsystems. Applications of MEMS in the automotive, health care, aerospace, industrial products, consumer products and telecommunications.

UNIT 2 **MICROSENSORS AND ACTUATORS** ***9 Periods***

Silicon capacitive accelerometer, piezo resistive pressure sensor, conductometric gas sensor, electrostatic comb drive, a magnetic micro relay, portable blood analyzer, piezoelectric inkjet print head, micromirror array for video projection, micro-PCR systems, smart materials and systems.

UNIT 3 **MICROFABRICATION TECHNOLOGIES** ***9 Periods***

Silicon as a material for micromachining, Thin-film deposition, lithography, doping, etching, silicon micromachining: bulk and surface, specialized materials for microsystems: polymers and ceramic materials, advanced processes for micro fabrication: wafer bonding techniques, dissolved wafer processes, LIGA process, HexSil process.

UNIT 4	MEMS PACKAGING	9 Periods
Overview of Mechanical Packaging of Microelectronics, Micro-system Packaging, Interfaces in Micro-system Packaging, Essential Packaging Technologies, Three-Dimensional Packaging, Assembly of MEMS, Selection of Packaging Materials, Signal Mapping and Transduction, Design Case: Pressure Sensor Packaging.		
UNIT 5	**NANOSENSORS**	**9 Periods**
Introduction to nano sensors, mechanical nano sensors, thermal nano sensors, magnetic nano sensors, optical nano sensors, chemical nano sensors and nano biosensors.		
		Total: 45 Periods

	TextBooks	References
Learning Resources	1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, Micro and Smart Systems, Wiley India, 2010. 2. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, Wiley, 2008. 3. Vinod Kumar Khanna, Nano sensors: Physical, Chemical and Biological, Series in Sensors, CRC press Taylor and Francis Group, 2012.	1. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley, 2006. 2. Mohamed GadelHak , The MEMS Handbook, University of Notre Dame, 3. M.-H. Bao, “Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes”, Elsevier, New York, 2000 4. M.J. Madou, "Fundamentals of Microfabrication",3rd Ed, CRC, 2011

Learning Assessment		
Continuous Learning Assessment(CLA)(40%weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ECO02	Course Name	FUNDAMENTALS OF VLSI	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electronics & Communication Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- To understand the Basic NMOS, CMOS & BiCMOS circuits and their process technology.
- To design of stick diagrams and layouts for MOS transistors.
- To learn the concepts of modelling of Delay techniques and MOS layers.
- To learn the concepts of Technology Scaling of MOS transistors.
- To learn methods of testing Combinational and sequential circuits

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the Basic NMOS, CMOS & BiCMOS circuits and their process technology.	U	3	2	-	-	-	-	-	-	-	-	-	-	3	1	2
CO-2:	Designing of stick diagrams and layouts for MOS transistors.	U	2	2	3	-	2	-	-	-	-	-	-	-	3	2	2
CO-3:	Learn the concepts of modeling of Delay techniques and MOS layers.	U	3	2	-	1	-	-	-	-	-	-	-	-	3	2	2
CO-4:	Learn the concepts of Technology Scaling of MOS transistors.	U	3	2	-	1	-	-	-	-	-	-	-	-	2	1	3
CO-5:	Understand the concepts of testing of combinational and sequential circuits and also the scan of design techniques	U	2	2	2	-	2	-	-	-	-	-	-	-	2	3	2

Unit-1	**INTRODUCTION OF MICROELECTRONICS AND MOS TECHNOLOGY**	***9 Periods***
Introduction MOS and related VLSI technology – NMOS-CMOS-BICMOS-GaAas Technologies – thermal aspects of processing – production of E beam masks.		
Unit-2	**MOS AND BICMOS CIRCUIT DESIGN PROCESS**	***9 Periods***
MOS layers – stick diagrams – design rules and layout - CMOS rules – Layout diagrams – CMOS Sub System Design: Introduction, Addition/Subtraction, Single bit addition, Full adder design, XOR/XNOR circuits		
Unit-3	**BASIC CIRCUIT CONCEPTS**	***9 Periods***
Sheet resistance – Area capacitance of layers – Delay unit – Wiring capacitances – Choice of layers – Basic passive components (R, C) – RC time constant – Power dissipation in digital circuits.		
Unit-4	**SCALING OF MOS CIRCUITS**	***9 Periods***
Scaling of MOS circuits: Scaling modesl – Scaling function for device parameters – Limitation of Scaling- Subsystem design process: Architectural issues – switch logic – examples of structural design (Combinational logic)– design of ALU subsystem – commonly used storage elements.		
Unit-5	**TEST AND TESTABILITY**	***9 Periods***
Test and Testability: Design for testability built in self test (BIST) – teaching combinational logic – testing sequential logic – practical design for test guide lines – scan design techniques		
	Total:	**45 Periods**

	Text Books	References
Learning Resources	1. Basic VLSI design by Douglas A, Pucknell, Kamran Eshraghian, Prantice Hall, 1996 3rd edition	1. Mead, C.A and Conway, L.A., Introduction to VLSI Systems, Wesley – Wesley.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24ECO03	Course Name	MASS COMMUNICATION	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics & Communication Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce students to the basic concepts and principles of mass communication.
- Understand the role and evolution of mass media in society.
- Familiarize students with digital media technologies and social media communication
- Understand media ethics, laws, and responsible communication
- Enable students to analyze media influence on public opinion and society.

Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Understand the basic concepts and process of communication	U	2	1								2		1	1	2	2
CO-2:	Explain the evolution and functions of different mass media.	U	2	2								2		1	1	1	3
CO-3:	Analyze the role of digital media and communication technologies	AN	1	2		2						2		1	2	2	3
CO-4:	Understand media ethics, laws and responsible media practices.	U	1	1				2				2		1	1	3	2
CO-5:	Apply mass communication concepts in advertising, PR and digital communication.	AP	1	1	1	2					2	2		1	2	2	3

Unit-1 **INTRODUCTION TO COMMUNICATION** ***9Periods***

Communication: Definition – Process of communication – Elements of communication – Types of communication: Intrapersonal, Interpersonal, Group communication and Mass communication. Models of communication: Shannon and Weaver Model, Lasswell Model, Berlo's SMCR Model. Characteristics and functions of mass communication.

Unit-2 **EVOLUTION OF MASS MEDIA** ***9 Periods***

History and development of mass media – Print media – Radio broadcasting – Television – Cinema. Functions of mass media: Information, Education, Entertainment and Persuasion. Role of media in modern society.

Unit-3 **DIGITAL MEDIA AND NEW COMMUNICATION TECHNOLOGIES** ***9 Periods***

New media and digital communication – Internet communication – Social media platforms. Blogs, podcasts, online journalism, video streaming platforms. Impact of digital media on communication and society.

Unit-4 **MEDIA ETHICS AND MEDIA LAWS** ***9 Periods***

Media ethics – Objectivity – Privacy – Bias in media – Fake news and misinformation. Media regulations and laws – Press regulations – Broadcasting regulations. Copyright, intellectual property rights and plagiarism

Unit-5 **APPLICATIONS OF MASS COMMUNICATION** ***9 Periods***

Advertising: Concepts and objectives – Types of advertising media. Public Relations: Meaning – Functions – PR strategies – Corporate communication. Digital marketing – Media influence on public opinion – Media literacy

Total: 45 Periods

	Text Books	References
Learning Resources	1. Keval J. Kumar, Mass Communication in India, Jaico Publishing House. 2. Denis McQuail, Mass Communication Theory, Sage Publications.	1. Baran, Stanley J., Introduction to Mass Communication, McGraw Hill. 2. Ralph Hanson, Mass Communication: Living in a Media World, Sage Publications. 3. Joseph Turow, Media Today, Routledge.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ECO04	Course Name	SENSOR TECHNOLOGIES	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Electronics & Communication Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamentals of sensors, actuators, and transducers along with their characteristics and measurement principles.
- To study different sensing and transduction principles such as resistive, inductive, capacitive, thermal, magnetic, and piezoelectric sensors.
- To learn the interface electronic circuits used for signal conditioning, data conversion, and transmission in sensor systems.
- To explore the architecture, fabrication, and communication standards of smart sensors and smart sensor networks.
- To analyze the applications of various sensors in fields such as motion detection, pressure measurement, biosensing, vibration monitoring, and industrial systems.

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain fundamentals of Sensors & Transducers	U	3	1			1							1	2	1	3
CO-2:	Describe physical principles of sensing	U	3	2			1							1	2	1	3
CO-3:	Compare various sensor materials and technology used in designing sensors	AN	2	3	1		1							1	3	1	3
CO-4:	Select appropriate sensor for given application	AP	2	3	2	1	2							1	3	2	3
CO-5:	Recognize the latest trends in the field of sensor	R	1	1			1							2	2	1	3

Unit-1	**SENSORS FUNDAMENTALS AND CHARACTERISTICS**	***9 Periods***
Sensor, actuator and transducer, Signals and Systems; Sensor Classification: passive and active Sensor, absolute and relative Sensor; Units of Measurements; Sensor Characteristics: Transfer Function, Calibration, Nonlinearity, Saturation Repeatability, Dead Band, Resolution.		
Unit-2	**PRINCIPLE OF SENSING & AMP TRANSDUCTION**	***9 Periods***
Mechanical and Electromechanical sensor, Resistive (potentiometric type), Strain gauge, Inductive sensor: common types- Reluctance change type, LVDT, Capacitive Sensors, Thermal Sensors, Magnetic Sensors, Proximity Sensor, Piezoelectric Effect.		
Unit-3	**INTERFACE ELECTRONIC CIRCUITS**	***9 Periods***
Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.		
Unit-4	**SMART SENSOR TECHNOLOGIES**	***9 Periods***
Architecture of Smart Sensor: Features, Fabrication of Sensor and Smart Sensor, Integration of Micromachining and Microelectronics, Wafer bonding, LIGA process, Standard of Smart Sensor Network, Communication for smart sensors.		
Unit-5	**SENSORS IN DIFFERENT APPLICATION AREA**	***9 Periods***
Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors Neuro sensors, Biosensors, MEMS Sensors, Sensors for Mechanical Shock, Machinery Vibration Monitoring Sensors, Humidity Sensors, Electromagnetism in Sensing.		
	Total:	**45 Periods**

	Text Books	References
Learning Resources	1. John S.Wilson “Sensor Technology” 4TH edition,Elsevier.2005 2. Jacob Fraden “Sensor Technology Design & Application”4thedition, Springer .2010 3. Frank “Understanding Smart Sensors”2nd Ed.2002.	1. Ramon P. A. and Webster J. G., “Sensors and Signal Conditioning” 2nd 2001 Ed., John Wiley and Sons. 2. Feng Z. and Leonidas G., “Wireless Sensor Networks”, Elsevier Eastern Limited. 2007 3. Barney G., “Intelligent Instrumentation”, Prentice-Hall International Editions 4. Yamasaki H., “Intelligent Sensors”, Elsevier Eastern Limited. 1996

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ECO05	Course Name	NANOMATERIALS AND DEVICES	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics & Communication Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understanding the evolution of nanomaterials and different types of nanomaterials for future engineering applications
- Learning the influence of dimensionality on the mechanical, electrical, optical and magnetic properties of nanomaterials
- Understanding different synthesis and processing techniques used for fabricating nanomaterials
- Gaining knowledge of characterization techniques used to analyze nanomaterials
- Acquiring knowledge of nanodevices and applications of nanomaterials in different engineering fields

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the fundamental concepts and classification of nanomaterials	U	3	1										1	2	1	3
CO-2:	Analyze the influence of dimensionality on the mechanical, electrical, optical and magnetic properties of nanomaterials	AN	3	2	1	3	2							1	3	1	3
CO-3:	Describe the synthesis and processing techniques used for the fabrication of nanomaterials	U	3	2		2								1	2	1	3
CO-4:	Select appropriate characterization techniques to analyze the structure and properties of nanomaterials	AP	3	2		2								1	3	1	3
CO-5:	Analyze the working principles of nanodevices and their applications	AN	3	2	1	3	2							1	3	2	3

Unit-1 **NANOMATERIALS** ***9 Periods***

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

Unit-2 **THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS** ***9 Periods***

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

Unit-3 **PROCESSING** ***9 Periods***

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

Unit-4 **STRUCTURAL CHARACTERISTICS** ***9 Periods***

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis.

Unit-5 **NANODEVICES AND APPLICATIONS** ***9 Periods***

Introduction to nanodevices, carbon nanotube-based devices, quantum dot devices, nanowire-based devices, nanosensors and biosensors, applications of nanomaterials and nanodevices in electronics, energy systems, medical technology, environmental protection, and nanocoatings.

Total: 45 Periods

Learning Resources	Text Books	References
	1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007. 2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, roperties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.	1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003. 2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004. 3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008. 4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000. 5. Gutkin Y., Ovid’ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60%)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ECO06	Course Name	MACHINE LEARNING FOR ELECRONICS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses		Progressive Courses	
Course Offering Department	Electronics & Communication Engineering	**Data Book / Codes / Standards**			

Course Objective: ***The purpose of learning this course is to:***

- To introduce fundamental concepts of machine learning.
- To understand data preprocessing and feature extraction techniques for electronic signals.
- To apply supervised and unsupervised learning methods in electronics applications.
- To design ML-based models for real-time electronic systems.
- To implement ML algorithms in embedded and biomedical applications.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Describe basic concepts and applications of ML in electronics	U	3	2	-	-	-							2	2	2	3
CO-2:	Apply preprocessing and feature extraction techniques on electronic data	AP	3	3	2	2	2							2	3	2	3
CO-3:	Analyze supervised and unsupervised learning algorithms	AN	3	3	2	3	2							2	3	2	3
CO-4:	Design ML models for electronic system applications	AN	3	3	3	3	3				1	1	1	3	3	3	3
CO-5:	Implement ML solutions in real-time electronics applications	AP	3	3	3	3	3	1			2	2	1	3	3	3	3

Unit-1 **INTRODUCTION TO MACHINE LEARNING**	***9 Periods***
Fundamentals of machine learning, types of machine learning such as supervised, unsupervised and reinforcement learning, comparison of machine learning with traditional programming, data types and datasets in electronics, applications of machine learning in signal processing, communication systems, biomedical engineering and IoT systems	
Unit-2 **DATA PROCESSING & FEATURE ENGINEERING**	***9 Periods***
Data acquisition from sensors including EEG, ECG and IoT devices, signal preprocessing techniques such as filtering, normalization and artifact removal, feature extraction using time-domain methods like mean, variance and RMS, frequency-domain methods such as FFT and power spectral density, time-frequency analysis using wavelet transform, dimensionality reduction using principal component analysis	
Unit-3 **SUPERVISED LEARNING TECHNIQUES**	***9 Periods***
Regression techniques including linear regression and logistic regression, classification methods such as k-nearest neighbors, support vector machines, decision trees and naïve Bayes, training and testing of models, performance evaluation metrics including accuracy, precision, recall and confusion matrix, cross-validation techniques	
Unit-4 **UNSUPERVISED LEARNING AND DEEP LEARNING**	***9 Periods***
Clustering techniques including k-means and hierarchical clustering, dimensionality reduction and visualization, fundamentals of artificial neural networks, introduction to deep learning models such as convolutional neural networks and recurrent neural networks, applications in image processing and time-series signal analysis	
Unit-5 **APPLICATIONS OF ML IN ELECTRONICS**	***9 Periods***
Machine learning applications in biomedical systems such as ECG and EEG signal classification, fault detection and diagnosis in electronic circuits, machine learning for communication systems, IoT and edge AI applications including TinyML, real-time implementation using Python and MATLAB	
Total:	**45 Periods**

Learning Resources	Text Books	References
	1. Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer 2. Machine Learning – Tom M. Mitchell, McGraw Hill	1. Introduction to Machine Learning with Python – Andreas C. Müller and Sarah Guido, O'Reilly Media 2. Deep Learning – Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press 3. Machine Learning Applications in Electronic Design Automation – Haoxing Ren and Jiang Hu, Springer 4. Analog Circuits for Machine Learning – Pieter Harpe, Kofi A.A. Makinwa and Andrea Baschirotto, Springer

Learning Assessment

Continuous Learning Assessment (CLA) (40% weightage)		End Semester Examination (60%)
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24ECO07	Course Name	WIRELESS AND MOBILE COMMUNICATION	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics & Communication Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamental concepts of wireless and mobile communication systems and their evolution.
- To study the design principles of cellular systems including frequency reuse, co-channel interference, and capacity improvement techniques.
- To analyze frequency management strategies and channel assignment methods used in cellular networks.
- To understand different multiple access techniques used in wireless communication
- To learn the concepts of handoff mechanisms and mobility management in cellular communication systems.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the principles of wireless communication systems and compare wireless and mobile communication technologies.	U	3	2	-	-	-	-	-	-	-	-	-	-	2	1	3
CO-2:	Understand cellular system design parameters such as frequency reuse and co-channel interference.	U	3	2	-	1	-	-	-	-	-	-	-	-	3	1	3
CO-3:	Evaluate frequency management and channel allocation techniques in cellular networks.	AN	3	3	1	2	-	-	-	-	-	-	-	-	3	2	3
CO-4:	Understand multiple access techniques in wireless communication systems.	U	3	2	-	1	-	-	-	-	-	-	-	-	2	1	3
CO-5:	Apply and evaluate handoff mechanisms and mobility management in cellular systems.	AP	3	3	2	2	-	-	-	-	-	-	-	-	3	2	3

Unit-1	**INTRODUCTION TO MOBILE COMMUNICATION**	***9 Periods***
Difference between wireless and mobile, Advantage, Disadvantage and Applications of Wireless communication, Evolution of Mobile Radio Communication, Paging and Messaging system, Cordless Telephone System, Mobile Radio Systems around the world, examples of Wireless Communication Systems, Cellular Systems.		
Unit-2	**FUNDAMENTALS OF CELLULAR RADIO SYSTEM DESIGN**	***9 Periods***
Concept of Frequency Reuse, Co-Channel Interference, Co-Channel Interference Reduction Factor, Desired C/I from a Normal Case in a Omni Directional Antenna System, System Capacity Improving Coverage and Capacity in Cellular Systems- Cell Splitting, Sectoring, Microcell Zone Concept.		
Unit-3	**FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT**	***9 Periods***
Spatial reuse- Numbering and Grouping, Setup Access and Paging Channels, Channel Assignments to Cell Sites and Mobile Units, Co-channel interference Analysis- Erlang Capacity Analysis- Spectral efficiency and Grade of Service, Erlang formulas		
Unit-4	**MULTIPLE ACCESS TECHNIQUES FOR WIRELESS COMMUNICATION**	***9 Periods***
Introduction to multiple access, FDMA, TDMA, CDMA, Spread spectrum multiple access, Space division multiple access, and OFDMA		
Unit-5	**HANDOFFS AND MOBILITY MANAGEMENT**	***9 Periods***
Handoff Initiation, types of Handoff, Delaying Handoff, advantages of Handoff, Power Difference Handoff, Forced Handoff, Mobile Assisted and Soft Handoff, Intersystem handoff, handoff and dropped Call Rates and Dropped Calls Evaluation.		

	Total: 45 Periods

	Text Books	References
Learning Resources	1. Theodore S. Rappaport: “Wireless Communications, Principles and Practice”, Pearson Education Asia, 2nd edition, 2002. 2. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Person Education, 3rd edition, 2004.	1. William C Y Lee. “Mobile Communications Engineering Theory and Applications”, Second Edition, McGraw Hill Telecommunication,2002. 2. Andrea Goldsmith, “Wireless Communications”, Cambridge University press, 2007. 3. William Stallings. “Wireless Communications and Networks”, Pearson Education Asia. 4. T. L. Singal. “Wireless Communication”, McGraw Hill Education (India).

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ECO08	Course Name	IOT AND ITS APPLICATIONS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Electronics & Communication Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To study the fundamentals about IoT
- To study about IoT Access technologies
- To study the design methodology and different IoT hardware platforms.
- To study the basics of IoT Data Analytics and supporting services.
- To study about various IoT case studies and industrial applications.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basics of IoT.	U	3	2	-	-	1	-	-	-	-	-	-	-	2	1	3
CO-2:	Implement the state of the Architecture of an IoT.	AP	3	2	2-	1	2	-	-	-	1	-	-	-	3	2	3
CO-3:	Understand design methodology and hardware platforms involved in IoT.	U	3	2	2	1	2	-	-	-	-	-	-	-	3	2	3
CO-4:	Understand how to analyze and organize the data.	AN	3	3	-	-	2	-	-	-	-	-	-	-	3	3	3
CO-5:	Compare IOT Applications in Industrial & realworld.	AN	2	2	1	2	1	2	1	-	-	-	-	-	2	2	3

Unit-1	**FUNDAMENTALS OF IoT**	***9 Periods***
Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.		
Unit-2	**IoT PROTOCOLS**	***9 Periods***
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions,Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport ,Methods: SCADA, Application Layer, Protocols: CoAP and MQTT.		
Unit-3	**DESIGN AND DEVELOPMENT**	***9 Periods***
Design Methodology, Embedded computinglogic, Microcontroller, System on Chips, IoT system building blocks,IoT Platform overview: Overview of IoT supported Hardware platforms such as:Raspberry pi, Arduino Board details		
Unit-4	**DATA ANALYTICS AND SUPPORTING SERVICES**	***9 Periods***
Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M,Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.		
Unit-5	**CASE STUDIES/INDUSTRIAL APPLICATIONS**	***9 Periods***
IoT applications in home infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments, Industry 4.0 concepts.		
	Total:	**45 Periods**

Learning	**Text Books**	**References**

Resources	1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017 2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015 3. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill HigherEducation	1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit2). 2. "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence",Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014. 3. Architecting the Internet of Things,Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer,2011. 4. Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition,Michael Margolis,Arduino Cookbook and O"Reilly Media,2011.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MEO01	Course Name	INTRODUCTION TO MEMS AND NEMS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	Nil	**Progressive Courses**	NIL
Course Offering Department	Mechanical Engineering	**Data Book / Codes / Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- To introduce Nano-and Microsystems
- To understand the modeling of micro and nano scale electromechanical systems
- To conceptualize organic and inorganic Sensors
- To understand the Photoelectric Effect and magneto-optical phenomena
- To identify and regonize the future Nanosystems..

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Acquire the knowledge of Nano-and Microsystems.	U	3	2	2	3	2								1	-	2
CO-2:	Identify the methods of modelling of micro and nano scale electromechanical systems	AP	3	2	2	3	2								2	1	2
CO-3:	Classify organic and inorganic enabled sensors	AP	3	2	2	3	2								1	-	2
CO-4:	Learn various Physical effects of sensors	U	3	2	2	3	2								1	-	2
CO-5:	Identify the future of Nanomachines	U	3	2	2	3	2								1	-	3

Unit-1	**INTRODUCTION TO MEMS AND NEMS**	***9 Periods***
MEMS and NEMS definitions, Taxonomy of Nano-and Microsystems-Synthesis and Design. Classification and considerations, Biomimetics, Biological analogies, and design–Biomimetics Fundamentals, Biomimetics for NEMS and MEMS, Nano-ICs and Nanocomputer architectures.		
Unit-2	**MODELING OF MICRO AND NANO SCALE ELECTROMECHANICAL SYSTEMS**	***9 Periods***
Introduction to modelling, analysis and simulation, basic electro-magnetic with application to MEMS and NEMS, modeling developments of micro-and nano actuators using electromagnetic-Lumped-parameter mathematical models of MEMS, energy conversion in NEMS and MEMS.		
Unit-3	**INORGANIC AND ORGANIC ENABLED SENSORS**	***9 Periods***
Introduction-types of sensors-Mechanical, optical, spintronic, bioelectronic and biomagnetic sensors-surface modification-surface materials and interactions and its examples		
Unit-4	**SENSOR CHARACTERISTICS AND PHYSICAL EFFECTS**	***9 Periods***
Introduction to sensors, static Characteristics and dynamic characteristics, Physical effects : - Photoelectric Effect, Photoluminescence Effect, Electroluminescence Effect, Chemiluminescence Effect, Doppler Effect , Hall Effect, thermoelectric effect, magneto-optical phenomena		
Unit-5	**FUTURE NANOSYSTEMS**	***9 Periods***
Nano machines, nano robots, electronics based on CNT, molecular Electronics. Quantum Computation: Future of Meso/Nanoelectronics -Interfacing with the Brain, towards molecular medicine, Lab-on-BioChips- Guided evolution for challenges and the solutions in Nano-Manufacturing technology.		
	Total:	**45 Periods**

Learning	**Text Books**	**References**

Resources	1. Sergey Edward Lyshevski, Lyshevski Edward Lyshevski, Micro-Electro Mechanical and Nano-Electro Mechanical Systems, Fundamental of Nano-and Micro-Engineering 2005, 2nd Ed., CRC Press. 2. A. S. Edelstein and Cammarata, Nanomaterials: Synthesis, Properties and Applications,2002, Institute of Physics, Bristol, Philadelphia	1. Zheng Cui, Nanofabrication, Principles, Capabilities and Limits, 2008, Springer 2. Kalantar–Zadeh K, Nanotechnology Enabled Sensors, 2008, Smpringer. 3. Serge Luryi, Jimmy Xu, Alex Zaslavsky, Future trends in 3Micro Electronics, 2007, John Wiley & Sons, Inc. Hoboken, New Jersey.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MEO02	Course Name	ENERGY CONSERVATION AND MANAGEMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	Nil	Progressive Courses	NIL
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.	U	3	3	2		2		3					2	-	-	1
CO-2:	Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion	AP	3	3	2		2		3					2	-	-	1
CO-3:	Skills on combustion thermodynamics and kinetics.	AP	3	3	2		2		3					2	1	-	1
CO-4:	Apply calculation and design tube still heaters.	U	3	3	2		2		3					2	1	-	1
CO-5:	Studied different heat treatment furnace with burner design.	U	3	3	2		2		3					2	-	-	1

Unit-1	**INTRODUCTION**	***9 Periods***
Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.		
Unit-2	**ELECTRICAL SYSTEMS**	***9 Periods***
Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination		
Unit-3	**THERMAL SYSTEMS**	***9 Periods***
Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories		
Unit-4	**ENERGY CONSERVATION IN MAJOR UTILITIES**	***9 Periods***
Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets		
Unit-5	**ECONOMICS**	***9 Periods***
Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept		
	Total:	**45 Periods**

Learning Resources	Text Books	References
	1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.	1. Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988. 2. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981. 3. Dryden. I.G.C., “The Efficient Use of Energy” Butterworths, London, 1982 4. Turner. W.C., “Energy Management Hand book”, Wiley, New York, 1982. 5. Murphy. W.R. and G. Mc KAY, “Energy Management”, Butterworths, London 1987

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MEO03	Course Name	Fundamentals of Additive Manufacturing	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand the Fundamentals of Additive Manufacturing (AM)
- Develop Design Skills for AM Applications
- Explore Software Tools for AM
- Analyse Medical and Industrial Applications of AM
- Evaluate and Optimise AM Processes

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1:	Describe the fundamentals, evolution, and business opportunities of Additive Manufacturing.	U	3	2	1	1	1							2	-	-	1
CO-2:	Apply Additive Manufacturing design guidelines and utilise relevant CAD and slicing software tools for developing product models	AP	3	3	3	2	3							2	2	1	2
CO-3:	Demonstrate major AM processes and fabricate parts using extrusion and VAT polymerisation techniques.	AP	3	3	3	2	3							2	1	-	2
CO-4:	Analyse sheet lamination, directed energy deposition, jetting, and hybrid AM processes.	AN	3	3	2	3	2							2	1	-	2
CO-5:	Evaluate Rapid Tooling methods and industrial applications of Additive Manufacturing through case studies.	E	3	3	2	2	2							2	1	-	2

Unit-1	**INTRODUCTION**	***9 Periods***
Overview – Distinction between traditional manufacturing and AM – Evolution of Additive Manufacturing (AM) - AM Process workflow - Classification – Benefits. AM Standards - AM Considerations-Business and Societal Implications of AM -Economic aspects.		
Unit-2	**DESIGN FOR ADDITIVE MANUFACTURING (DfAM)**	***9 Periods***
AM Unique Capabilities- Need for DfAM- Design consideration in AM- Part Consolidation - Topology Optimization- Generative Design- Lightweight Structure - DfAM for Part Quality Improvement. CAD Model Preparation - File formats for AM (STL, PLY, VRML, AMF) - Part Orientation and Support Structure Generation - Model Slicing - Tool Path Generation.		
Unit-3	**PHOTO POLYMERISATION, MATERIAL EXTRUSION, AND POWDER BED FUSION PROCESSES**	***9 Periods***
Photo polymerisation: Stereo lithography Apparatus (SLA) - Materials - Process - Capabilities - Applications. Digital Light Processing (DLP) - Materials – Process - Capabilities - Applications. Continuous Liquid Interface Production (CLIP) - Materials - Process - Capabilities and Applications. Extrusion Based System: Fused Deposition Modeling (FDM) - Process – TypesMaterials - Applications. Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Materials - Application. Multijet fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Principle - Process - Capabilities and Applications.		
Unit-4	**SHEET LAMINATION, DIRECT ENERGY DEPOSITION, BINDER AND MATERIAL JETTING PROCESSES**	***9 Periods***
Sheet Lamination Process: Laminated Object Manufacturing (LOM) - Basic Principle Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and		

Limitation Direct Energy Deposition Process: Laser Engineered Net Shaping (LENS) and Wire Arc Additive Manufacturing (WAAM) - Process -Material Delivery - Process Parameters -Materials - Capabilities – Industrial Applications. Binder and Material Jetting: Three- imensional Printing - Materials - Physics of 3DP – Process- Types of printing – Material - Capabilities - Application. Hybrid Additive Manufacturing – Need - Principles - Synergy in Hybrid AM Materials - Part Quality - Process Efficiency.		
Unit-5	**APPLICATION OF ADDITIVE MANUFACTURING**	***9 Periods***
Rapid tooling - Direct tooling - Indirect tooling – Soft tooling - ridge tooling. Rapid Tooling for Investment Casting, sand casting, Injection molding. Case Studies/Application: Aerospace - Automotive industries, Medical - Healthcare - Architecture - Construction - Food Printing -Printing Electronics - Consumer products - Fashion.		
		Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Gibson, Ian, David Rosen, Brent Stucker, Mahyar Khorasani, Ian Gibson, David Rosen, Brent Stucker, and Mahyar Khorasani. "Design for additive manufacturing." Additive manufacturing technologies (2021), ISBN: 978-3-030-56126-0. 2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2016, ISBN: 978-1- 56990-582-1.	1. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020. 2. Additive Manufacturing, Second Edition, Amit Bandyopadhyay, Susmita Bose, CRC Press, Taylor & Francis Group, 2020, ISBN- 978-1-4822-2360-6. 3. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017. 4. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, Second Edition, CRC Press., United States, 2020, ISBN 9781032238593. 5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MEO04	Course Name	Lean Six Sigma	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	Nil	Progressive Courses	NIL
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- To provide a strong foundation in Lean and Six Sigma principles.
- To equip students with practical tools and techniques for process improvement.
- To develop skills in Six Sigma methodologies and risk management.
- To address challenges in Six Sigma implementation.
- To promote continuous improvement and waste elimination.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply foundational quality frameworks and performance metrics to quantify the financial impact of process variation.	U	3	2										1	1	3	1
CO-2:	Deploy diagnostic and problem-solving tools to eliminate operational bottlenecks and optimize workflow efficiency.	AP	3	3	2	2									2	3	1
CO-3:	Implement risk mitigation models and design frameworks to proactively prevent failures and manage change.	U	3	2										1	2	3	2
CO-4:	Execute structured deployment plans and project management strategies to navigate operational and cultural challenges.	AP	2	3	3	2									1	3	2
CO-5:	Utilize continuous improvement methods and economic metrics to eliminate operational waste and maximize ROI.	AP	2	3	3	2	1						2	2	1	3	2

Unit-1 **LEAN & SIX SIGMA BACKGROUND AND FUNDAMENTALS** ***9 Periods***

Historical Overview – Definition of quality – What is six sigma -TQM and Six sigma - lean manufacturing and six sigma- six sigma and process tolerance – Six sigma and cultural changes – six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ), Cost of Doing Nothing – assessment questions

Unit-2 **THE SCOPE OF TOOLS AND TECHNIQUES** ***9 Periods***

Tools for definition – IPO diagram, SIPOC diagram, Flow diagram, CTQ Tree, Project Charter – Tools for measurement – Check sheets, Histograms, Run Charts, Scatter Diagrams, Cause and effect diagram, Pareto charts, Control charts, Flow process charts, Process Capability Measurement, Tools for analysis – Process Mapping, Regression analysis, RU/CS analysis, SWOT, PESTLE, Five Whys, interrelationship diagram, overall equipment effectiveness, TRIZ innovative problem solving – Tools for improvement – Affinity diagram, Normal group technique, SMED, 5S, mistake proofing, Value stream Mapping, forced field analysis – Tools for control – Gantt chart, Activity network diagram, Radar chart, PDCA cycle, Milestone tracker diagram, Earned value management.

Unit-3 **SIX SIGMA METHODOLOGIES** ***9 Periods***

Design For Six Sigma (DFSS), Design for Six Sigma Method - Failure Mode Effect Analysis (FMEA), FMEA process - Risk Priority Number (RPN)- Six Sigma and Leadership, committed leadership – Change Acceleration Process (CAP)- Developing communication plan – Stakeholder

Unit-4	SIX SIGMA IMPLEMENTATION AND CHALLENGES	9 Periods
Tools for implementation – Supplier Input Process Output Customer (SIPOC) – Quality Function Deployment or House of Quality (QFD) – alternative approach – implementation – leadership training, close communication system, project selection – project management and team – champion training – customer quality index – challenges – program failure, CPQ vs six sigma, structure the deployment of six sigma – cultural challenge – customer/internal metrics		
Unit-5	**EVALUATION AND CONTINUOUS IMPROVEMENT METHODS**	***9 Periods***
Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S.		
		Total: 45 Periods

	Text Books	References
Learning Resources	1. Michael L. George Lean Six Sigma: Combining Six Sigma Quality with Lean Speed, McGraw-Hill 2002, ISBN-13: 978-0071385213 2. The Six Sigma Handbook, 5th Edition, Thomas Pyzdek , Paul A. Keller, McGraw-Hill 2021, ISBN-13 : 978-9354601965	1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill 2003, ISBN-13: 978-0071426688. 2. Lean Six Sigma for Leaders: A Practical Guide for Leaders to Transform the Way They Run Their Organization, Martin Brenig-Jones, Jo Dowdall , 2018, ISBN-13 : 978-1119374749 3. Fred Soleimannejed, Six Sigma, Basic Steps and Implementation, Author House, 2004, ISBN-13: 978-1418448011. 4. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, Managing Six Sigma: A Practical Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, 2000, ISBN-13: 978-0471396734. 5. James P. Womack, Daniel T.Jones, Lean Thinking, Free Press Business, 2003. ISBN-13: 978-0743249270.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MEO05	Course Name	Agriculture Technology	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	NIL	**Progressive Courses**	NIL
Course Offering Department	Mechanical Engineering	**Data Book / Codes / Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand the Fundamentals of Agricultural Technology
- quip Students with Knowledge of Agricultural Machinery
- Introduce Post-Harvest and Processing Technologies
- Explore Precision Agriculture and Robotics
- Promote Sustainable Agricultural Practices and Renewable Energy Use

Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**Program Outcomes (PO)**												**Program Specific Outcome (PSO)**		
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Demonstrate Knowledge of Soil and Water Management	AP	3	2					3					2	-	-	1
CO-2:	Operate and Maintain Agricultural Machinery	AP	2	2	3		2							2	-	-	1
CO-3:	Apply Post-Harvest Technologies	AP	2	2	2		2							2	1	-	1
CO-4:	Utilize Advanced Technologies in Agriculture	AN	2	3	2	2	3							2	2	1	3
CO-5:	Adopt Sustainable and Renewable Practices	AP	2	2			2		3	2				3	1	-	2

Unit-1	**OIL AND WATER MECHANICS**	***9 Periods***
Soil composition - classification, and properties-Tillage - Principles, types of tillage - soil tillage equipment-Overview of irrigation methods- design of irrigation systems - water distribution methods- Fundamentals of field drainage and its significance in crop production.		
Unit-2	**AGRICULTURAL MACHINERY**	***9 Periods***
Tractors and Power Units - Classification, components, and operating principles- Crop Production Equipment- Plows, harrows, seeders, and cultivators: types and applications- Harvesting Equipment - Combine harvesters, reapers, and threshers: construction and operation-Maintenance of Agricultural Machinery - Preventive maintenance - safety measures - troubleshooting.		
Unit-3	**POST-HARVEST TECHNOLOGY**	***9 Periods***
Post-Harvest Processes - Cleaning, grading, and material handling techniques - Storage Technology - Grain storage structures (silos, warehouses) and temperature control systems- Processing of Agricultural Produce - Overview of milling, drying, and packaging methods - Automation in Post-Harvest Systems - Sensors, robotics, and AI applications in post-harvest management.		
Unit-4	**PRECISION AGRICULTURE AND ROBOTICS**	***9 Periods***
Precision Agriculture - Concepts, applications of GPS and GIS in farming - Sensor Technology - Soil and crop monitoring sensors - principles and applications - Agricultural Drones - Role of drones in field mapping - spraying - monitoring - Autonomous Tractors - Design, components, and challenges in implementation.		
Unit-5	**SUSTAINABLE AGRICULTURE AND ENERGY SYSTEMS**	***9 Periods***
Renewable Energy in Agriculture - Solar- wind- bioenergy applications in farming- Energy Efficiency - Role of energy-efficient machines in agriculture - Sustainable Practices- Conservation tillage - integrated pest management - and organic farming - Environmental Impact- Assessing mechanization's effects on soil, water, and air.		
	Total:	**45 Periods**

Learning Resources	Text Books	References
	1. Rajendra Prasad, Text Book of Field Crop Production. Directorate of Information and Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi, 2015. 2. . Saroja Raman, Agricultural Sustainability – Principles, Processes and Prospects, CRCPress, 2013 3. R.A. Kepner, Roy Bainer, E.L. Berger, "Principles of Farm Machinery" Springer, 2005	1. Bose T. K. and L.P.Yadav. Commercial Flowers, Naya Prakash, Calcutta.1989 2. Irrigation water Management, Training Manual No 6, Drainage of Irrigated Lands, Food and Agriculture Organisation, Rome 1996. 3. Peart, R.M., and Shoup, W. D., “Agricultural Systems Management”, Marcel Dekker, New York, 2004. 4. K. Rajesh Arumugam, "Agricultural Robotics: Mechanisms and Practice", CRC Press, 2021

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MHO01	Course Name	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To get a knowledge of working on Industrial robots and their load handling capacity
- To enlist with an application of robots in various operation
- To familiar with a material handling system
- To impart the knowledge on robotic welding
- To obtain the knowledge on various type of robot welding operation

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply the concepts of industrial robots to identify suitable robot configurations in industry	AP	3	2	2									1	1	-	2
CO-2:	Analyze the factors influencing robot selection and evaluate appropriate manufacturing procedures for robotic implementation.	AN	3	2	2	2		1					1	1	1	-	2
CO-3:	Analyze various material handling and manufacturing processes to determine efficient system design in robotic environments.	AN	3	2	2	2	2	1	1				1	1	1	-	2
CO-4:	Apply robotic welding techniques and programming methods to perform and optimize welding operations.	AP	3	2	2	1	3				1			1	2	1	2
CO-5:	Analyze real-world robotic applications in manufacturing and develop an optimized plan for robotic system integration..	AN	3	3	3	2	2	1	1		1		2	2	2	1	3

Unit-1 **INDUSTRIAL ROBOTS AND MATERIAL HANDLING SYSTEMS** ***9 Periods***

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell

Unit-2 **SELECTION OF ROBOTS AND OTHER APPLICATIONS** ***9 Periods***

Factors influencing the choice of a robot - robot performance testing - economics of robotisation - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

Unit-3 **MATERIAL HANDLING** ***9 Periods***

concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design software.

Unit-4 **ROBOTIC WELDING** ***9 Periods***

Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding

Unit-5 **APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESS**	***9 Periods***
Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications	
	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. John J Craig, —Introduction to Robotics: Mechanics and control, Pearson, 2009,4th Ed, 2018. ISBN-13: 978-0133489798, ISBN-10: 0133489795 2. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019. ISBN-13: 978-9361592959 (Pearson India/Anna University Edition) or 978-0134605463 (Global 5th Ed) 3. Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010. □ ISBN-13: 978-1852339531 (Print), eText ISBN: 978-1846281914	1. Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013 2. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006. ISBN-10: 0137820534 ISBN-13: 9780137820535 3. Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, AshishDutta,"Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd2012. ISBN-10:1259006212 ISBN-13: 9781259006210 4. Saha S K, —Introduction to Robotics‖, Tata McGraw Hill Education Pvt. Ltd,2010, 2 nd Ed, 2014. ISBN-10: 9332902801, ISBN-13: 9789332902800

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MHO02	Course Name	ROBOTICS AND AUTOMATION	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Robotics	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To teach the need of embedded system technology for robot building.
- To study the Various Parts of Robots and Fields of Robotics.
- To study the Various Kinematics and Inverse Kinematics of Robots.
- To study the Trajectory Planning for Robot.
- To study the Control of Robots for Some Specific Applications

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply embedded boards in robots	AP	3	2	1		2							1	2	1	3
CO-2:	Demonstrate the concepts of robotics & automation and Working of Robot	AP	3	2	1		1							1	2	1	3
CO-3:	Analyze the Function of Sensors and actuators In the Robot	AN	3	3	2	2	2							1	2	1	3
CO-4:	Develop Program to Use a Robot for a Typical Application	AP	3	2	3	1	3				1			1	3	3	3
CO-5:	Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on Embedded system based robot development	AP	2	3	3	2	2	1	1		1	1	1	2	2	2	3

Unit-1	**FUNDAMENTALS OF ROBOTICS & AUTOMATION**	***9 Periods***
Fundamentals of Robotics & Automation – Principles and Strategies of Automation System –Hardware and software for Automation- Embedded Processors for Automation- Different Types of Robots – Various Generations of Robots – Asimov’s Laws Of Robotics – Key components of a robot – Design Criteria for Selection of a Robot – Role of embedded system in Robotics and Automation – Recent trends.		
Unit-2	**SENSORS AND DRIVE SYSTEMS**	***9 Periods***
Hydraulic, Pneumatic And Electric Drive Systems – Understanding how motor power, current torque, friction co-efficient affect the design of a Robot – Determination of Motor HP and Gearing Ratio – Variable Speed Arrangements. Sensors – Classification based on sensing type (including Optical, Acoustic, Magnetic) – Proximity Sensors – Ranging Sensors – Speed & Displacement Sensing – Tactile Sensors – Vision Sensing – Smart Sensors – MEMS sensors.		
Unit-3	**MANIPULATORS AND GRIPPERS**	***9 Periods***
Introduction to Manipulators – Joints and Degrees of Freedom – Construction of Manipulators – Manipulator Dynamics And Force Control – Electronic And Pneumatic Manipulator Control Circuits – End Effectors – Various Types Of Grippers – Design Considerations.		
Unit-4	**KINEMATICS AND PATH PLANNING**	***9 Periods***
Kinematic Equations – Forward and Inverse Kinematics – Solution Of Inverse Kinematics Problem – Jacobian based Velocity Kinematics– Various Path Planning Algorithms – Hill Climbing Techniques – Robot Operating System – Simulation and modeling of a simple Path Planning application.		

Unit-5 ROBOTIC APPLICATIONS AND CASE ANALYSIS	9 Periods
Robot Cell Design – Humanoid Robot – Robots in healthcare applications – Robot Machine Interface – Robots in Manufacturing and Non-Manufacturing Applications – Self balancing robots – Micro/nano robots.	

Total: 45 Periods

	Text Books	References
Learning Resources	1. Jaulin, Luc. Automation for robotics. John Wiley & Sons, 2015. ISBN-13: 978-1848217980, 2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998. ISBN-13: 978-0122818455. 3. Groover, Mikell P. Automation, production systems, and computer-integrated manufacturing. Pearson Education India, 2016. ISBN-13: 978-9332572492.	1. Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An Integrated Approach", Prentice Hall of India, New Delhi, 1994, ISBN-13: 9780137820535 2. Mc Kerrow P.J. "Introduction to Robotics", Addison Wesley, USA, 1991, ISBN-13: 9780201182408 3. Issac Asimov "Robot", Ballantine Books, New York, 1986, ISBN-13: 9780345314826 4. Barry Leatham – Jones, "Elements of Industrial Robotics" PITMAN Publishing, 1987, ISBN-13: 9780273027270 5. MikellP.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology, Programming And Applications ", McGraw Hill Book Company 1986, ISBN-13: 9780070249899 6. Fu K.S. Gonzaleaz R.C. And Lee C.S.G., "Robotics Control Sensing, Vision and Intelligence" McGraw Hill International Editions, 1987, ISBN-13: 9780070226258

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MHO03	Course Name	AUTONOMOUS MOBILE ROBOTS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Robotics	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce mobile robotic technology and its types in detail
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors
- To acquaint the localization strategies and mapping technique for mobile robot
- To aware the collaborative mobile robotics in task planning, navigation and intelligence

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Apply the principles of mobile robot locomotion and design to select suitable robots for different applications.	AP	3	2	1		1	1						1	2	1	3
CO-2:	Analyze the performance and characteristics of sensors used in mobile robots for perception and intelligent operation.	AN	3	3	2	2	2							1	2	1	3
CO-3:	Analyze the kinematics of wheeled and legged robots to evaluate mobility and motion constraints.	AN	3	3	2	2	1							1	2	1	2
CO-4:	Develop the localization strategies and mapping technique for mobile robot.	AP	3	3	3	2	3				1	2		1	3	2	3
CO-5:	Analyze the collaborative mobile robotics for planning, navigation and intelligence fordesired applications.	AN	3	3	3	2	2	1	1		1	1	1	2	3	2	3

Unit-1 **OVERVIEW OF MOBILE ROBOTICS** ***6 Periods***

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues –Unmanned Aerial and Underwater Vehicles – Teleportation and Control.

Unit-2 **KINEMATICS** ***9 Periods***

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints– Degree of Mobility and Steerability – Maneuverability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control – Humanoid Robot - Kinematics Overview

Unit-3 **PERCEPTION** ***9 Periods***

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Vision Based Sensors – Uncertainty - Statistical Representation - Error Propagation - Feature Extraction based on Range Data (Laser, Ultrasonic, Vision-Based Ranging) - Visual Appearance based Feature Extraction.

Unit-4 **LOCALIZATION**	***12 Periods***
The Challenge of Localization - Sensor Noise and Aliasing - Effector Noise – Localization Base Navigation Versus Programmed Solutions - Belief Representation – Single - Hypothesis Belief And Multiple-Hypothesis Belief - Map Representation - Continuous Representations - Decomposition Strategies - Current Challenges In Map Representation - Probabilistic Map-Based Localization - Markov Localization - Kalman Filter Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Stochastic Map Technique - Other Mapping Techniques. Simultaneous Localization and Mapping (SLAM).	
Unit-5 **PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS** ***9 Periods***	
Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.	
	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2011. 2nd Edition. ISBN-13: 978-0262015356, ISBN-10: 0262015358	1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018. ISBN-10: 0128119954 ISBN-13: 9780128119952 2. MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015. SBN-10: 3659692024, ISBN-13: 9783659692024 3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017 ISBN-10: 3319544130, ISBN-13: 9783319544137 4. Robin R. Murphy, “ Introduction to AI Robotics” The MIT Press, ISBN: 9780262038485, 2019. 2nd Edition 5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009. 6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978- 1107031159.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MHO04	Course Name	INTRODUCTION TO DRONE TECHNOLOGIES	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Unmanned Aerial Vehicle	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the basics of drone concept
- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO)												Program Specific Outcome (PSO)		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Apply drone concepts & selection invarious type of drone technology, drone fabrication and programming.	AN	3	2	1		1							1	2	1	2
CO-2:	Apply drone operation procedures and Execute the suitable operating procedures for functioning a drone	AP	3	2	1		2							1	1	0	2
CO-3:	Select appropriate sensors and actuators for Drones	AN	3	3	2	2	2							1	2	1	3
CO-4:	Develop a drone mechanism for specific applications	AP	3	2	3	1	2				1			1	3	2	3
CO-5:	Create the programs for various drones	AN	3	3	2	2	2	1	1		1	1	1	2	3	3	3

Unit-1 **FUNDAMENTALS OF DRONE TECHNOLOGY** ***9 Periods***

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability.

Unit-2 **DRONE DESIGN, FABRICATION AND PROGRAMMING** ***9 Periods***

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

Unit-3 **DRONE FLYING AND OPERATION** ***9 Periods***

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

Unit-4 **DRONE COMMERCIAL APPLICATIONS** ***9 Periods***

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

Unit-5 **FUTURE DRONES AND SAFETY** ***9 Periods***

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.

Total: 45 Periods

Learning Resources	Text Books	References
	1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc, ISBN-13: 978-1119534310 2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016, ISBN-13: 978-1680450514	1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016, ISBN-13: 9780789758934 2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018, ISBN-13: 9783319730967

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MHO05	Course Name	MEDICAL MECHATRONICS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Mechatronics	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Mechatronics Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand how to measure biochemical parameters and various physiological information
- To study the need and technique of electrical safety in hospitals.
- To study the use of radiation for diagnostic and therapy
- To study about recorders and advanced equipment in medicine
- To study about computational tools for biomedical data processing

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain different measurement techniques used in physiological parameters measurement.	U	2	2	1									1	1	-	2
CO-2:	Demonstrate the use of sensors and signal conditioning circuits for biomedical applications.	AP	2	2	2									1	2	1	2
CO-3:	Examine the performance of amplifiers, recording units and display devices used in biomedical applications.	AN	2	3	1									1	1	1	2
CO-4:	Differentiate the working of recorders and explain the advanced systems used in medicine	AN	2	3	1									1	1	-	3
CO-5:	Implement biomedical diagnostic instruments for healthcare and clinical applications.	AP	2	2	2									1	2	2	3

Unit-1 **INTRODUCTION** ***9 Periods***

Cell structure – electrode – electrolyte interface, electrode potential, resting and action potential –electrodes for their measurement, ECG, EEG, EMG – machine description – methods of measurement – three equipment failures and trouble shooting

Unit-2 **TRANSDUCERS FOR BIO-MEDICAL INSTRUMENTATION** ***9 Periods***

Basic transducer principles Types – source of bioelectric potentials – resistive, inductive, capacitive, fiber-optic, photoelectric and chemical transducers – their description and feature applicable for biomedical instrumentation – Bio & Nano sensors & application

Unit-3 **SIGNAL CONDITIONING, RECORDING AND DISPLAY** ***9 Periods***

Input isolation, DC amplifier, power amplifier, and differential amplifier – feedback, op-Amp- Electrometer amplifier, carrier Amplifier – instrument power supply. Oscillographic – galvanometric - X-Y, magnetic recorder, storage oscilloscopes – electron microscope – PMMC writing systems –Telemetry principles – Bio telemetry

Unit-4 **MEDICAL SUPPORT** ***9 Periods***

Electrocardiograph measurements – blood pressure measurement: by ultrasonic method – Plethysmography – blood flow measurement by electromagnetic flow meter cardiac output measurement by dilution method – phonocardiography – vector cardiography Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry – laser equipment and application – cardiac pacemaker – DC– defibrillator patient safety - electrical shock hazards. Centralized patent monitoring system.

Unit-5	BIO-MEDICAL DIAGNOSTIC INSTRUMENTATION	9 Periods
Introduction – computers in medicine – basis of signal conversion and digital filtering data Reduction technique – time and frequency domain technique – ECG Analysis.		
		Total: 45 Periods

Learning Resources	Text Books	References
	1. Arumugam.M. "Biomedical Instrumentation", Anuradha Agencies Publishers, Kumbakonam, 2006. ISBN 9798187721122 2. Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Printice Hall of india , 2014. ISBN 9788120306530 3. Siamak Najarian" Mechatronics in Medicine – A Bio medical engg approach", McGraw – Hill Education, 2011. ISBN 9780071768979	1. Geddes L.A., and Baker, L.E., "Principles of Applied Bio-medical Instrumentation", 3rd Edition, John Wiley and Sons, 2010. ISBN 9780471608998 2. Khandpur, R.S., "Handbook of Biomedical Instrumentation", McGraw Hill,2024, 3rd Edition. ISBN 9789355328021 3. N. Vyas, S. Khalid, "Biomedical Signal Processing", Laxmi Publications,2012 ISBN 9789381159040.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MHO06	Course Name	SENSORS AND ACTUATORS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Sensors and Instrumentation	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Mechatronics Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To provide foundational knowledge of measurement principles and sensor technologies
- To develop understanding of the operating principles, construction, characteristics, and applications of variable resistance and inductance sensors
- To familiarize students with advanced and special-purpose sensors
- To impart knowledge on various automotive actuators
- To understand and analyze automatic temperature control systems

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the common types of sensor and actuators used in vehicles.	U	2	2	1		1							1	1	-	2
CO-2:	Implement instrumentation techniques for measuring pressure, force, temperature and flow parameters.	AP	2	2	2	1	1							1	2	1	2
CO-3:	Examine the design aspects of sensors and actuators used in automotive applications.	AN	2	3	2	1	2							1	2	1	2
CO-4:	Analyze the operation of sensors, actuators and electronic control systems.	AN	2	3	1	1	1							1	2	1	2
CO-5:	Develop temperature control actuator systems for automotive applications.	AN	2	2	3	1	2							1	2	2	3

Unit-1	**INTRODUCTION TO MEASUREMENTS AND SENSORS**	***9 Periods***
Sensors: Functions- Classifications- Main technical requirement and trends Units and standards-Calibration methods- Classification of errors- Error analysis- Limiting error-Probable error-Propagation of error- Odds and uncertainty- principle of transduction- Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers-Dynamic characteristics of first and second order transducers for standard test inputs.		
Unit-2	**VARIABLE RESISTANCE AND INDUTANCE SENSORS**	***9 Periods***
Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT		
Unit-3	**VARIABLE AND OTHER SPECIAL SENSORS**	***9 Periods***
Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers- Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.		
Unit-4	**AUTOMOTIVE ACTUATORS**	***9 Periods***
Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.		

Unit-5	**AUTOMATIC TEMPERATURE CONTROL ACTUATORS**	***9 Periods***
Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.		
		Total: 45 Periods

Learning Resources	**Text Books**	**References**
	1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN. Manik McGraw Hill Publishers, 2019. ISBN 9780070173385 2. K.V.Fadadu, B.H.Kadiya, " Automotive Computer controlled System", BOOKS INDIA PUBLICATIONS,2018, 3rd Edition. 3. William Kimberley," Bosch Automotive Handbook", 11th Edition, Robert Bosch GmbH, 2022. ISBN 9780470519363 4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN 978-3-658-01783-5.	1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013. ISBN 9780134074733 2. Hollembeak, Barry. Today's Technician: Automotive Electricity and Electronics, Classroom and Shop Manual Pack. Cengage Learning, 2014. ISBN 9780357766385 3. R.Y.Borse, " Sensors and Transducers: Principles and Applications, Adhyayan Publishers, 2008. ISBN 978-8184350524 4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012. ISBN 9780080970981

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MHEO07	Course Name	MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)	Course Category	T	Professional Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Sensors and Instrumentation	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Recognize MEMS Energy Domains and Transducers, Sensors and Actuators.	U	2	2	1		1						1	1	1	-	2
CO-2:	Select the Various MEMS sensors and its Stress and strain	U	2	2	1	1	1						1	1	2	-	2
CO-3:	Apply various MEMS actuators in Real time system.	AP	2	1	1		1						1	1	2	1	3
CO-4:	Demonstrate various micro machining processes, Structural and Sacrificial Materials	AP	2	1	1		2						1	1	1	-	1
CO-5:	Analyze the various MEMS inertial, tactile, pressure and flow sensors in real time system	AN	2	1	1		1						1	1	2	1	3

Unit-1 **INTRODUCTION**	***9 Periods***
Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices –Polymers in MEMS– Polyamide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon.	
Unit-2 **SENSORS**	***9 Periods***
Characteristics of sensors - Electrostatic sensors – Parallel plate capacitors – Piezoresistive sensors – Piezoresistive sensor materials - Stress and strain analysis – Flexural beam bending - Torsional deflection– Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials	
Unit-3 **ACTUATORS**	***9 Periods***
Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications –Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators -Actuation using Shape Memory Alloys	
Unit-4 **MICROMACHINING**	***9 Periods***
Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching– Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antirestriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process	

Unit-5	APPLICATIONS OF MEMS INERTIAL SENSORS	9 Periods
Application to Acceleration, Inertia, Acoustic, Tactile, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors -Actuators for Active Optical MEMS.– RF MEMS and Microfluidics.		
	Total:	**45 Periods**

	Text Books	References
Learning Resources	1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2014, 2nd edition. ISBN 978-0-13-249736-7 2. Stephen D Senturia, "Microsystem Design", Springer-Verlag New York Inc. Publication, 2013. ISBN 9781475774573 3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2017. ISBN 978-0-470-08301-7	1. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010, ISBN 978-0-8247-5824-0 2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2013, ISBN 9788126540822 3. Cornelius T. Leondes, "The MEMS Handbook", Springer Verlag, 2006, ISBN 9780387245201 4. Eun Sok Kim," Fundamentals of Micro Electro Mechanical System", McGraw Hill, 2021. ISBN 9781264257591 5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer 2011, ISBN 9781489984210

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MHO08	Course Name	INDUSTRY 4.0	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Computer Integrated Manufacturing	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Mechatronics Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Describe the evolution and key drivers of Industry 4.0 and its relevance to mechatronics systems.
- Understand and explain foundational technologies (IoT, IIoT, cyber-physical systems, big data, cloud) and how they integrate with mechatronics.
- Analyse the interoperability and communication standards (RAMI4.0, OPC-UA, TSN) in smart manufacturing.
- Illustrate concepts of a connected factory: digital twin, smart logistics, predictive maintenance, AR/VR, and traceability.
- Propose a mechatronics-based Industry 4.0 solution (for example a smart machine or production cell) by combining sensors, actuators, embedded devices, networked systems and data analytics.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain different technologies used in Industry 4.0 and its applications.	U	2	2	1	1	1	1				1		2	2	1	3
CO-2:	Perform AI/ML-based analytics in an Industry 4.0 framework.	AP	3	2	2	1	2	1				1		2	3	2	3
CO-3:	Develop cyber-physical system models for Industry 4.0 applications.	AP	3	3	2		3		1			1		2	3	2	3
CO-4:	Solve interoperability issues in smart manufacturing using standards like OPC-UA and TSN.	AP	3	3	2	2	3		1			2		2	2	3	3
CO-5:	Illustrate augmented reality (AR) and cloud-based applications in smart factories.	AP	3	3	2	2	3	1						3	2	2	3

Unit-1 **Introduction to Industry 4.0** ***9 Periods***

The four industrial revolutions: from mechanisation, electrification, computerisation to Industry 4.0. Definition of Industry 4.0; comparison of conventional automation vs Industry 4.0 factory. Drivers, enablers, compelling forces, challenges for Industry 4.0; digitalisation & network-economy.

Unit-2 **Basic principles & components of Industry 4.0** ***9 Periods***

Internet of Things (IoT) / Industrial IoT (IIoT) / Internet of Services (IoS). Big Data, Smart Manufacturing, Smart Logistics. Product customisation, Digital Twins, cloud applications in manufacturing.

Unit-3 **Cyber-Physical Systems (CPS) in Mechatronics, AI/ML Analytics** ***9 Periods***

Core elements of CPS: real-time requirements, self-organization, communication in CPS.Modelling and programming of CPS; model-integrated development. AI & Machine Learning based analytics for smart manufacturing / mechatronics systems.

Unit-4 **Interoperability & Communication Standards** ***9 Periods***

Industrial communication networks: Ethernet/IP, PROFINET, Profibus, EtherCAT etc. Reference Architecture Model for Industry 4.0 (RAMI4.0) and service-oriented architecture. OPC (classic) vs OPC-UA, services, system architecture; OPC-UA + cloud. Time-Sensitive Networking (TSN): architecture, standards, benefits of adoption. Case studies of OPC-UA/TSN implementations. (Assignment/case study)

Unit-5 **Connected Factory / Smart Manufacturing**	***9 Periods***
Virtualisation, Augmented Reality (AR) in manufacturing; integrating design and manufacturing. Data visualisation, work-piece traceability using QR codes, RFID, beacon tags. Big data in production; Cloud-based ERP and MES solutions for smart manufacturing. Case Study: digital twin in a production cell; modular smart machine design; sustainability and ethical aspects.	
	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016, ISBN 978-1-4842-2046-7. 2. "Industrial Internet of Things: Cyber Manufacturing Systems", Sabina Jeschke et al., Springer, 2017, ISBN 978-3-319-42558-0.	1. "Digital Twin Driven Smart Manufacturing", Fei Tao et al., Elsevier, 2019, ISBN 978-0-12-817630-6.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24BM001	Course Name	FUNDAMENTALS OF RADIOLOGICAL EQUIPMENTS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	NIL	**Progressive Courses**	NIL
Course Offering Department	Biomedical Engineering	**Data Book / Codes / Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- To understand X-ray generation and its medical imaging applications.
- To study the basic principles of Computed Tomography
- To know the techniques used for visualizing various sections of the body.
- To learn the principles of different radio diagnostic equipment in Imaging.
- To discuss the radiation therapy techniques and radiation safety

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Describe the working principle of the X-ray machine and its application.	U	3	2	1	1	3	1					2		1		1
CO-2:	Illustrate the principle computed tomography	U	3	2	1	1	3	1					2		1		1
CO-3:	Interpret the technique used for visualizing various sections of the body using Magnetic Resonance Imaging.	U	3	2	1	1	3	1					2		1		1
CO-4:	Demonstrate the applications of radionuclide imaging.	U	3	2	1	1	3	1					2		1		1
CO-5:	Analyze different imaging techniques and choose appropriate imaging equipment for better diagnosis and outline the methods of radiation safety.	AN	3	2	2	2	3	2					2		1		1

Unit-1 **X-RAYS** ***9 Periods***

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography - discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.

Unit-2 **COMPUTED TOMOGRAPHY** ***9 Periods***

Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors – Viewing systems – spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques – back projection and iterative method.

Unit-3 **MAGNETIC RESONANCE IMAGING** ***9 Periods***

Fundamentals of magnetic resonance- properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system – system magnet (Permanent, Electromagnet and Superconductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, electronic components, fMRI.

Unit-4 **NUCLEAR IMAGING** ***9 Periods***

Radioisotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera – Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyser. Principles of SPECT and PET

Unit-5	**RADIATION THERAPY AND RADIATION SAFETY**	***9 Periods***
Radiation therapy – linear accelerator, Telegamma Machine. SRS – SRT – Recent Techniques in radiation therapy – 3D CRT – IMRT – IGRT and Cyber knife – radiation measuring instruments Dosimeter, film badges, Thermo Luminescent dosimeters – electronic dosimeter – Radiation protection in medicine – radiation protection principles		
	Total:	**45 Periods**

	Text Books	**References**
Learning Resources	1. Isaac N. Bankman (Ed.), *Handbook of Medical Image Processing and Analysis*, 2nd Edition, Academic Press (Elsevier), 2009. 2. Jacob Beutel (Editor), M. Sonka (Editor), Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis , SPIE Press 2000 3. Khin Wee Lai, Dyah Ekashanti Octorina Dewi "Medical Imaging Technology", Springer Singapore, 2015	1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill Education (India), New Delhi, 4th Edition, 2014. 2. Geoff Dougherty (Ed.), *Medical Image Processing – Techniques and Applications*, Springer, 2011.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24BMO02	Course Name	BIOMEDICAL INSTRUMENTATION BASICS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	NIL	**Progressive Courses**		NIL
Course Offering Department	Biomedical Engineering		**Data Book / Codes / Standards**		NIL	

Course Objective: ***The purpose of learning this course is to:***

- Study about the different bio potential and its propagation.
- Understand the different types of electrodes and its placement for various recordings.
- Study the design of bio amplifiers for various physiological recordings.
- Learn the different measurement techniques for non-physiological parameters.
- Familiarize the different biochemical measurements.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	To Learn the different bio potential and its propagation	R				3		2				1		1			
CO-2:	To get Familiarize the different electrode placement for various physiological recording	U				3		2				1		1			
CO-3:	Students will be able design bio amplifier for various physiological recording	AP	3	3	3	3	2	2				1		1			
CO-4:	Students will understand various technique non electrical physiological measurements	AN			3	3	2	2				1		1			
CO-5:	Understand the different biochemical measurements	AP			3	3	2	2				1		1			

Unit-1 **BIO POTENTIAL GENERATION AND ELECTRODES TYPES** ***9 Periods***

Origin of bio potential and its propagation. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes

Unit-2 **BIOSIGNAL CHARACTERISTICS AND ELECTRODECONFIGURATIONS** ***9 Periods***

Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven‟s triangle,standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode.EMG– unipolar and bipolar mode.

Unit-3 **SIGNAL CONDITIONING CIRCUITS** ***9 Periods***

Need for bio-amplifier - differential bio-amplifier, Impedance matching circuit, isolation amplifiers,Power line interference, Right leg driven ECG amplifier, Band pass filtering

Unit-4 **MEASUREMENT OF NON-ELECTRICAL PARAMETERS** ***9 Periods***

Blood Pressure: indirect methods -Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement.

Unit-5 **BIO-CHEMICAL MEASUREMENT** ***9 Periods***

Blood gas analyzers and Non-Invasive monitoring, colorimeter, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

Total: 45 Periods

Learning Resources	Text Books	References
	1. John G. Webster, “Medical Instrumentation: Application and Design”, Wiley India Pvt Ltd, 4th Edition, 2015. — Covers bio-potential generation, electrodes, bio-amplifiers, ECG/EEG/EMG systems, signal conditioning circuits. 2. R. S. Khandpur, “Handbook of Biomedical Instrumentation”, McGraw-Hill Education, 3rd Edition, 2024. — Comprehensive coverage of biosignal acquisition, non-electrical measurements (blood pressure, blood flow, cardiac output), and biochemical measurement instrumentation. 3. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson, 4th Edition, 2018. — Includes bioelectric signals, electrode types, signal conditioning, and measurement techniques for non-electrical physiological parameters.	1. **Edward J. Terner and John G. Webster, “Bioinstrumentation”, Elsevier, 3rd Edition, 2020.** — Focused on biosignal characteristics, electrodes, amplifier circuits, and modern instrumentation for physiological monitoring. 2. **Leo L. Chua and Anand Kumar, “Biosensors and Biomedical Instrumentation”, CRC Press, 1st Edition, 2021.** — Includes non-invasive blood analysis, biochemical analyzers, and optical/colorimetric biosensors.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24BMO03	Course Name	MEDICAL ROBOTICS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the basic concepts of robot modeling, including kinematics and motion analysis.
- To learn the fundamental principles of robot dynamics and equations of motion.
- To understand how robots plan their paths and trajectories for different tasks.
- To learn the basics of robot control, including linear, nonlinear, and force control methods.
- To know the applications of robots in the medical field, such as surgical and rehabilitation robots.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the applications of robots and the concept of grippers and actuators.	U	3	2	2	1	2	1	1	1	2	1	1	2			
CO-2:	Comprehend the functions of manipulators and basic kinematics.	U	3	3	3	2	3				1	1		2			
CO-3:	Analyze different robotic control mechanism	AN	3	3	3	2	3	1			1	1		2			
CO-4:	Design and analyze the robotic systems for rehabilitation	AN	3	2	3	2	3	1	1	1	2	2	1	3			
CO-5:	Design the wearable robots.	AP	3	2	3	2	3	1	1	1	2	2	1	3			

Unit-1 **INTRODUCTION TO ROBOT MODELING** ***9 Periods***

Position Kinematics: Transformations, Rigid Motions, Forward Kinematics: DenavitHartenberg Convention, Inverse Kinematics. Velocity Kinematics – The Jacobian: Angular and Linear Velocity: Singularities, Accelerations.

Unit-2 **ROBOT DYNAMICS** ***9 Periods***

Equations of Motion, Kinetic and Potential Energy, Euler-Lagrange Equations, Recursive Newton-Euler Formulation

Unit-3 **ROBOT MOTION PLANNING** ***9 Periods***

Path and Trajectory Planning: Path vs. Trajectory, The Configuration Space, Path Planning in Configuration Space, Probabilistic Roadmap Planner, Potential Fields, RRTs, Trajectory Planning, Point To Point Motion, Paths Specified by Via Points.

Unit-4 **ROBOT CONTROL** ***9 Periods***

Linear Control: Feedback and closed-loop control, second-order linear systems, control of second-order systems, Control-law partitioning, trajectory-following control, disturbance rejection, Continuous vs. Discrete time control, modelling and control of a single joint, architecture of an industrial-robot controller. Nonlinear control: Nonlinear and time-varying systems, multi-input, multi-output control systems, control of manipulators, practical considerations, Lyapunov stability analysis, cartesian-based control systems, adaptive control Force Control: Interaction with Environment, Force Control, Hybrid Force/Motion control.

Unit-5 **ROBOT APPLICATIONS IN MEDICAL DOMAIN** ***9 Periods***

SURGICAL ROBOTS: Da Vinci Surgical System, Nanorobotics. REHABILITATION AND ASSISTIVE ROBOTS: Robotic Therapy for the Upper Extremity and Walking, ClinicalBased Gait Rehabilitation Robots, Robotic Exoskeletons – Design considerations, Hybrid assistive limb.

Total: 45 Periods

Learning Resources	Text Books	References
	1.Kevin M. Lynch and Frank C. Park, Modern Robotics: Mechanics, Planning and Control, Cambridge University Press, 2017. 2.Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani and Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer, 2010. 3.Paolo Dario (Ed.), Medical Robotics, Springer, 2021.	1.Saha S. K., Introduction to robotics. Tata McGraw-Hill Education 2. Spong M. W., Hutchinson, S., and Vidyasagar, M., Robot modeling and control. New York: Wiley. 3. O'Kane J. M., A Gentle Introduction to ROS, ISBN 978-1492143239 4. Craig J. J, Introduction to robotics: mechanics and control. Pearson/Prentice Hall. 5. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System 46 Applications & Visions”, Springer, 2011 6. Jocelyn Troccaz, Medical Robotics, Wiley, 2012 7. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24BMO04	Course Name	PRINCIPLES OF TELEMEDICINE	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Learn the key principles for telemedicine and health.
- Understand telemedical technology
- Know telemedical standards, mobile telemedicine and its applications

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyze benefits and limitations of telemedicine	AN	3				3					2					
CO-2:	Apply multimedia technologies in telemedicine	AP	3	1	3							2					
CO-3:	Explain encryption protocols and data security in telemedicine	U			3		3					2					
CO-4:	Develop or understand radiology-based information systems (PACS)	U						1				2					
CO-5:	Apply telemedicine in various healthcare domains (like teleradiology, telesurgery, etc.)	R				1		1				2					

Unit-1	**Apply telemedicine in various healthcare domains (like teleradiology, telesurgery, etc.)**	***9 Periods***
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, telemedicine systems, benefits & limitations of telemedicine		
Unit-2	**Information & Communication Infrastructure for Telemedicine**	***9 Periods***
Audio, video, still images, text and data; Internet; wireless communications (GSM, satellite, microwave); mobile health / ubiquitous healthcare		
Unit-3	**Ethical and Legal Aspects of Telemedicine**	***9 Periods***
Confidentiality, patient rights & consent; patient-doctor relationship; data protection & security; jurisdictional issues; legal/regulatory issues.		
Unit-4	**Picture Archiving and Communication System (PACS)**	***9 Periods***
Radiology Information System (RIS), DICOM, PACS architecture; strategic planning and technical issues for PACS		
Unit-5	**Applications of Telemedicine**	***9 Periods***
Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery etc.		
	Total:	**45 Periods**

	Text Books	References
Learning Resources	1.H K Huang, "PACS and Imaging Informatics: Basic Principles and Applications", Second Edition, Wiley, New Jersey, 2010. 2. Norris A C, - "Essentials of Telemedicine and Telecare", First Edition, John Wiley, New York, 2008. 2.R. S. Khandpur, Telemedicine: Theory and Practice, Elsevier, UpdateTd Edition, 2020. 3.S. L. Rosado, M. L. Young, Telemedicine Technologies: Information Technologies in Telemedicine and Telehealth, CRC Press,Updated Edition, 2023.	1. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006 2. David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008 3.Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers' series, USA, 2006

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24BMO05	Course Name	HOSPITAL MANAGEMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co- requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand the principles of hospital organization, planning, and administration processes.
- Understand human resource management functions and staff development in healthcare organizations.
- Analyze marketing strategies and consumer behavior in the healthcare sector.
- Describe hospital information systems and the management of supportive services.
- Evaluate hospital quality standards, accreditation systems, and safety practices.

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the principles, practices and areas of application in Hospital Management.	U	3						2	2				1			
CO-2:	Understand the biomedical waste disposal concept.	U	3						2	2				1			
CO-3:	Explain the importance of supportive services.	U	3						2	2				1			
CO-4:	Comprehend the quality aspect specified by the international standards.	U	3						2	2				1			
CO-5:	Knowledge on Hospital safety.	U	3						2	2				1			

Unit-1 **OVERVIEW OF HOSPITAL ADMINISTRATION** ***07 Periods***

Distinction between Hospital and Industry, Challenges in Hospital Administration –Hospital Planning – Equipment Planning- AMC – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management.

Unit-2 **HUMAN RESOURCE MANAGEMENT IN HOSPITAL** ***09 Periods***

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.

Unit-3 **MARKETING RESEARCH & CONSUMER BEHAVIOUR** ***10 Periods***

Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations - Consumer Markets & Consumer Buyer behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour - Major types of buying situations - global marketing in the medical sector - WTO and its implications

Unit-4 **HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES** ***10 Periods***

Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services

Unit-5 **QUALITY AND SAFETY ASPECTS IN HOSPITAL** ***09 Periods***

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems. NABA, JCI, NABL, NABH. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.

	Total: 45 Periods

	Text Books	References
Learning Resources	1. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI–4 th Edition,2006. 2.G.D.Kunders, “Hospitals – Facilities Planning and Management”, TMH, New Delhi – 5 th edition Reprint 2007.	1. Cesar A.Caceres and Albert Zara, “The Practice of Clinical Engineering”, Academic Press, New York,1977. 2. Norman Metzger , “Handbook of Health Care Human Resources Management”, Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990. 3. Peter Berman, “Health Sector Reform in Developing Countries”, Harvard University Press, 1995. 4. William A.Reinke, “Health Planning For Effective Management”, Oxford University Press, 1988. 5. Blane, David, Brunner, Eric , “Health and Social organization: Towards a health policy for the 21st century”, Calrendon Press, 1994. 6. Arnold D. Kalcizony & Stephen M.Shortell, “Health Care Management”, 6 th Edition, 2011.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24BMO06	Course Name	BIO MEMS AND APPLICATIONS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	NIL	**Progressive Courses**	NIL
Course Offering Department	Biomedical Engineering	**Data Book / Codes / Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- To understand MEMS materials and master micromachining and fabrication processes.
- To learn the mechanical and thermal principles used to design MEMS sensors and actuators.
- To study electrostatic and piezoelectric mechanisms for MEMS-based sensing and actuation.
- To understand microscale fluid dynamics and microfluidic components used in MEMS devices.
- To explore biomedical MEMS applications including biosensing, drug delivery, and microsystem tools.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Discuss various MEMS fabrication techniques.	U	3	2	1	1	2										
CO-2:	Explain different types of sensors and actuators and their principles of operation at the microscale level.	U	3	2	1	1	2										
CO-3:	Comprehend the characteristics of fluid flow and actuation through micro channels	U	3	2	1	1	2										
CO-4:	Explain the need and use of simulation for MEMS design.	U	3	2	1	1	2										
CO-5:	Design MEMS devices for different medical applications.	U	3	2	1	1	2										

Unit-1	**MEMS MATERIALS AND FABRICATION**	***09 Periods***
Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining- photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.		
Unit-2	**MECHANICAL AND THERMAL - SENSORS AND ACTUATORS**	***09 Periods***
Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor.		
Unit-3	**ELECTROSTATIC, PIEZOELECTRIC SENSORS AND ACTUATORS**	***09 Periods***
Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor,Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.		
Unit-4	**MICROFLUIDIC SYSTEMS**	***09 Periods***
Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale.Microscale fluid, expression for liquid flow in a channel. Fluid actuation methods- electro wetting, thermocapillary effect, electro osmosis, dielectrophoresis. Microfluid dispenser, microneedle, micro pumps- continuous flow system, micromixers.		
Unit-5	**APPLICATIONS OF BIOMEMS**	***09 Periods***
CAD for MEMs, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR),		

DNA sensor, MEMS based drug delivery, electronic nose, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor. Introduction to 3D printing, Introduction to COMSOL Multiphysics.
Total: 45 Periods

	Text Books	References
Learning Resources	1.T. Subhra Santra (Ed.), Microfluidics and BioMEMS: Devices and Applications, Jenny Stanford Publishing, 2020. 2.Gregory Barbillon, Alain Bosseboeuf, Kukjin Chun, Rosaria Ferrigno & Olivier Français (Eds.), Engineering of Micro/Nano Biosystems: Fundamentals & Applications, Springer, 2020. 3. Samira Hosseini, Michelle Alejandra Espinosa-Hernandez & Ricardo Garcia-Ramirez, BioMEMS: Biosensing Applications, Springer, 2021.	1. Wanjun Wang, Stephen A.Soper, “BioMEMS: Technologies and applications”, CRC Press, New York, 2007. 2. Marc J. Madou, "Fundamentals of Microfabrication: the science of miniaturization’’, CRC Press, 2002. 3. Nadim Maluf, Kirt Williams, “An Introduction to Micro electro mechanical Systems Engineering”, Second Edition, Artech House Inc, MA, 2004.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24BMO07	Course Name	FUNDAMENTALS OF BRAIN COMPUTER INTERFACE	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	NIL	**Progressive Courses**	NIL
Course Offering Department	Biomedical Engineering	**Data Book / Codes / Standards**	NIL		

Course Objective: ***The purpose of learning this course is:***

- To introduce the fundamentals of Brain–Computer Interface (BCI) systems and preprocessing methods.
- To provide an understanding of electrophysiological signal sources and neural mechanisms underlying BCI control.
- To develop knowledge of various feature extraction techniques for BCI signals and dimensionality-reduction methods.
- To impart the ability to apply and compare feature translation and classification methods and neural networks for BCI decision-making.
- To familiarize students with practical BCI applications and real-world case studies.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Describe the fundamentals of BCI systems and its potential applications.	U	3	2			2				1		2	3			
CO-2:	Analyze event related potentials and sensory motor rhythms.	AN	3	3		2	2						2	3			
CO-3:	Compute features suitable for BCI.	E	3	2		2	3						2	3			
CO-4:	Design classifier for a BCI system.	E	3	3		2	3				1		2	3			
CO-5:	Implement BCI for various applications.	AP	2	2	3	2	3	1		1	1	1	2	3			

Unit-1 **INTRODUCTION TO BCI** ***9 Periods***

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

Unit-2 **ELECTROPHYSIOLOGICAL SOURCES** ***9 Periods***

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuro-mechanisms.

Unit-3 **FEATURE EXTRACTION METHODS** ***9 Periods***

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

Unit-4 **FEATURE TRANSLATION METHODS** ***9 Periods***

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modelling – Hidden Markov Modelling – Neural Networks.

Unit-5 **APPLICATIONS OF BCI** ***9 Periods***

Functional restoration using Neuro-prosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

Total: 45 Periods

Learning Resources	Text Books	References
	1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, “Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction”, Springer, 2010. 2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, “Brain–Computer Interfaces: Fundamentals and Applications”, First Edition, Oxford University Press, 2012.	1. Lara V. Marcuse, Madeline C. Fields, Jiyeoun Jenna Yoo, “Rowan’s Primer of EEG”, Third Edition, Elsevier, Biomedical Press, 2024. 2. Arnon Cohen,” Biomedical signal processing Vol 1 Time and Frequency Domain Analysis”, CRC Press, 1986. 3. Arnon Cohen, “Biomedical Signal Processing Vol 2: Compression and automatic recognition”, CRC Press Inc., 2021. 4. Bishop C.M., “Neural Networks for Pattern Recognition”, Oxford, Clarendon Press, 1995. 5. P Christopher M, “Pattern Recognition and Machine Learning” Springer, 2006.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24BMO08	Course Name	PRINCIPLES OF REHABILITATION ENGINEERING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	**Co- requisite Courses**	NIL	**Progressive Courses**	NIL
Course Offering Department	Biomedical Engineering	**Data Book / Codes / Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the fundamental concepts of impairments, disabilities, handicaps, residual functions, and the multidisciplinary rehabilitation team.
- Provide knowledge on engineering approaches for sensory rehabilitation including visual, auditory, and tactual augmentation/substitution techniques.
- Familiarize students with engineering concepts in motor rehabilitation, including prosthetics, orthotics, myoelectric devices, and functional electrical stimulation (FES).
- Develop understanding of virtual reality (VR)–based rehabilitation systems and their application in mobility and motor recovery.
- Provide insight into rehabilitation medicine, physiological and psychological recovery, and legal rights of persons with disabilities as per the PWD Act 2016.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain key rehabilitation concepts such as impairments, disabilities, handicaps, residual functions, and rehabilitation care models.	U	3	1	1			1		1				1			
CO-2:	Describe sensory rehabilitation techniques including visual, auditory, and tactual augmentation and substitution systems.	U	3	1	1			1		1				1			
CO-3:	Apply engineering principles in designing prosthetic/orthotic systems, myoelectric devices, and functional electrical stimulation systems.	AP	3	1	1			1		1				1			
CO-4:	Analyze virtual reality–based rehabilitation systems, phantom haptics, and robotic applications in mobility rehabilitation.	AN	3	1	1			1		1				1			
CO-5:	Evaluate physiological, psychological, and legal aspects of rehabilitation, including provisions under the PWD Act 2016.	E	3	1	1			1		1				1			

Unit-1 **INTRODUCTION** ***9 Periods***

Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation team members and their functions. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

Unit-2 **ENGINEERING CONCEPTS IN SENSORY REHABILITATION** ***9 Periods***

Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system-Tactual augmentation, Tactual substitution, Computerized wheel chairs.

Unit-3 **ENGINEERING CONCEPTS IN MOTOR REHABILITATION** ***9 Periods***

Prosthesis and orthoses, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

Unit-4 **VIRTUAL REALITY IN REHABILITATION** ***9 Periods***

Introduction to virtual reality, Virtual reality-based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

Unit-5 **REHABILITATION MEDICINE AND ADVOCACY** ***9 Periods***

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal rights of persons with disabilities- The PWD Act 2016, Provisions available in education, employment, and in day-to-day life.
Total: 45 Periods

	Text Books	References
Learning Resources	1. Joseph D Bronzino, "The Biomedical Engineering Handbook". 4^{th} edition, CRC Press, 2015. 2. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.	1. Sashi S Kommu, "Rehabilitation Robotics", 1st edition, CRC Press, 2007. 2. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007. 3. Horia- Nocholai Teodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitationEng ineering", CRC; December 2000 4. Etienne Grandjean, Harold Oldroyd, "Fitting the task to the man", Taylor & Francis, 1988. 5. Keswick. J., "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", Springer Verlag, New York, 1982. 6. Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods",CRC, 2002. 7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CHO01	Course Name	INDUSTRIAL POLLUTION PREVENTION AND CONTROL	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co-requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Chemical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is :***

- To introduce the fundamental concepts of industrial pollution, types of pollutants, and their environmental impacts.
- To understand pollution prevention techniques and waste minimization strategies used in process industries.
- To study pollution control strategies including clean technologies, life cycle analysis, and sustainable waste management practices.
- To provide knowledge of air pollution sources, control technologies, and regulatory frameworks for air quality management.
- To understand water pollution control regulations, water quality standards, and the role of regulatory agencies in pollution management

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the sources, types, and environmental impacts of industrial pollutants including solid, liquid, gaseous, and noise pollution, and understand environmental regulations, greenhouse gases, global warming, and ozone depletion.	U	3	2				2	3	1				2	-	-	1
CO-2:	Apply principles and techniques of pollution prevention and waste minimization, including source reduction, raw material substitution, recycling, reuse, and waste auditing in process industries.	AP	3	2	2	1	1		3					2	1	-	1
CO-3:	Analyze pollution control strategies such as life cycle analysis, clean technologies, cradle-to-grave concept, zero discharge effluent, and resource recovery through case studies in chemical process industries.	AP	3	3	2	1	1		3					2	1	1	2
CO-4:	Understand the sources and effects of air pollution, air pollution control devices, emission standards, and the provisions of the Air (Prevention and Control of Pollution) Act.	U	2	2	1		2	2	3	1				2	-	-	1
CO-5:	Interpret the provisions of the Water (Prevention and Control of Pollution) Act, water quality standards, regulatory responsibilities, consent procedures, and sampling methods for pollution control.	U	2	2	1		1	3	3	2				2	-	-	1

Unit-1 **INDUSTRIAL POLLUTION** ***9 Periods***

Industrial pollution- Definition- source- types of pollutant generated in an industry- solid, liquid, gaseous & noise - their effects on the environment; Environmental regulatory legislations and standards; Importance of industrial pollution abatement; Concept of sustainable development; Greenhouse gases- Global warming and Ozone depletion. Case studies on industrial applications of cleaner technologies

Unit-2 POLLUTION PREVENTION	*9 Periods*
Principles and techniques for industrial pollution prevention and waste minimization; Nature and characteristics of industrial wastes; Prevention versus control of industrial pollution; Source reduction tools and techniques- raw material substitution, toxic use reduction and elimination, process modification and procedural changes; Recycling and reuse; Opportunities and barriers to cleaner technologies; Pollution prevention economics; Waste audits, emission inventories and waste management hierarchy for process industries.	
Unit-3 POLLUTION CONTROL STRATEGIES	***9 Periods***
Pollution control strategies - cradle to grave concept, life cycle analysis, clean technologies; concept of zero discharge effluent. Pollution prevention frame work – Government perspective- Incentives-Barriers-Regulations-Recycling and Reuse of Wastes, Resource recovery; Case studies - Managing Pollution Control in Chemical Process Industries.	
Unit-4 AIR POLLUTION CONTROL ACTS & RULES	***9 Periods***
Air (Prevention & Control of Pollution) Act, Air pollution-sources and types of Pollutants Adverse effects - Air pollution control devices, Air pollution emission standards; Emerging technologies and strategies to mitigate air pollution.	
Unit-5 WATER POLLUTION CONTROL ACTS & RULES	***9 Periods***
Water (Prevention & Control of Pollution) Act, 1974- Introduction to various aspects of water pollution and water quality standard; Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal; sampling procedure	
	Total: 45 Periods

	Text Books	References
Learning Resources	1. Pollution Control in Process Industries by S.P. Mahajan – 2004 2. Bishop P.E. Pollution Prevention: Fundamentals and Practice, McGraw Hill. 3. Industrial Pollution Prevention Handbook, Harry Freeman 4. Eckenfelder, W. W., Industrial Water Pollution Control, McGraw-Hill 5. Shyam Divan and Armin Roseneranz “Environmental law and policy in India “Oxford University Press, New Delhi, 2001	1. Wastewater Engineering: Treatment & Re-use - Metcalf & Eddy (Tata McGraw Hill) 2. Industrial Pollution Prevention Handbook - Shen, T.T. (Springer-Verlag, Berlin)

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CHO02	Course Name	PETROLEUM TECHNOLOGY	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co-requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Chemical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is :***

- To help students understand where petroleum is found, the types of reservoir rocks and traps, and the basic mechanisms that control oil and gas movement in reservoirs.
- To introduce students to how oil and gas wells are drilled, the equipment used, and the role of drilling fluids and cementing in well construction.
- To make students learn the basic logging methods, understand the information logs provide, and use them to evaluate formations and complete wells.
- To teach students how well performance is tested, how production is improved, and how artificial lift and recovery methods increase oil and gas output.
- To give a basic understanding of surface equipment, processing and transportation of oil and gas and the economic factors affecting petroleum supply and demand.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamentals of Earth science and the occurrence of petroleum reservoirs.	U	3	2	1	1	1						1	2	-	-	1
CO-2:	Understand the basic concepts of drilling of oil and gas wells.	U	3	3	2	2	2						1	2	-	-	1
CO-3:	Understand the various types of well logs used in petroleum exploration.	U	3	3	2	2	3						1	2	1	-	1
CO-4:	Understand the principles and procedures of well testing.	U	3	3	2	2	2						1	2	1	-	1
CO-5:	Understand the operation of surface production equipment. and Assess the Petroleum economics.	U	3	3	3	2	2						1	3	1	-	1

222

Unit-1 Petroleum Geology and Reservoir Mechanics ***9 Periods***

Earth science – Seismic methods -2D, 3D seismic methods,4D seismic, occurrence of petroleum Rocks and traps. Reservoir rocks and properties. Classification of oil and gas reserves Reservoir mechanics and drive mechanism.

Unit-2 Drilling Technology and Well Construction ***9 Periods***

Drilling – introduction to drilling of oil and gas wells. Drilling rigs and equipment's. Drilling fluids and cementing-3D Drilling

Unit-3 Well Logging and Formation Evaluation ***9 Periods***

Logging techniques. Various types of logs. Formation parameters. Log applications. Formation evaluation. Well completion.

Unit-4 Petroleum Production Techniques and Recovery Methods ***9 Periods***

Petroleum exploitation – well testing, production potential and well performances. Material balance, Artificial lift, Improved recovery methods.

Unit-5 Surface Operations, Processing, and Petroleum Economics ***9 Periods***

Surface equipment’s, processing of oil and gas. Transportation of oil and gas. Effluent treatment. Petroleum economics. Supply and demand trends.
Total: 45 Periods

	Text Books	References
Learning Resources	1. Geology of Petroleum by Leverson A.L.- 2nd edition The AAPG foundation, 2006. 2. Principles of oil production by T.E.W Nind- 2nd edition Mc Graw-Hill, 1981. 3. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.	1. Petroleum Reservoir Rock and Fluid Properties by Abhijit.Y. Dandekar- 2nd Edition CRC Press, 2013 2. Reservoir Engineer Handbook by Tarek Ahmed- 3rd Edition Gulf Professional Publishing, 2006. 3. Recent Advances in Enhanced Oil and Gas Recovery, IstvanLaktos, Academy Kiado, 2001. 4. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elesevier Science & Technology Books, 2007. 5. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CHO003	Course Name	GREEN CHEMISTRY AND ENGINEERING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is :***

- To understand the principles and concepts of Green Chemistry and sustainable chemical processes.
- To identify pollution types, waste sources, and methods for waste minimization and recycling.
- To learn green reagents, alternative solvents, and environmentally friendly synthesis methods.
- To understand the design of safe and efficient green chemical processes.
- To explore the applications of nanotechnology in environmental protection and renewable energy.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the principles of green engineering and technology	U	3	2			1		3			1		1	-	-	1
CO-2:	Learn about pollution using hazardous chemicals and solvents	U	3	2					3		1			1	-	-	1
CO-3:	Modify processes and products to make them green and safe.	U	2	3	2	1	2		2	1	1	1	1	1	1	-	2
CO-4:	Design processes and products using green technology	U	2	3	2	2	2		2	1	1	1	1	2	1	1	2
CO-5:	Understand advanced technology in green synthesis	U	1	3	1	2	2		2	0	1	2		1	1	-	2

Unit-1	**PRINCIPLES OF GREEN CHEMISTRY**	***9 Periods***
Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.		
Unit-2	**POLLUTION TYPES**	***9 Periods***
Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.		
Unit-3	**GREEN REAGENTS AND GREEN SYNTHESIS**	***9 Periods***
Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, deep eutectic solvents-types, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions.		
Unit-4	**DESIGNING GREEN PROCESSES**	***9 Periods***
Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention.		
Unit-5	**GREEN NANOTECHNOLOGY**	***9 Periods***
Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology.		
	Total:	**45 Periods**

<table>
<tr><td rowspan="2">Learning Resources</td><td>Text Books</td><td>References</td></tr>
<tr><td>1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications,2008</td><td>1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017</td></tr>
</table>

<table>
<tr><td colspan="3">Learning Assessment</td></tr>
<tr><td colspan="2">Continuous Learning Assessment (CLA) (40% weightage)</td><td rowspan="2">End Semester Examination (60% weightage)</td></tr>
<tr><td>Average of Internal Test (20%)</td><td>Critical Thinking Assessment (20%)</td></tr>
<tr><td colspan="3">* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%</td></tr>
</table>

Course Code	24CHO04	Course Name	BIO-ENERGY TECHNOLOGY	Course Category	T	Open Elective Course	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Chemical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Knowledge on biomass resources, composition, and bioenergy potential.
- Understand thermochemical and biochemical conversion technologies used for biofuel and bioenergy production.
- Design and operational aspects of bioenergy systems, including digestion, gasification, and biorefineries.
- Understand biofuel applications, energy systems, and waste-to-energy technologies.
- Learn the sustainability, environmental impacts, and global bioenergy policies.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Identify and classify various biomass resources and evaluate their energy potential.	U	3	3		2	1	1	1	1		1		2	-	-	1
CO-2:	Able to explain thermochemical conversion processes - pyrolysis, gasification, combustion and their applications.	U	3	3	2	2	2	1	1	1		1		1	-	-	1
CO-3:	Gather knowledge on biochemical conversion pathways, including anaerobic digestion, fermentation, and biodiesel production.	U	3	3	2	2	2	1	1	1		1		1	-	-	1
CO-4:	Analyze and design basic components of bioenergy systems for heat, power, and fuel generation.	AN	3	3	3	3	2	1	1	1	1	1	2	2	1	-	2
CO-5:	Knowledge on sustainability, environmental impacts, and policy frameworks related to bioenergy technologies.	U	3	2	1	2	1	3	1	1	1	2	1	2	-	-	2

Unit-1 INTRODUCTION TO BIOENERGY ***9 Periods***

Importance of bioenergy - Global and Indian bioenergy potential - Biomass resources: classification, availability, characteristics - Energy crops and their cultivation - Biomass composition: cellulose, hemicellulose, lignin Environmental and economic benefits of bioenergy -Challenges in large-scale bioenergy deployment

Unit-2 BIOMASS CONVERSION TECHNOLOGIES ***9 Periods***

Biomass preprocessing: drying, sizing, densification, pelletization - Thermochemical conversion: Pyrolysis, gasification, combustion and Process parameters - Hydrothermal processing: liquefaction and carbonization - Comparison of thermochemical conversion routes

Unit-3 BIOCHEMICAL CONVERSION TECHNOLOGIES ***9 Periods***

Anaerobic digestion - Biogas production - Alcohol fermentation: ethanol from sugar, starch and lignocellulosic biomass - Enzymatic hydrolysis of biomass - Biodiesel production: transesterification - Biorefineries, integrated biomass utilization

Unit-4 BIOENERGY SYSTEMS AND APPLICATIONS ***9 Periods***

Biomass-based power generation systems - Combined Heat and Power (CHP) using biomass - Biofuel applications in transportation - Algal biofuels and photobioreactors - Waste-to-energy systems

Unit-5 SUSTAINABILITY, POLICIES AND RECENT ADVANCES ***9 Periods***

Environmental impacts of bioenergy systems - Life cycle assessment of biofuels - Carbon sequestration and greenhouse gas mitigation - National and international bioenergy policies - Advances in 2G and 3G biofuels - Bio-electrochemical systems

	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Demirbas, Ayhan. *Bioenergy: Principles and Applications.* Springer, 2018. 2. Chynoweth, David P., et al. *Renewable Energy: Sources for Fuels and Electricity.* Island Press, 2012. 3. Klass, Donald L. *Biomass for Renewable Energy, Fuels and Chemicals.* Academic Press, 1998.	1. Basu, Prabir. *Biomass Gasification, Pyrolysis and Torrefaction.* Academic Press, 2018. 2. Schiavon, Mauro, and Luigi Pierobon. *Bioenergy Systems: Sustainable Design and Practice.* Wiley, 2021.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CHO05	Course Name	CARBON CAPTURE UTILIZATION AND STORAGE	Course Category	T	Open Elective Course	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is:***

- To understand the role of carbon capture in mitigating climate change.
- To learn different CO_2 capture technologies and separation principles.
- To study CO_2 transport and storage methods.
- To explore industrial applications and utilization pathways of CO_2.
- To analyze techno-economic, environmental, and policy aspects of CCUS.

Course Outcomes (CO): *At the end of this course, learners will be able to:*		BL	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	Program Specific Outcome (PSO) 1	2	3
CO-1:	Explain global CO_2 emission trends and interpret policy and regulatory frameworks governing carbon footprint reduction and CCS&U.	UN	3	2				2	3	2		2		3	-	-	1
CO-2:	Analyze different CO_2 capture technologies and evaluate the performance of various capture agents and industrial processes.	AN	3	3	2	2	2	2	2	1		2		3	1	-	2
CO-3:	Assess geological and biomimetic CO_2 sequestration techniques in terms of feasibility, safety, and environmental sustainability.	AN	3	2	2		2	3	3	2		2		3	1	-	2
CO-4:	Examine technical pathways for CO_2 utilization to produce fuels, polymers, solvents, and higher carbon products.	AP	3	2	3	2	3	2	2	1		2	1	3	1	-	2
CO-5:	Conduct environmental assessment and Life Cycle Assessment (LCA) for CO_2 capture and utilization systems using ISO methodologies.	AP	3	3	2	3	2	3	2	2		2	1	3	1	1	2

Unit-*1* CLIMATE CHANGE AND FUNDAMENTALS OF CCUS **9 Periods**

Climate change and global carbon cycle – Greenhouse gases and their impact – Global and Indian CO_2 emission scenario – Major industrial sources of CO_2 emissions – Concept of Carbon Capture, Utilization and Storage (CCUS) – Role of CCUS in achieving net-zero emissions – Technology readiness levels – Life cycle assessment of CCUS pathways – Global and national initiatives for carbon management.

Unit-2 CO_2 CAPTURE TECHNOLOGIES **9 Periods**

Principles of gas separation – Post-combustion, pre-combustion and oxy-fuel combustion capture processes – Absorption using chemical solvents (amines) – Adsorption using solid sorbents (activated carbon, zeolites, MOFs) – Membrane separation technologies – Cryogenic separation – Chemical looping combustion – Emerging capture materials such as ionic liquids and advanced solvents.

Unit-*3* CO_2 TRANSPORT AND STORAGE **9 Periods**

CO_2 compression and conditioning – Pipeline transportation of CO_2 – Shipping and transport logistics – Geological storage options: saline aquifers, depleted oil and gas reservoirs – Enhanced oil recovery using CO_2 – Mineral carbonation and geological trapping mechanisms – Monitoring, verification and risk assessment of storage sites – Environmental safety considerations.

Unit-*4*	CO_2 UTILIZATION TECHNOLOGIES	9 Periods
CO_2 conversion into fuels and chemicals – Thermocatalytic and electrocatalytic CO_2 reduction – Production of methanol, synthetic fuels and syngas – CO_2 utilization in polymers and chemical industries – Biological conversion using algae and microorganisms – Mineralization for construction materials – Industrial integration of CO_2 utilization technologies.		
Unit-5	**TECHNO-ECONOMIC ANALYSIS AND POLICY ASPECTS OF CCUS**	**9 Periods**
Cost analysis of carbon capture technologies – Techno-economic assessment methods – Life cycle assessment and carbon footprint analysis – Carbon markets and emission trading systems – National and international policies on CCUS – Regulatory frameworks and environmental regulations – Future trends: direct air capture (DAC), integration with renewable energy and hydrogen economy.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Carbon dioxide utilization: Closing the Carbon Cycle, Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Elsevier, 2015, 1st Edition. 2. Carbon Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry ,Goel M, Sudhakar M, Shahi RV, TERI, Energy and Resources Institute, 2015, 1st Edition. 3. Carbon Capture and Storage, CO2 Management Technologies, Amitava Bandyopadhyay, CRC Press, 2014, 1st Edition.	1. Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO2) Capture, Fennell P, Anthony B, Woodhead Publishing Series in Energy: No. 82, 2015, 1st Edition. 2. Developments in Innovation in Carbon Dioxide Capture and Storage Technology: Carbon Dioxide Storage and Utilization, Mercedes Maroto-Valer M, Vol 2, Woodhead Publishing Series in Energy, 2014, 1st Edition. 3. Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs, AlirezaBahadori, Elsevier Inc., 2018, 1st Edition.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Theory (40% weightage)		
Average of Internal Test (10%)	**Critical Thinking Assessment (10%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CHO006	Course Name	BATTERY TECHNOLOGY	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Chemical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is:***

- To understand the fundamentals of electrochemical energy storage and battery technologies.
- To analyse major battery chemistries and evaluate battery performance and testing methods.
- To learn recent advancements in battery materials, solid electrolytes, thin-film batteries, and supercapacitors.
- To understand electrochemical techniques used to characterize battery materials and performance.
- To learn automotive applications, including design, performance analysis, environmental impacts, and future prospects of vehicular energy storage systems.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Recognize the basic physical concepts of thermodynamics and kinetics involved in electrochemical reactions.	U	2		2	2	3							2	-	-	1
CO-2:	Understand the characterization methods of batteries and interpret concepts describing battery performance.	U	2	2	2	1	3							2	1	-	1
CO-3:	Explain recent battery technologies and their applications in energy storage systems.	U	2		1	1	3							2	1	--	2
CO-4:	Understand electrochemical techniques to evaluate the performance and characteristics of electrochemical systems.	U	3	2	2	1	3							2	1	-	2
CO-5:	Understand automotive battery systems, evaluate their performance, and understand environmental and recycling aspects for sustainable vehicle electrification.	U	3	2	2	1	3							2	1	-	2

Unit-1 INTRODUCTION TO ELECTROCHEMICAL ENERGY STORAGE ***9 Periods***

Introduction to battery technologies- Electromotive force- Reversible cells- Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell- Current challenges in Energy storage Technologies.

Unit-2 MAJOR BATTERY CHEMISTRIES DEVELOPMENT AND TESTING ***9 Periods***

Battery performance evaluation- Primary battery - Service time- Voltage data- Service life – ohmic load curve- Effect of operating temperature on service life. Secondary batteries Discharge curves- Terminal voltages- Plateau voltage –Lead acid Batteries – Construction and application.

Unit-3 RECENT TECHNOLOGIES ***9 Periods***

Recent development of electrode materials in lithium-ion batteries- Recent development of solid electrolytes and their application to solid state batteries-Polymer solid electrolytes for lithium-ion conduction– Thin Film solid state Batteries: Fundamentals, Constriction and application – Super Capacitors: Fundamental, Construction and application.

Unit-4 ELECTROCHEMICAL TECHNIQUES ***9 Periods***

Cyclic voltammetry, Chrono amperometry, Chrono potentiometry, Differential pulse voltammetry, Galvanostatic charge-discharge, dQ/dV vs. Capacity plot, Impedance spectroscopy, a non-destructive technique, Galvanostatic intermittent titration, Symmetric cell for critical current density analysis, Li^+ transport number calculation.

Unit-5	BATTERIES FOR AUTOMOTIVES – FUTURE PROSPECTS	*9 Periods*
Degrees of vehicle electrification - Battery size vs. application -USABC and DOE targets for vehicular energy storage systems - Analysis and Simulation of batteries - Equivalent circuit and life modelling – Environmental concerns in battery production – Recycling of batteries		
		Total: 45 Periods

	Text Books	References
Learning Resources	1. David Linden, Thomas B.Reddy, Handbook of Batteries 3rd edition, McGraw Hill 2. T.Minami, M.Tatsumisago, M.Wakihara,C. Iwakura, S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009 3. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001. 4. Bard, Allen J., and Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed., Wiley– VCH, Verlag, GmbH, 2000.	1. Masataka Wakihara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance, Wiley–VCH, Verlag GmbH, 1999. 2. Robert A.Huggins, Advanced Batteries – Materials science aspects, Springer, 2009.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CHO007	Course Name	ENERGY MANAGEMENT	Course Category	T	Open Elective Course	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is:***

- To understand energy resources, global and Indian energy scenarios, and the importance of energy conservation and efficiency.
- To learn the principles, methods, and instrumentation used in energy auditing and management.
- To analyze thermal and electrical energy management techniques in industrial systems.
- To understand economic evaluation methods used in energy management and conservation projects.
- To study practical applications of energy management through industrial case studies and modern monitoring systems.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand global and Indian energy scenario, resources, and conservation principles.	U	2	2	1	1					1	2	1		-	-	1
CO-2:	Understand the concepts of energy audits and apply instrumentation for monitoring and total energy management.	U	2	3	3	2	1				1	2	1		1	1	2
CO-3:	Implement energy management strategies in thermal, electrical, and mechanical systems.	U	2	2	2	2	1				1	2	1		1	-	2
CO-4:	Understand economic feasibility and financial aspects of energy projects.	U	2	2	2	1	1				1	2	1	2	1	-	1
CO-5:	Understand modern energy management techniques and emerging technologies in industries.	U	2	2	3	2	1				2	2	2	2	1	1	3

Unit-1 BASICS OF ENERGY & ENERGY SCENARIO ***9 Periods***

Energy Scenario – India and World – Energy Resources in India – Energy consumption Pattern, Energy Conservation and Energy Efficiency – Needs and Advantages, Role of Energy Manager –Energy Conservation Act.

Unit-2 AUDITING AND INSTRUMENTATION IN ENERGY MANAGEMENT ***9 Periods***

Energy Audit – Purpose, Types, Methodologies, Barriers with respect to Process Industries, Power Plants, Boilers and Certain Energy Intensive Industries; Energy Audit Questionnaire - Role of instrumentation in energy conservation - total energy systems - concept of total energy – advantages, limitations & Application.

Unit-3 ENERGY MANAGEMENT ***9 Periods***

Thermal energy management-Various Energy management Measures in Steam Systems –Losses in Boiler – Methodology of upgrading Boiler programme – Energy Conservation in Refrigeration and Air-conditioning Systems - Electrical Energy management- Potential Areas for Electrical Energy management in Various Industries-Energy Management Opportunities in Electrical Heating, Lighting system, Cable selection - Energy Efficient Motors - Factors involved in Determination of Motor Efficiency Adjustable AC Drives, Applications & its use variable speed Drives/Belt Drives.

Unit-4 ENERGY ECONOMICS ***9 Periods***

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing, risk and Sensitivity Analysis, Financing Options, Energy Performance Contract and Role of ETCOS.

Unit-5 APPLICATIONS ***9 Periods***

Case studies on sugar Industry –Co generation, Thermal power plant; Petrochemical Industries, ISO 50001 Energy Management System, Energy monitoring, targeting, SCADA, Smart meters, demand-side management, Carbon footprint, GHG management, Emerging trends: AI/ML in energy, EV integration, microgrids.

Total: 45 Periods

Learning Resources	Text Books	References
	1. Handbook on Energy Efficiency, TERI, New Delhi, 2001 2. Murphy W.R. and Mckay G., Energy Management, Elsevier, 2007. 3. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, Guide to Energy Management, 7th Ed., Keinnedu Fairmant Press, 2011.	1. Handbook on Energy Efficiency, TERI, New Delhi, 2001 2. Jefferson W. Tester, Elisabeth M. Drake, Michael J Driscoll, Michael W. Golay, William A Peters, Sustainable Energy – Choosing among options, Prentice Hall of India, 2006 3. Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning, 2012.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CHO08	Course Name	ENVIRONMENTAL AUDITING	Course Category	T	Open Elective Course	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Chemical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand environmental management systems and standards.
- Learn principles and practices of environmental auditing.
- Gain knowledge of environmental laws and regulatory bodies
- Learn environmental impacts and performance of processes.
- Study key environmental policies and pollution control acts.

Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**Program Outcomes (PO)**												**Program Specific Outcome (PSO)**		
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the principles, standards, and implementation of Environmental Management Systems (EMS) and related frameworks like ISO 14000 and TQM.	U	3	2	2	2			2					1	1	1	2
CO-2:	Understand environmental auditing techniques, including planning, execution, reporting, and evaluation of various types of environmental audits.	U	2	3	2	3					2	2			1	1	2
CO-3:	Understand environmental legislations, roles of regulatory bodies, and key national and international environmental policies.	U	2	2	2	2		3	3	2					-	-	1
CO-4:	Understand environmental aspects, impacts, and performance of industrial operations using tools like LCA and process evaluation.	U	2	3	2	2			3						1	1	2
CO-5:	Understand major environmental laws and policies in India and their role in pollution control and sustainable development.	U	2	3	2	2	2		3						-	-	1

Unit-1 ENVIRONMENTAL MANAGEMENT SYSTEM ***9 Periods***

Environmental policy, implementation and requirements of Environmental Management System (EMS) standards, inter-relationships and differences between the ISO 14000 series, EMAS, the ISO 9000 series and Total Quality Management.

Unit-2 ENVIRONMENTAL AUDIT ***9 Periods***

Principles of auditing, types of environmental audit, compliance audits, environmental risk assessments, pre-acquisition/ divestment audits, EMS audits, environmental statement audits, internal audit, single issue audits (e.g. waste or energy). Planning and preparation, audit team, examination of documented systems and internal control, site setting, site inspections and interviews, audit reporting and follow-up.

Unit-3 ENVIRONMENTAL LEGISLATIONS: ***9 Periods***

Roles and responsibilities of all national environmental regulatory agencies; local government and regional planning authorities; waste, environmental health and water regulatory authorities, other agencies responsible for enforcement of environmental law. Knowledge of major national environmental legislation (planning law, air, water, land, waste, hazardous substances, Eco – labeling, IPCC), National Environmental Protection Acts, Environmental Policy Plans.

Unit-4 ENVIRONMENTAL ASPECTS AND PERFORMANCE ***9 Periods***

Environmental aspects/ impacts of an operation, identification of fugitive emissions and waste streams, interpretation of process flow diagrams. Assessment of environmental effects of products using LCA, environmental performance of industry, amelioration techniques to mitigate environmental effects.

Unit-5	ENVIRONMENTAL LAW & POLICY	*9 Periods*
Highlights of the Acts, Institutional arrangements for: The Water (Prevention & Control of Pollution) Act, 1974 amended in 1988; The Air (Prevention and Control of Pollution) Act, 1981 amended in 1987; The Water (Prevention and Control of Pollution) Cess Act, 1977 amended in 1991; The Environment (Protection) Act, 1986; The Public Liability Insurance Act, 1991; Indian Policy Statement for abatement of Pollution, 1992.		
	Total:	**45 Periods**

Learning Resources	Text Books	References
	1. Canadian Standards Association (1992). Environmental Life Cycle Assessment. Draft Report. Ontario (Toronto), Canada: Canadian Standards Associations 2. Ciambrone, D.F. (1997). Environmental Life Cycle Analysis, CRC Press. 3. Environ (1988). Elements of Toxicology and Chemical Risk Assessment. Washington, D.C. Environ Corporation. 4. Environmental Legislation In India (Encyclopaedia of Environment), Vol.4 Hardcover – 1 January 2006 by K.R. Gupta.	1. Freeman, A.M., (1982). Air and water Pollution Control: A Benefit-Cost Assessment. Wiley, New York. 2. Guinee, Jeroen B. (1992). Classification. Draft Report. Leiden Sweden: Center of Environmental Science, Lieden University. 3. Handbook on Life Cycle Assessment (2004). Operational Guide to the ISO Standards, Kluwer Academic Publishers.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24IT001	Course Name	INTRODUCTION TO FULL STACK WEB DEVELOPMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	
Course Offering Department	Information Technology	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the various components of full stack development
- To learn Node.js features and applications
- To develop applications with MongoDB
- To understand the role of Angular and Express in web applications
- To develop simple web applications with React

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**			
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	
CO-1:	Understand the various stacks available for web application development	U	3	3		3	1	3	-	-	1	2	1	1	1	2	1	3
CO-2:	Use Node.js for application development	AP	3	3		3	2	3	-	-	1	2	1	1	1	2	2	3
CO-3:	Develop applications with MongoDB	AN	3	3		3	3	3	-	-	1	2	1	1	1	2	2	3
CO-4:	Use the features of Angular and Express	AP	3	3		3	3	3	-	-	2	1	1	2	1	2	2	3
CO-5:	Develop React applications	C	3	3		3	3	2	-	-	1	2	1	1	1	2	2	3

Unit-1	**BASICS OF FULL STACK**	***9 Periods***
Introduction to HTML 5.0 , CSS, and Java Script with simple program, Understanding the Basic Web Development Framework - User - Browser – Webserver - Backend Services –Understanding the different MERN stacks and its role.		
Unit-2	**NODE JS**	***9 Periods***
Basics of Node JS – Installation – Working with Node packages – Using Node package manager – Creating a simple Node.js application – Implementing HTTP services in Node.js		
Unit-3	**MONGO DB**	***9 Periods***
Understanding NoSQL and MongoDB – Building MongoDB Environment – User accounts – Access control –Connecting to MongoDB from Node.js – simple applications		
Unit-4	**EXPRESS AND ANGULAR**	***9 Periods***
Implementing Express in Node.js - Configuring routes - Using Request and Response objects - Angular - Typescript - Angular Components - Expressions - Data binding - Built-in directives		
Unit-5	**REACT**	***9 Periods***
Basic React applications – React Components – React State – Express REST APIs - Modularization and Webpack - Routing with React Router – Server-side rendering		
	Total:	**45 Periods**

	Text Books	References

Learning Resources	1. Brad Dayley, Brendan Dayley, Caleb Dayley, 'Node.js, MongoDB and Angular Web Development', Addison-Wesley, Second Edition, 2018 2. Vasan Subramanian, 'Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node', Second Edition, Apress, 2019.	1. Chris Northwood, 'The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer', Apress; 1st edition, 2018 2. Kirupa Chinnathambi, 'Learning React: A Hands-On Guide to Building Web Applications Using React and Redux', Addison-Wesley Professional, 2nd edition, 2018

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITO02	Course Name	INTRODUCTION TO DIGITAL MARKETING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- The primary objective of this module is to examine and explore the role and importance of digital marketing in today's rapidly changing business environment.
- It also focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.
- To analyze digital marketing campaigns and their effectiveness
- To provide hands-on exposure to commonly used digital marketing tools

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	To examine and explore the role and importance of digital marketing in today's rapidly changing business environment.	AN	3	3	2	1	3	-	-	-	1	2	3	3	1	1	1
CO-2:	To focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.	U	2	2	2	1	3	-	-	-	1	2	3	3	1	1	2
CO-3:	Design and execute integrated email and mobile marketing campaigns	AP	1	1	1	2	2	-	-	-	1	2	1	1	1	1	2
CO-4:	Develop and implement effective social media marketing strategies	AN	3	2	2	3	1	-	-	-	1	3	2	3	1	1	2
CO-5:	Analyze digital transformation strategies and apply channel attribution and digital analytics tools	AN	2	3	1	3	3	-	-	-	2	3	1	2	1	1	2

Unit-1 INTRODUCTION TO ONLINE MARKET **9 Periods**

Online Market space- Digital Marketing Strategy- Components - Opportunities for building Brand Website - Planning and Creation - Content Marketing.

Unit-2 SEARCH ENGINE OPTIMISATION **9 Periods**

Search Engine optimisation - Keyword Strategy- SEO Strategy - SEO success factors -On-Page Techniques - Off-Page Techniques. Search Engine Marketing- How Search Engine works- SEM components- PPC advertising -Display Advertisement

Unit-3 E- MAIL MARKETING **9 Periods**

E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation - Integrating Email with social media and Mobile- Measuring and maximizing email campaign effectiveness. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting

Unit-4 SOCIAL MEDIA MARKETING **9 Periods**

Social Media Marketing - Social Media Channels- Leveraging Social media for brand conversations and buzz. Successful /benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.

Unit-5 DIGITAL TRANSFORMATION **9 Periods**

Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.

		Total Theory: 45 Periods
	Text Books	**References**
Learning Resources	1. Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications 2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2013 3. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour	1. Philip Kotler et al., Marketing 4.0, Wiley 2. Ryan Deiss, Digital Marketing for Dummies, Wiley

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITO03	Course Name	SOCIAL MEDIA MARKETING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes / Standards			

Course Objective: ***The purpose of learning this course is to:***

- To understand social media policies, privacy, etiquette, and ethical issues.
- To learn how online communities grow and how influencers, audiences, and digital PR work.
- To gain knowledge on marketing analytics, metrics, and performance measurement
- To explore web analytics, data collection methods, KPIs, and analysis techniques.
- To understand search analytics, SEO, user behaviour, and digital content performance.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyze social media policies, ethical issues, and tracking methods used in digital platforms	AN	2	1	2	-	1	2	1	1	1	1	1	2	1	1	1
CO-2:	Build and manage online communities effectively using influencers, engagement strategies, and digital PR tools.	U	2	3	2	2	3	2	-	1	2	2	1	2	1	1	2
CO-3:	Apply marketing metrics and analytics tools to measure and improve marketing performance.	AP	1	2	3	2	2	2	1	1	2	2	2	2	1	1	2
CO-4:	Use web analytics to interpret data, plan strategies, and evaluate website performance.	U	2	2	3	2	3	2	-	1	3	2	2	2	1	1	2
CO-5:	Implement search analytics, SEO techniques, and user behavior insights to improve digital visibility	AP	1	1	2	1	1	3	2	1	1	1	1	2	1	1	2

Unit-1 **SOCIAL MEDIA POLICIES AND MEASUREMENTS** ***9 Periods***

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The road ahead in social media- The Basics of Tracking social media - social media analytics- Insights Gained From social media- Customized Campaign Performance Reports - Observations of social media use

Unit-2 **COMMUNITY BUILDING AND MANAGEMENT** ***9 Periods***

History and Evolution of social media-Understanding Science of social media -Goals for using social media- Social Media Audience and Influencers-Social theory and social media - technological determinism-Keys to Community Building - Promoting social media Pages- Linking Social Media Accounts-The Viral Impact of social media- Digital PR-social media as business.

Unit-3 **MARKETING ANALYTICS** ***9 Periods***

Introduction to Marketing Analytics-Marketing Budget and Marketing Performance Measure, Marketing Metrics and its application- Financial Implications of various Marketing Strategies- Geographical Mapping.

Unit-4 **WEB ANALYTICS** ***9 Periods***

Web Analytics - Present and Future, Data Collection - Importance and Options, Overview of Qualitative Analysis -Business Analysis- KPI and Planning-Critical Components of a Successful Web Analytics Strategy-Web Analytics Fundamentals.

Unit-5 **SEARCH ANALYTICS** ***9 Periods***

Search engine optimization (SEO), non-linear media consumption, user engagement, user generated content, web traffic analysis, navigation, usability, eye tracking, online security, online ethics, content management system, data visualization, RSS feeds, Mobile platforms, User centered design, Understanding search behaviors.
Total: 45 Periods

	Text Books	References
Learning Resources	1. Social Media Marketing: A Strategic Approach, 3rd Edition, 2024 2. .Social Media Marketing All-in-One For Dummies, Jan Zimmerman, 6th Edition, 2023	K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013. Christian Fuchs, social media a critical introduction, SAGE Publications Ltd, 2014 Bittu Kumar, Social Networking, V & S Publishers, 2013 Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007 ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress, 2004 Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITO04	Course Name	INTRODUCTION TO ETHICAL HACKING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards			

Course Objective: ***The purpose of learning this course is to:***

- To understand the basics of computer based vulnerabilities.
- To explore different foot printing, reconnaissance and scanning methods.
- To expose the enumeration and vulnerability analysis methods
- To understand hacking options available in Web and wireless applications.
- To explore the options for network protection.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	To express knowledge on basics of computer based vulnerabilities	U	2	2	3	2	1	-	-	-	1	2	2	1	2	2	3
CO-2:	To gain understanding on different foot printing, reconnaissance and scanning methods.	U	1	2	1	2	1	-	-	-	2	2	1	1	2	2	2
CO-3:	To demonstrate the enumeration and vulnerability analysis methods	AP	2	2	3	3	1	-	-	-	1	2	1	2	3	2	2
CO-4:	Analyze common vulnerabilities in web and wireless applications and associated hacking methods.	AN	2	1	1	2	1	-	-	-	1	3	3	3	3	2	2
CO-5:	Analyze different network security options to safeguard against threats and attacks.	AN	2	3	1	1	2	-	-	-	2	1	1	1	2	2	3

Unit-1	**INTRODUCTION**	**9 Periods**
Ethical Hacking Overview - Role of Security and Penetration Testers .- Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing .- Network and Computer Attacks - Malware -Protecting Against Malware Attacks.- Intruder Attacks - Addressing Physical Security		
Unit-2	**FOOT PRINTING, RECONNAISSANCE AND SCANNING NETWORKS**	**9 Periods**
Footprinting Concepts - Footprinting through Search Engines, Web Services, Social Networking Sites, Website, Email - Competitive Intelligence - Footprinting through Social Engineering -Footprinting Tools - Network Scanning Concepts - Port-Scanning Tools - Scanning Techniques -Scanning Beyond IDS and Firewall		
Unit-3	**ENUMERATION AND VULNERABILITY ANALYSIS**	**9 Periods**
Enumeration Concepts - NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration - Vulnerability Assessment Concepts - Desktop and Server OS Vulnerabilities - Windows OS Vulnerabilities - Tools for Identifying Vulnerabilities in Windows- Linux OS Vulnerabilities- Vulnerabilities of Embedded Oss		
Unit-4	**SYSTEM HACKING**	**9 Periods**
Hacking Web Servers - Web Application Components- Vulnerabilities - Tools for Web Attackers and Security Testers Hacking Wireless Networks - Components of a Wireless Network –Wardriving- Wireless Hacking - Tools of the Trade		

Unit-5 NETWORK PROTECTION SYSTEMS	9 Periods
Access Control Lists. - Cisco Adaptive Security Appliance Firewall - Configuration and Risk Analysis Tools for Firewalls and Routers - Intrusion Detection and Prevention Systems - NetworkBased and Host-Based IDSs and IPSs - Web Filtering - Security Incident Response Teams – Honeypots.	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Michael T. Simpson, Kent Backman, and James E. Corley, Hands-On Ethical Hacking and Network Defense, Course Technology, Delmar Cengage Learning, 2010. 2. The Basics of Hacking and Penetration Testing - Patrick Engebretson, SYNGRESS, Elsevier, 2013. 3. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, Dafydd Stuttard and Marcus Pinto, 2011.	1. Black Hat Python: Python Programming for Hackers and Pentesters, Justin Seitz , 2014

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24ITO05	Course Name	INFORMATION STORAGE MANAGEMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes / Standards**			

Course Objective: ***The purpose of learning this course is to:***

- To understand how data grows and why businesses need proper storage.
- To learn the basic components and architecture of storage systems.
- To study how disks work and how their performance is measured
- To understand RAID levels and different types of storage systems.
- To learn about intelligent storage systems and high-availability features.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain different storage technologies and their uses.	U	3	2	1	-	-	-	-	-	-	-	-	2	3	2	2
CO-2:	Identify hardware and software components in storage environments.	AP	3	3	2	2	2	-	-	-	-	-	-	2	3	3	3
CO-3:	Describe disk structures and evaluate disk performance.	AP	3	3	3	2	1	-	-	-	-	-	-	2	3	3	2
CO-4:	Choose suitable RAID levels for different applications	AP	3	3	2	2	2	2	2	-	-	-	-	2	3	2	3
CO-5:	Understand intelligent storage features like caching, tiering, and virtualization.	U	2	1	2	1	2	2	2	-	-	-	-	3	2	2	3

Unit-1	**STORAGE TECHNOLOGY**	**9 Periods**
Data creation and growth trends - Types and sources of enterprise data-Business value of data Challenges in data storage and data management-Overview of storage solutions: DAS, NAS, SAN, Cloud Storage, SDS-Core elements of data center infrastructure-Compute layer-Storage layer-Network layer-Facility layer -Role of data center components in supporting business processes		
Unit-2	**STORAGE SYSTEMS ARCHITECTURE**	**9 Periods**
Hardware components of host environment- Servers, HBAs, NICs, Controllers-Software components of host environment-Operating systems, File systems, Volume managers, Device drivers-Connectivity environment- Physical components: cables, switches, ports, adapters -Logical components: LUNs, zoning, WWN, masking		
Unit-3	**DISK STORAGE SYSTEMS**	**9 Periods**
Physical components of disk drives - Platters, spindle, actuator arm, read/write heads, controller -Logical disk structures-Sectors, tracks, cylinders, blocks, partitions-Disk access characteristics-Seek time, rotational latency, transfer rate-Performance implications: IOPS, throughput, workload patterns		
Unit-4	**RAID & STORAGE SYSTEM TYPES**	**9 Periods**
Concept of RAID-RAID components: striping, mirroring, parity-RAID levels and applications-RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 6-Nested RAID: RAID 0+1, RAID 1+0-Suitability of RAID levels for enterprise applications -Integrated vs Modular storage systems-Architecture, features, advantages, limitations		
Unit-5	**INTELLIGENT STORAGE SYSTEMS**	**9 Periods**

Architecture of an intelligent storage system-Front-end ports-Cache memory-Back-end controllers Disk arrays-Intelligent features-Data caching-Automated storage tiering-Virtualization support High availability concepts
Total: 45 Periods

	Text Books	References
Learning Resources	1.Information Storage and Management: Storing, Managing and Protecting Digital Information in classic, Virtualized and Cloud Environments, 2nd Edition, EMC Educations Services, Wiley, May 2012.	EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", Wiley, India, 2010 Marc Farley, –Building Storage Networks‖, Tata McGraw Hill ,Osborne, 2001. Robert Spalding, –Storage Networks: The Complete Reference–, Tata McGraw Hill , Osborne, 2003.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITO06	Course Name	INTRODUCTION TO CYBER SECURITY	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To learn cybercrime and cyberlaw
- To understand the cyber attacks and tools for mitigating them
- To understand information gathering
- To learn how to detect a cyber attack
- To learn how to prevent a cyber attack

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the basics of cyber security, cyber crime and cyber law	U	1	1	1	1	-	1	-	-	-	-	1	-	2	1	2
CO-2:	Classify various types of attacks and learn the tools to launch the attacks	U	1	3	1	3	2	1	-	-	-	-	-	-	3	2	2
CO-3:	Apply various tools to perform information gathering	AP	2	1	1	1	-	1	-	-	-	-	1	-	3	2	2
CO-4:	Apply intrusion techniques to detect intrusion	AP	3	3	2	2	-	1	-	-	-	-	-	-	3	2	2
CO-5:	Apply intrusion prevention techniques to prevent intrusion	AP	3	2	1	1	1	1	-	1	-	-	1	-	2	2	3

Unit-1 **INTRODUCTION**	**9 Periods**
Cyber Security – History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime; Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment	
Unit-2 **ATTACKS AND COUNTERMEASURES**	**9 Periods**
OSWAP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures	
Unit-3 **RECONNAISSANCE**	**9 Periods**
Harvester - Whois – Netcraft - Host – Extracting Information from DNS – Extracting Information from E-mail Servers – Social Engineering Reconnaissance; Scanning – Port Scanning – Network Scanning and Vulnerability Scanning – Scanning Methodology – Ping Sweer Techniques – Nmap Command Switches – SYN – Stealth – XMAS – NULL – IDLE – FIN Scans – Banner Grabbing and OS Finger printing Techniques.	
Unit-4 **INTRUSION DETECTION**	**9 Periods**
Host -Based Intrusion Detection – Network -Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots – Example System Snort.	
Unit-5 **INTRUSION PREVENTION**	**9 Periods**
Firewalls and Intrusion Prevention Systems: Need for Firewalls – Firewall Characteristics and Access Policy – Types of Firewalls – Firewall Basing – Firewall Location and Configurations –Intrusion Prevention Systems – Example Unified Threat Management Products.	
Total:	**45 Periods**

	Text Books	References
Learning Resources	1. Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", Notion Press, 2021 (Unit 1) 2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publishers, 2011 (Unit 1) 3. https://owasp.org/www-project-top-ten/	1. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning Publishers, 2013 (Unit 2) 2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made easy", Elsevier, 2011 (Unit 3) 3. Kimberly Graves, "CEH Official Certified Ethical hacker Review Guide", Wiley Publishers, 2007 (Unit 3) 4. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", Third Edition, Pearson Education, 2015 (Units 4 and 5) 5. Georgia Weidman, "Penetration Testing: A Hands-On Introduction to Hacking", No Starch Press, 2014 (Lab)

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITO07	Course Name	SOFTWARE TESTING ESSENTIALS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Information Technology	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the basics of software testing
- To learn how to do the testing and planning effectively
- To build test cases and execute them
- To focus on wide aspects of testing and understanding multiple facets of testing
- To get an insight about test automation and the tools used for test automation

Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**Program Outcomes (PO)**												**Program Specific Outcome (PSO)**		
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basic concepts of software testing and the need for software testing	U	3	3	2	1	2	-	-	-	1	1	3	2	2	3	2
CO-2:	Design Test planning and different activities involved in test planning	AP	2	3	1	1	1	-	-	-	2	2	1	2	2	3	2
CO-3:	Design effective test cases that can uncover critical defects in the application	AP	2	2	1	3	1	-	-	-	1	3	1	2	3	3	2
CO-4:	Carry out advanced types of testing	AP	2	1	3	2	1	-	-	-	1	1	1	2	2	3	2
CO-5:	Automate the software testing using Selenium and TestNG	AN	2	2	1	3	1	-	-	-	1	3	2	1	3	3	3

Unit-1 **FOUNDATIONS OF SOFTWARE TESTING** **9 Periods**

Why do we test Software?, Black-Box Testing and White-Box Testing, Software Testing Life Cycle, V-model of Software Testing, Program Correctness and Verification, Reliability versus Safety, Failures, Errors and Faults (Defects), Software Testing Principles

Unit-2 **TEST PLANNING** **9 Periods**

The Goal of Test Planning, High Level Expectations,Intergroup Responsibilities, Test Phases, Test Strategy, Resource Requirements, Tester Assignments, Test Schedule, Test Cases, Bug Reporting, Metrics and Statistics

Unit-3 **TEST DESIGN AND EXECUTION** **9 Periods**

Test Objective Identification, Test Design Factors, Requirement identification, Testable Requirements, Modeling a Test Design Process, Modeling Test Results, Boundary Value Testing, Equivalence Class Testing, Path Testing, Data Flow Testing, Test Design Preparedness Metrics, Test Case Design Effectiveness, Model-Driven Test Design, Test Procedures, Test Case Organization and Tracking, Bug Reporting, Bug Life Cycle.

Unit-4 **ADVANCED TESTING CONCEPTS** **9 Periods**

Performance Testing: Load Testing, Stress Testing, Volume Testing, Fail-Over Testing, Recovery Testing, Configuration Testing, Compatibility Testing, Usability Testing, Testing the Documentation, Security testing, Testing in the Agile Environment, Testing Web and Mobile Applications

Unit-5 **TEST AUTOMATION AND TOOLS** **9 Periods**

Automated Software Testing, Automate Testing of Web Applications, Selenium: Introducing Web Driver and Web Elements, Locating Web Elements, Actions on Web Elements, Different Web Drivers, Understanding Web Driver Events, Testing: Understanding Testing.xml, Adding Classes, Packages, Methods to Test, Test Reports

Total: 45 Periods

	Text Books	References
Learning Resources	1. Yogesh Singh, “Software Testing”, Cambridge University Press, 2012 2. Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" - Second Edition 2018	1. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3rd Edition, 2012, John Wiley & Sons, Inc. 2. Ron Patton, Software testing, 2nd Edition, 2006, Sams Publishing 3. Paul C. Jorgensen, Software Testing: A Craftsman’s Approach, Fourth Edition, 2014, Taylor & Francis Group. 4. Carl Cocchiaro, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing. 5. Elfriede Dustin, Thom Garrett, Bernie Gaurf, Implementing Automated Software Testing, 2009, Pearson Education, Inc. 6. Satya Avasarala, Selenium WebDriver Practical Guide, 2014, Packt Publishing. 7. Varun Menon, TestNg Beginner's Guide, 2013, Packt Publishing.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ITO08	Course Name	INTRODUCTION TO UI AND UX DESIGN	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Information Technology	Data Book / Codes Standards			

Course Objective: ***The purpose of learning this course is to:***

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- To understand the various Research Methods used in Design
- To explore the various Tools used in UI & UX
- Creating a wireframe and prototype

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Build UI for user Applications	U	3	1	1	3	1	-	-	-	3	3	2	1	3	2	1
CO-2:	Evaluate UX design of any product or application	AN	2	3	1	3	2	-	-	-	1	2	2	2	2	2	2
CO-3:	Demonstrate UX Skills in product development	AP	1	3	3	2	2	-	-	-	2	3	1	2	2	3	2
CO-4:	Implement Sketching principles	AP	1	2	3	3	1	-	-	-	3	2	1	3	3	3	2
CO-5:	Create Wireframe and Prototype	AP	1	2	3	2	1	-	-	-	2	1	1	1	3	2	2

Unit-1	**FOUNDATIONS OF DESIGN**	**9 Periods**
UI vs. UX Design - Core Stages of Design Thinking - Divergent and Convergent Thinking - Brainstorming and Game storming - Observational Empathy		
Unit-2	**FOUNDATIONS OF UI DESIGN**	**9 Periods**
Visual and UI Principles - UI Elements and Patterns - Interaction Behaviours and Principles – Branding - Style Guides		
Unit-3	**FOUNDATIONS OF UX DESIGN**	**9 Periods**
Introduction to User Experience - Why You Should Care about User Experience - Understanding User Experience - Defining the UX Design Process and its Methodology - Research in User Experience Design - Tools and Method used for Research - User Needs and its Goals - Know about Business Goals		
Unit-4	**WIREFRAMING, PROTOTYPING AND TESTING**	**9Periods**
Sketching Principles - Sketching Red Routes - Responsive Design – Wireframing - Creating Wire flows - Building a Prototype - Building High-Fidelity Mockups - Designing Efficiently with Tools - Interaction Patterns - Conducting Usability Tests - Other Evaluative User Research Methods - Synthesizing Test Findings - Prototype Iteration		
Unit-5	**RESEARCH, DESIGNING, IDEATING, & INFORMATION ARCHITECTURE**	**9 Periods**
Identifying and Writing Problem Statements - Identifying Appropriate Research Methods - Creating Personas - Solution Ideation - Creating User Stories - Creating Scenarios - Flow Diagrams - Flow Mapping - Information Architecture		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Joel Marsh, “UX for Beginners”, O’Reilly , 2022. 2. Jon Yablonski, “Laws of UX using Psychology to Design Better Product & Services” O’Reilly 2021.	1. Jenifer Tidwell, Charles Brewer, Aynne Valencia, “Designing Interface” 3 rd Edition , O’Reilly 2020 2. Steve Schoger, Adam Wathan “Refactoring UI”, 2018 3. Steve Krug, “Don't Make Me Think, Revisited: A Commonsense Approach to Web & Mobile”, Third Edition, 2015 4. https://www.nngroup.com/articles/ 5. https://www.interaction-design.org/literature.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	

***** The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24ADO01	Course Name	INTRODUCTION TO MACHINE LEARNING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses		**Co- requisite Courses**	Nil	**Progressive Courses**	Big Data Analytics
Course Offering Department	Artificial Intelligence and Data Science	**Data Book / Codes / Standards**	Chi-Square Table		

Course Objective: ***The purpose of learning this course is to:***

- Teach the theoretical foundations of various learning algorithms.
- Train the students better understand the context of supervised and unsupervised learning through real-life examples.
- Understand the need for Reinforcement learning in real – time problems.
- Apply all learning algorithms over appropriate real-time dataset.
- Introduce the fundamentals of reinforcement learning and equip students with the skills to evaluate model performance using various metrics and validation techniques.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to :***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand, visualize, analyze and preprocess the data from a real-time source	U	3	2	1	2	2	-	-	-	-	-	-	2	3	2	2
CO-2:	Apply appropriate algorithm to the data.	AP	3	3	3	2	1	-	-	-	2	2	3	3	2	3	2
CO-3:	Analyze the results of algorithm and convert to appropriate information required for the real – time application.	AN	2	3	3	2	1	-	-	-	2	2	1	2	2	3	3
CO-4:	Evaluate the performance of various algorithms that could be applied to the data and to suggest most relevant algorithm according to the environment.	E	2	3	2	2	3	-	-	-	1	3	2	3	2	3	1
CO-5:	Understand the concepts of Reinforcement Learning.	U	2	2	1	1	2	-	-	-	3	1	3	2	3	2	3

Unit-1 **INTRODUCTION TO MACHINE LEARNING AND PRE-REQUISITES** ***9 Periods***

Introduction to Machine Learning – Learning Paradigms – PAC learning – Version Spaces – Role of Machine Learning in modern applications. Linear and Non-Linear examples – Simple Linear Regression – Multiple Linear Regression – Logistic Regression.

Unit-2 **SUPERVISED LEARNING** ***9 Periods***

Basics of Classification – Multi-Class & Multi-Label classification – Naïve Bayes Classifier – Decision Trees (ID3, CART) – K-Nearest Neighbors (K-NN) classifier – Perceptron – Introduction to Artificial Neural Networks (Single & Multi-layer) – Support Vector Machines (Linear & Non-linear).

Unit-3 **ENSEMBLE LEARNING** ***9 Periods***

Clustering basics (Partitioned, Hierarchical, and Density-based) – K-Means clustering – K-Mode clustering – Self-organizing maps. Dimensionality Reduction: Principal Component Analysis (PCA) – Kernel PCA – tSNE (basics and intuition) – Metrics for evaluating clusters.

Unit-4 **UNSUPERVISED LEARNING** ***9 Periods***

Bias – Variance Tradeoff –Bagging and Boosting (Random forests, Adaboost, XG boost inclusive) –Metrics & Error Correction-Class Imbalance –SMOTE – One Class SVM – Optimization of hyper parameters,Customer Segmentation using Unsupervised Learning .

Unit-5 **REINFORCEMENT LEARNING** ***9 Periods***

Basics of Reinforcement Learning – The RL Framework (Agent, Environment, Reward) – Markov Decision Process (MDP) – The dilemma of Exploration Vs Exploitation – Policies and Value Functions – Introduction to Q-learning,Reinforcement Learning from Human Feedback (RLHF).

	Total: 45 Periods

	Text Books	References
Learning Resources	1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014. 2. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”, O’Reilly Media, 3rd Edition, 2022. 3. John Gress, Digital Visual Effects and Compositing, New Riders Press, 1st Edition, 2014.	1. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012. 2. Kevin P. Murphy, “Probabilistic Machine Learning: An Introduction”, MIT Press, 2022. 3. Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014 4. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, Pearson Education, Fourth Edition, 2020. 5. https://www.blender.org/features/vfx/ 6. https://natrongithub.github.io/

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADO02	Course Name	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Basic Programming	Co- requisite Courses	NIL	Progressive Courses	Natural Language Processing
Course Offering Department	Artificial Intelligence and Data Science	**Data Book / Codes Standards**	NIL		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamental concepts, history, and scope of Artificial Intelligence and intelligent agents.
- To learn problem-solving techniques using search strategies and classical planning methods..
- To Analyze uncertainty in AI using probability theory and Bayesian reasoning models.
- To study various machine learning techniques including supervised, unsupervised, and reinforcement learning.
- To explore real-world AI applications such as Natural Language Processing, Computer Vision, and Robotics.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Basic concepts of AI, intelligent agents, and problem-solving approaches	U	3	2	1	1	1	-	-	-	1	2	-	1	2	1	1
CO-2:	Apply search algorithms and classical planning techniques to solve AI problems	AP	3	3	2	2	2	-	-	-	1	1	-	1	3	2	2
CO-3:	Analyze uncertain environments using probability theory and Bayesian networks.	AN	3	3	2	2	1	-	-	-	-	1	-	1	2	2	3
CO-4:	Implement and evaluate machine learning models such as decision trees, regression, and neural networks.	AP	2	2	3	2	3	-	-	-	1	1	-	1	3	2	3
CO-5:	Develop AI-based solutions for real-world applications in NLP, Computer Vision, and Robotics.	AP	2	2	3	3	3	-	-	-	2	2	-	2	3	3	3

Unit-1 INTRODUCTION **9 Periods**

Foundations of artificial intelligence (AI). History of AI; The State of the Art. Agents and Environments, Good Behaviour, The Nature of Environments, The Structure of Agents, Problem solving agents, Example problems, searching for solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions-Search Algorithms in Artificial Intelligence .

Unit-2 ROBOTICS AND CLASSICAL PLANNING **9 Periods**

Classical Planning: Definition, Algorithms for Planning as State-Space Search, Planning Graphs, Other Classical Planning Approaches, Analysis of P2la9nning Approaches, Robotics: Introduction, Robot Hardware, Robotic Perception, planning to move, Planning Uncertain Movements- AI-Based Motion and Path Planning .

Unit-3 UNCERTAINTY,NAVIE BAYES AND PROBABILISTIC REASONING **9 Periods**

Acting Under Uncertainty, Review of Basic Probability, Bayes Theorem, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks,,Exact Inference in Bayesian Networks, Time and Uncertainty, Inference in Temporal Models-Bayesian Networks in Artificial Intelligence .

Unit-4 LEARNING **9 Periods**

Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis, Regression and Classification with Linear Models, Artificial Neural Networks. Reinforcement Learning-Decision Trees and Intelligent Prediction .

Unit-5 APPLICATIONS **9 Periods**

Natural Language Processing: Language Models, Text Classification, Information Retrieval, Information Extraction, Computer Vision: Image Formation, Early Image-Processing Operations, Object Recognition by Appearance, Reconstructing the 3D World, Object Recognition from Structural Information, Using Vision-Large Language Models and Generative AI .

		Total : 45 Periods
	Text Books	**References**
Learning Resources	1 .S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009. 2 I. Bratko, ―Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.	1. Artificial Intelligence, Pallab Das Gupta and Partha Pratim.C 30M. 2Tim Jones, ―Artificial Intelligence: A Systems Approach(Computer Science)‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008 3. Nils J. Nilsson, ―The Quest for Artificial Intelligence‖, Cambridge University Press, 2009. 4. William F. Clocksin and Christopher S. Mellish,‖ Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003. 5. Gerhard Weiss, ―Multi Agent Systems‖, Second Edition, MIT Press, 2013.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination** **(60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADO03	**Course Name**	INTRODUCTION TO BIG DATA ANALYTICS	**Course Category**	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Machine Learning	**Co- requisite Courses**	Nil	**Progressive Courses**	Business Analytics
Course Offering Department	Artificial Intelligence and Data Science	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to :***

- Understand the Big Data Platform and its Use cases and provide an overview of Apache Hadoop
- Provide HDFS Concepts and Interfacing with HDFS.
- Understand Map Reduce Jobs
- Provide hands on Hodoop Eco System and apply analytics on Structured, Unstructured Data.
- Exposure to Data Analytics with R.

			Program Outcomes (PO)											**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Identify Big Data and its Business Implications and List the components of Hadoop and Hadoop Eco-System.	AP	3	3	3	3	3	-	-	-	2	2	3	1	1	3	3
CO-2:	Access and Process Data on Distributed File System and Manage Job Execution in Hadoop Environment	U	3	3	2	3	2	-	-	-	2	2	3	3	2	3	2
CO-3:	Develop Big Data Solutions using Hadoop Eco System	AP	3	3	3	2	3	-	-	-	2	2	1	2	2	3	3
CO-4:	Analyze Infosphere BigInsights Big Data Recommendations.	AN	2	3	3	3	3	-	-	-	2	2	3	2	3	3	2
CO-5:	Apply Machine Learning Techniques using R..	AP	3	3	3	3	3	-	-	-	3	1	3	2	3	2	3

Unit-1 **INTRODUCTION TO BIG DATA AND HADOOP** ***9 Periods***

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.

Unit-2 **HDFS(Hadoop Distributed File System)** ***9 Periods***

The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit-3 **MAP REDUCE** ***9 Periods***

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features,AI-Driven Data Classification using Hadoop MapReduce .

Unit-4 **HADOOP ECO SYSTEM**	***9 Periods***
Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS, Big Data Analytics for AI using Hadoop MapReduce	
Unit-5 **DATA ANALYTICS WITH R**	***9 Periods***
Machine Learning : Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	
	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Bill Chambers, Matei Zaharia, "Spark: The Definitive Guide – Big Data Processing Made Simple", O'Reilly Media, 2018. 2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.	1. Jeff Carpenter, Eben Hewitt, "Cassandra: The Definitive Guide – Distributed Data at Web Scale", O'Reilly Media, 3rd Edition, 2022. 2. Lars George, "HBase: The Definitive Guide", O'Reilly Media, 2011. 3. Alan Gates, Daniel Dai, "Programming Pig", O'Reilly Media, 2nd Edition, 2016. 4. Edward Capriolo, Dean Wampler, Jason Rutherglen, "Programming Hive", O'Reilly Media, 2012. 5. Durgesh Mishra, Xin-She Yang, Aynur Unal, Dharm Singh Jat (Eds.), "Data Science and Big Data Analytics", Springer, 2024.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADO04	Course Name	BASICS OF DATA SCIENCE	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Database Management Systems	Co- requisite Courses	NIL	Progressive Courses	Big Data Analytics
Course Offering Department	Artificial Intelligence and Data Science	Data Book / Codes Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Apply fundamental tidy data concepts
- Familiar with Tools for Data Science
- Pull data from CSV or web (using API)
- Understand Data Analysis and Data reporting.
- Learn working with Data .

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Develop relevant programming abilities.	U	3	3	3	-	-	-	-	-	-	-	-	2	2	-	2
CO-2:	Demonstrate proficiency with statistical analysis of data.	U	3	3	3	-	-	-	-	-	-	-	-	2	2	-	2
CO-3:	Develop the ability to build and assess data-based models	U	2	3	3	-	-	-	-	-	-	-	3	2	3	-	-
CO-4:	Execute statistical analyses with professional statistical software	AP	2	3	2	3	-	-	-	-	-	-	2	2	3	2	-
CO-5:	Demonstrate skill in data management	AP	2	3	2	3	-	-	-	-	-	-	2	2	3	2	-

Unit-1 INTRODUCTION **9 Periods**

Overview of Data Science: Challenges in Data Science, History of Data Science, Data Science Process, Discovery and Preparation, Model Planning and Building, Introduction to Python: Variables, Data types, Strings, Conditions and statements, Classes and objects, Type conversion, Functions and Packages-AI-Based Data Preparation and Processing .

Unit-2 DATA EXPLORATION AND PROCESSING **9 Periods**

Pandas - Data Structures, Series, DataFrame, NumPy - array, SciPy - SciPy subpackages, Data Structures, Matplotlib, Seaborn, Datashader. Data Processing: Processing CSV, JSON, XLS data, Data Wrangling, Data Aggregation-Artificial Intelligence for Data Exploration .

Unit-3 DATA VISUALIZATION **9 Periods**

Context of data Visualization, Seven stages of Data Visualization, Objectives, Mapping, Chart Properties, Chart styling, Box plots, Heat Maps, Scatter Plots, Bubble Charts, 3D charts, Time Series, Geographical Data, Graph Data-AI-Based Interactive Visualization Systems .

Unit-4 MACHINE LEARNING **9 Periods**

Introduction to machine learning, Goals and applications of machine learning, aspects of developing a learning system, training data, concept representation, function approximation, Classification, Regression, Clustering, Decision trees , Recursive induction of decision trees-AI-Based Predictive Analytics .

Unit-5 DEEP LEARNING **9 Periods**

Introduction to Deep Learning, Supervised Learning With Neural Networks, Neural Network Basis: Binary Classification, Logistic Regression, Derivatives, Computation graph, Broadcasting in python, Neural Style transfer, text generation and image generation-Neural Style Transfer using AI .

Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Han J., Kamber M., Pei J. "Data Mining Concepts and Techniques", Morgan Kaufmann, 2011 2. Hastie T., Tibshirani R., Friedman J. "The Elements of Statistical Learning", 2nd Edition, Springer, 2009. 3. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media 4. Principles of Data Science, Shaun V. Ault, Soohyun Nam Liao, and Larry Musolino, OpenStax, 2025.	1. F. Provost, T Fawcett, "Data Science for business", O'Reilly Media, 2013 2. Murphy, K., "Machine Learning: A Probabilistic Perspective", MIT Press, 2012 2.Modern Artificial Intelligence and Data Science: Tools, Techniques and Systems, Abdellah Idrissi (Ed.), Springer, 2024.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADO05	Course Name	R PROGRAMMING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Problem Solving using Python Programming	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Artificial Intelligence and Data Science	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the basics of R and different data types
- Application of different operators and control statements
- Analyzing data and understanding different statistics using R
- Load, manage, analyze, and visualize data effectively in R using built-in functions
- Analyze relationships between variables using correlation and regression techniques

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Learn Fundamentals of R.	R	2	1	-	-	1	-	-	-	-	-	-	1	1	1	-
CO-2:	Covers how to use different functions in R, how to read data into R, accessing R packages, writing R functions, debugging, and organizing data using R functions.	AP	2	2	-	1	3	-	-	-	1	-	-	1	2	2	2
CO-3:	Cover the Basics of statistical data analysis with examples.	U	3	2	-	2	2	-	-	-	-	-	-	1	2	2	2
CO-4:	Apply mathematical and statistical operations data structures in R	AP	3	3	-	2	3	-	-	-	-	-	-	1	3	3	2
CO-5:	Apply correlation and regression techniques to analyze relationships between variables	AN	3	3	1	3	3	-	-	-	-	-	-	1	3	3	3

Unit-1 **BASICS OF R** ***9 Periods***

Introduction to R: What is R? – Why R? – Advantages of R over Other Programming Languages- R Studio: R command Prompt, R script file, comments. Handling Packages in R: Installing a R Package, Few commands to get started: installed. packages(), package. Description(), help(), find. Package(), library() - Input and Output – Entering Data from keyboard. R - Data Types: Vectors, Lists, Matrices, Arrays, Factors, Data Frame. R - Variables: Variable assignment, Data types of Variable, Finding Variable ls(), Deleting Variables

Unit-2 **OPERATORS AND LOOPS** ***9 Periods***

R - Operators: Arithmetic Operators, Relational Operators, Logical Operator, Assignment Operators, Miscellaneous Operators.R - Decision Making: if statement, if – else statement, if – else if statement, switch statement.R - Loops: repeat loop, while loop, for loop - Loop control statement: break statement, next statement.R - Function: function definition, Built-inn functions: mean(), paste(), sum(), min(), max(), seq(), userdefined function, calling a function, calling a function without an argument, calling a function with argument values.

Unit-3 **DATA TYPES IN R** ***10 Periods***

R - Strings: Manipulating Text in Data: substr(), strsplit(), paste(), grep(), toupper(), tolower().R – Vectors: Sequence vector, rep function, vector access, vector names, vector math, vector recycling, vector element sorting.R – List: Creating a List, List Tags and Values, Add/Delete Element to or from a List, Size of List,Merging Lists, Converting List to Vector.R – Matrices: Accessing Elements of a Matrix, Matrix Computations: Addition, subtraction,Multiplication and Division.R - Arrays: Naming Columns and Rows, Accessing Array Elements, Manipulating Array Elements,Calculation Across Array Elements.R – Factors: creating factors, generating factor levels gl().R - Data Frames: Create Data Frame, Data Frame Access, Understanding Data in Data Frames: dim(),nrow(), ncol(), str(), Summary(), names(), head(), tail(), edit() functions - Extract Data from Data

Frame,Expand Data Frame: Add Column, Add Row - Joining columns and rows in a Data frame rbind() and cbind() – Merging Data frames merge() – Melting and Casting data melt(), cast().		
Unit-4	**DATA VISUALIZATION**	***8 Periods***
Loading and handling Data in R: Getting and Setting the Working Directory – getwd(), setwd(), dir() - R-CSV Files - Input as a CSV file, Reading a CSV File, Analyzing the CSV File: summary(), min(),max(), range(), mean(), median(), apply() - Writing into a CSV File – R -Excel File – Reading the Excel file.Data Visualization through various plots and charts: bar charts, histogram, frequency polygon,density plots, scatter plots, box & whisker plots, heat and contour plots, plotting the above graphs in R,plotting with package ggplot2,AI-Based Interactive Data Visualization and Predictive Analytics using R Programming .		
Unit-5	**CORRELATION AND REGRESSION**	***9 Periods***
Analysis of Relationship, Positive and Negative Correlation, Perfect Correlation, Correlation Matrix, Scatter Plots, Simple Linear Regression, R Square, Adjusted R Square, Testing of Slope, Standard Error of Estimate, Overall Model Fitness, Assumptions of Linear Regression, Multiple Regression, Coefficients of Partial Determination, Durbin Watson Statistics, Variance Inflation Factor.		
		Total: 45 Periods

Learning Resources	**Text Books**	**References**
	1. W. N. Venables, D. M. Smith and the R core Team, An introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics, version 3.3.2, 2016. 2. Saroj Dahiya Ratnoo and Himmat Singh Ratnoo, Essentials of R for Data Analytics, Wiley,2021. 3. Hadley Wickham and Garrett Grolemund, R for Data Science Import, Tidy, Transform and model Data, O'Reilly, 2017. 4. R Programming: Statistical Data Analysis in Research, Kingsley Okoye and Samira Hosseini, Springer, First Edition, 2024.	1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer, 2013. 2. Han, J., Kamber, M, Pei, J., Data Mining Concepts and Techniques, Third edition, Morgan Kaufmann, 2012. 3. Programming in R with Applications in Machine Learning and Data Analytics, Priyanka P. Shinde, Varsha P. Desai, Kavita S. Oza, and Rajanish K. Kamat, Viva Books, 2023.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
***** The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADO06	Course Name	FUNDAMENTALS OF DEEP LEARNING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Machine Leaning	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Artificial Intelligence and Data Science	Data Book / Codes / Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the Mathematical models and basic key concepts in Deep learning
- Build the linear models and stochastic optimization methods for training deep neural networks
- Describe the Convolution Neural Networks and Recurrent Neural Networks
- Exemplify the Basic principles of auto encoders
- Emphasize the Various deep architectures and applications of computer vision

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		BL	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1:	Illustrate the basic concepts of linear algebra for Mathematical models and Deep neural network model	U	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-2:	Construct the feed forward network using gradient descent and regularization techniques	C	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-3:	Model the Convolutional neural network and articulate the sequence modelling using Recurrent models for processing	C	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-4:	Articulate the concepts of auto encoders	U	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3
CO-5:	Design the deep neural network to model computer vision related applications such as object detection, image captioning	C	-	3	-	-	3	-	-	-	-	-	3	-	2	3	3

Unit-1 **INTRODUCTION**	***9 Periods***
Introduction--Machine Learning Basics: Learning Algorithm, Supervised and Unsupervised Training, Linear Algebra for machine Learning, Dimensionality reduction, Over/Under-fitting, Cross-Validation, Hyper parameters, Training set, Test set and validation set, Estimators, Bias, Variance, Regularization, Historical Trends in Deep Learning, Introduction to a simple DNN, Deep learning software Libraries, Applications of Machine Learning in Real-World Systems.	
Unit-2 **FEED FORWARD NETWORKS AND BACK PROPAGATION**	***9 Periods***
Deep feed forward networks-Introduction, Shallow Neural Network, Deep Neural Network, Hyper-parameter Tuning, Batch Normalization, Learning XOR, Gradient-Based Learning, Back propagation, Activation Functions, Error Functions, Architecture Design, differentiation algorithms, - Regularization for Deep learning, Early Stopping, Drop out, Optimization Techniques for Neural Network Training.	
Unit-3 **ADVANCED DEEP LEARNING**	***9 Periods***
Convolutional Networks, Convolutional operation, Pooling, Normalization, Applications in Computer Vision, Sequence Modelling, Recurrent Neural Networks, Difficulty in Training RNN, LSTM, GRU, Encoder Decoder architectures, Application, Spam classification, sentiment analysis, Deep Learning Applications in Image and Text Processing.	
Unit-4 **GENERATIVE NETWORKS**	***9 Periods***
Auto encoders – Architecture, under complete, regularized, stochastic, denoising, contractive, Variational Autoencoders, Applications, Optimization for Deep Learning, RMSprop for RNNs, SGD for CNNs, Adversarial Generative Networks, Applications, Generative AI Models for Multimedia and Data Generation .	

Unit-5 **DEEP ARCHITECTURE**	*9 Periods*
Deep Architectures in Computer Vision, imagenet and imagenet Large Scale Visual Recognition Challenge (ILSVRC), Resnet, Graph Convolution Network (GCN), , Applications in image captioning, Applications in video Tasks, Modern Deep Learning Architectures and Their Applications.	
	Total: 45 Periods

	Text Books	**References**
Learning Resources	1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012 3. Michael Nielsen, “Neural Networks and Deep Learning”, Online book, 2016 4. Jason Brownlee, “Deep Learning with Python”, 2016.	1. Aaron Courville, Ian Goodfellow, and Yoshua Bengio, “Deep Learning”, MIT Press, 2015. 2. Fundamentals of Deep Learning: Designing Next- Generation Machine Intelligence Algorithms, Nithin Buduma, Nikhil Buduma, Joe Papa, O’Reilly Media, 2nd Edition, 2022.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24ADO07	Course Name	AI INHEALTH CARE APPLICATIONS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Artificial Intelligence	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Artificial Intelligence and Data Science	Data Book / Codes / Standards	NIL		

Course Objective: ***The purpose of learning this course is to:***

- Understand artificial intelligence, its history, its various subfields and overview of the healthcare industry, its challenges, and the potential for AI to address these challenges.
- Understand the importance of healthcare data, including electronic health records (EHRs), medical imaging data, and patient-generated data.
- Understand how AI can be used to build clinical decision support systems that assist healthcare professionals in making better treatment decisions.
- Understand emerging trends in AI and healthcare, and encourage students to explore potential research opportunities in the field
- Understand the main applications of artificial intelligence in healthcare.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the fundamentals of artificial intelligence as applied to healthcare.	U	3	2	1	1	2	-	-	-	-	-	-	2	2	3	1
CO-2:	Evaluate the impact of AI on clinical decision-making, diagnostics, and patient outcomes.	E	2	3	2	2	2	2	1	1	-	1	-	2	3	3	2
CO-3:	Analyze the ethical and privacy considerations in AI healthcare applications.	AN	1	3	1	1	-	3	2	3	-	1	-	2	2	2	2
CO-4:	Develop the critical perspective on the current state and future trends of AI in healthcare.	E	2	2	3	2	2	2	2	2	1	2	1	3	3	3	3
CO-5:	To discover the applications of AI in drug discovery, molecular modeling, drug delivery, and pharmaceutical development.	AP	3	3	2	3	3	1	1	1	-	1	1	2	3	3	2

Unit-1 **INTRODUCTION** ***9 Periods***

Introduction to AI in Healthcare: Overview of AI and machine learning in healthcare, Historical perspective and milestones, Role of AI in modern healthcare. Capabilities and limitations of AI in healthcare. Time series and non-time series data, data sourcing, Data enrichment, Advantages and Challenges in observational data, Geographic and demographic variation in medical data.

Unit-2 **INTRODUCTION TO CDSS AND AI** ***10 Periods***

Clinical Decision Support System (CDSS): Introduction to CDSS and AI - powered diagnostics, case studies of AI - driven CDSS applications and Ethical consideration in CDSS. Classification, regression, clustering for healthcare applications. Bias and error in medical data, analyse of data from IOT body sensors, Automated diagnosis processes, treatment protocol development. Disease Detection using Tabular medical data

Unit-3 **MEDICAL IMAGING AND AI** ***10 Periods***

Predictive modelling, Early detection, Cancer detection using tabular data, Risk estimation in medical insurance, Medical imaging, MRI, CT Scan, ECG, EEG etc., Handling hyper-dimensional medical images, Multimodal data analysis. Medical Imaging and AI:, Medical image Analysis using AI, Medical image segmentation and classification. Natural Language processing (NLP) for medical data analysis, Electronic health record (HER) .

Unit-4	**ETHICAL & PRIVACY CONSIDERATION**	***7 Periods***
Ethical & Privacy consideration : Ethical guidelines for AI in healthcare, privacy issues, HIPAA compliance, patient data protection. Drug Development Analysis, Drug discovery, modelling drug-drug interactions, Pandenic spread predictive, infection pattern identification, computer vision system for physiotherapy, pose estimation, Gait Analysis.		
Unit-5	**APPLICATIONS**	***9 Periods***
Applications of Artificial Intelligence in Drug Delivery and Pharmaceutical Development: The evolving pharmaceutical field, Drug delivery and nanotechnology, Quality-by-design R&D, Artificial intelligence in drug delivery modeling, Artificial intelligence application in pharmaceutical product R&D, Landscape of AI implementation in the drug delivery industry.		
	Total:	**45 Periods**

	Text Books	References
Learning Resources	1. Adam Bohr and Kaveh Memarzadeh, “Artificial Intelligence in Healthcare”, Academic Press, 2020/ Latest Edition. 2. Tianhua Chen, Jenny Carter, Mufti Mahmud and Arjab Singh Khuman, “Artificial Intelligence in Healthcare: Recent Applications and Developments”, Springer Nature, 2022/ Latest Edition.	1. Tianhua Chen, Jenny Carter, Mufti Mahmud and Arjab Singh Khuman, “Artificial Intelligence in Healthcare: Recent Applications and Developments”, Springer Nature, 2022/ Latest Edition. 2. Parag Suresh Mahajan MD - "Artificial Intelligence in Healthcare", Dr Parag Suresh Mahajan Publication.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	***Critical Thinking Assessment (20%)***	
* The expected levels for Bloom’s Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Open Elective Courses (TO BE OFFERED TO OTHER DEPARTMENTS)

Course Code	24CSO01	Course Name	INTRODUCTION TO ALGORITHMS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	C Programming,Data Structures	Co- requisite Courses	Nil	Progressive Courses	Algorithms
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand and apply the algorithm analysis techniques on searching and sorting algorithms
- Critically analyze the efficiency of graph algorithms
- Understand different algorithm design techniques
- Solve programming problems using state space tree
- Understand the concepts behind NP Completeness, Approximation algorithms and randomized algorithms

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Analyze the efficiency of algorithms using various frameworks	U	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-2:	Apply graph algorithms to solve problems and analyze their efficiency.	AP	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-3:	Make use of algorithm design techniques like divide and conquer, dynamic programming and greedy techniques to solve problems	AP	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-4:	Use the state space tree method for solving problems.	AP	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-5:	Solve problems using approximation algorithms and randomized algorithms.	AN	3	2	2	2	3	-	-	-	-	2	-	-	3	3	3

Unit-1 INTRODUCTION **9 Periods**

Algorithm analysis: Time and space complexity - Asymptotic Notations and its properties Best case, Worst case and average case analysis – Recurrence relation: substitution method - Lower bounds – searching: linear search, binary search and Interpolation Search, Pattern search: The naïve string-matching algorithm - Rabin-Karp algorithm - Knuth-Morris-Pratt algorithm. Sorting: Insertion sort – heap sort .

Unit-2 GRAPH ALGORITHMS **9 Periods**

Graph algorithms: Representations of graphs - Graph traversal: DFS – BFS - applications - Connectivity, strong connectivity, bi-connectivity - Minimum spanning tree: Kruskal’s and Prim’s algorithm- Shortest path: Bellman-Ford algorithm - Dijkstra’s algorithm - Floyd-Warshall algorithm Network flow: Flow networks - Ford-Fulkerson method – Matching: Maximum bipartite matching .

Unit-3 ALGORITHM DESIGN TECHNIQUES **9 Periods**

Divide and Conquer methodology: Finding maximum and minimum - Merge sort - Quick sort Dynamic programming: Elements of dynamic programming — Matrix-chain multiplication - Multi stage graph — Optimal Binary Search Trees. Greedy Technique: Elements of the greedy strategy - Activity-selection problem –- Optimal Merge pattern — Huffman Trees..

Unit-4 STATE SPACE SEARCH ALGORITHMS	9 Periods
Backtracking: n-Queens problem - Hamiltonian Circuit Problem - Subset Sum Problem – Graph colouring problem Branch and Bound: Solving 15-Puzzle problem - Assignment problem - Knapsack Problem - Travelling Salesman Problem	
Unit-5 NP-COMPLETE AND APPROXIMATION ALGORITHM	**9 Periods**
Tractable and intractable problems: Polynomial time algorithms – Venn diagram representation - NP-algorithms - NP-hardness and NP-completeness – Bin Packing problem - Problem reduction: TSP – 3-CNF problem. Approximation Algorithms: TSP - Randomized Algorithms: concept and application - primality testing - randomized quick sort - Finding kth smallest numberAbstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation– Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists – Polynomial ADT	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 3rd Edition, Prentice Hall of India, 2009. 2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran "Computer Algorithms/C++" Orient Blackswan, 2nd Edition, 2019.	1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012. 2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Reprint Edition, Pearson Education, 2006. 3. S. Sridhar, "Design and Analysis of Algorithms", Oxford university press, 014

Learning Assessment		
Continuous Learning Assessment (CLA) (50% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSO02	Course Name	FUNDAMENTALS OF SOFTWARE ENGINEERING	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the concepts of ADTs.
- Learn linear data structures – lists, stacks, and queues.
- Understand non-linear data structures – trees and graphs.
- Understand sorting, searching and hashing algorithms.
- Apply Tree and Graph structures.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Identify the key activities in managing a software project and understand different process models.	U	3	2	1	1	1	-	-	-	2	1	3	1			
CO-2:	Apply concepts of requirements engineering and Analysis Modeling	AP	3	3	2	2	1	-	-	-	1	1	-	1			
CO-3:	Apply systematic procedure for software design and deployment	AP	3	2	3	2	2	-	-	-	2	1	1	1			
CO-4:	Apply the various testing methods.	AP	2	3	2	3	2	-	-	-	1	1	-	1			
CO-5:	Manage project schedule, estimate project cost and effort required	AN	2	2	1	1	1	-	-	-	3	2	3	1			

Unit-1	**SOFTWARE PROCESS AND AGILE DEVELOPMENT**	**9 Periods**
Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models –Introduction to Agility-Agile process-Extreme programming-XP Process..		
Unit-2	**REQUIREMENTS ANALYSIS AND SPECIFICATION**	**9 Periods**
Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document – Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management- Classical analysis: Structured system Analysis, Petri Nets- Data Dictionary.		
Unit-3	**SOFTWARE DESIGN**	**9 Periods**

<table>
<tr><td colspan="3">Design process – Design Concepts-Design Model– Design Heuristic – Architectural Design - Architectural styles, Architectural Design, Architectural Mapping using Data Flow-User Interface Design: Interface analysis, Interface Design –Component level Design: Designing Class based components, traditional Components</td></tr>
<tr><td colspan="3">Unit-4 TESTING AND MAINTENANCE 9 Periods</td></tr>
<tr><td colspan="3">Software testing fundamentals-Internal and external views of Testing-white box testing - basis path testing-control structure testing-black box testing- Regression Testing – Unit Testing – Integration Testing – Validation Testing – System Testing And Debugging –Software Implementation Techniques: Coding practices-Refactoring-Maintenance and Reengineering-BPR model-Reengineering process model-Reverse and Forward Engineering.</td></tr>
<tr><td colspan="3">Unit-5 PROJECT MANAGEMENT 9 Periods</td></tr>
<tr><td colspan="3">Software Project Management: Estimation – LOC, FP Based Estimation, Make/Buy Decision COCOMO I & II Model – Project Scheduling – Scheduling, Earned Value Analysis Planning – Project Plan, Planning Process, RFP Risk Management – Identification, Projection - Risk Management-Risk Identification-RMMM Plan-CASE TOOLS</td></tr>
<tr><td colspan="3" align="right">Total Theory: 45 Periods</td></tr>
<tr><td></td><td>Text Books</td><td>References</td></tr>
<tr><td>Learning Resources</td><td>1. Roger S. Pressman, “Software Engineering – A Practitioner‟s Approach”, Seventh Edition, Mc Graw-Hill International Edition, 2010.
2. Ian Sommerville, “Software Engineering”, 9th Edition, Pearson Education Asia, 2011.</td><td>1. Rajib Mall, “Fundamentals of Software Engineering”, Third Edition, PHI Learning PrivateLimited, 2009.
2. Pankaj Jalote, “Software Engineering, A Precise Approach”, Wiley India, 2010.
3. Kelkar S.A., “Software Engineering”, Prentice Hall of India Pvt Ltd, 2007.
4. Stephen R.Schach, “Software Engineering”, Tata McGraw-Hill Publishing Company Limited,2007.
5. http://nptel.ac.in/.</td></tr>
</table>

<table>
<tr><td colspan="3">Learning Assessment</td></tr>
<tr><td colspan="2">Continuous Learning Assessment (CLA) (40% weightage)</td><td rowspan="2">End Semester Examination (60% weightage)</td></tr>
<tr><td>Average of Internal Test (20%)</td><td>Critical Thinking Assessment (20%)</td></tr>
<tr><td colspan="3">* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%</td></tr>
</table>

Course Code	24CSO03	Course Name	Introduction to Cloud Computing	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the fundamental concepts of cloud computing, including cloud architecture, service models and deployment models.
- To learn the principles of virtualization technologies, virtual machines and hypervisors.
- To explore virtualization infrastructure and container technologies.
- To gain knowledge of major cloud platforms and deployment environments.
- To understand cloud security challenges and mechanisms.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the design challenges in the cloud	**1**	3	2	1	1	1	-	-	-	2	3	1	3	2	1	3
CO-2:	Apply the concept of virtualization and its types.	**2**	3	1	2	2	1	-	-	-	1	2	1	3	2	2	1
CO-3:	Experiment with virtualization of hardware resources and Docker.	**3**	2	3	2	3	1	-	-	-	3	1	1	3	1	1	1
CO-4:	Develop and deploy services on the cloud and set up a cloud environment.	**4**	1	2	3	3	3	-	-	-	3	3	1	2	1	3	3
CO-5:	Explain security challenges in the cloud environment.	**5**	2	3	3	1	3	-	-	-	2	2	1	2	2	2	3

Unit-1	**CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE**	**9 Periods**
Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud ComputingReference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges.		
Unit-2	**VIRTUALIZATION BASICS**	**9 Periods**
Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts – Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices.		
Unit-3	**VIRTUALIZATION INFRASTRUCTURE AND DOCKER**	**9 Periods**
Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management –Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.		

Unit-4	**CLOUD DEPLOYMENT ENVIRONMENT**	**9 Periods**
Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack.		
Unit-5	**CLOUD SECURITY**	**9 Periods**
Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyperjacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architectureand Practice.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012. 2. James Turnbull, "The Docker Book", O'Reilly Publishers, 2014. 3. Krutz, R. L., Vines, R. D, "Cloud security. A Comprehensive Guide to Secure Cloud Computing", Wiley Publishing, 2010.	1. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005. 2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media,Inc., 2009.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSO04	Course Name	PRINCIPLES OF BLOCKCHAIN TECHNOLOGY	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the basics of Blockchain
- Learn Different protocols and consensus algorithms in Blockchain
- Learn the Blockchain implementation frameworks
- Understand the Blockchain Applications
- Experiment the Hyperledger Fabric, Ethereum networks

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand emerging abstract models for Blockchain Technology	U	3	3	2	2	1	-	-	-	1	-	-	2	3	1	1
CO-2:	Identify major research challenges and technical gaps existing between theory and practice in the crypto currency domain	U	3	3	3	3	1	-	-	-	2	-	-	2	1	2	1
CO-3:	Understanding of the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.	U	3	3	3	3	2	-	-	-	3	-	-	2	2	3	3
CO-4:	Apply hyper ledger Fabric and Ethereum platform to implement the Block chain Application.	AP	3	2	3	2	3	-	-	-	3	-	-	2	2	2	3
CO-5:	Apply blockchain technology in real-world applications such as smart contracts, DApps, NFTs, and industry use cases	AP	3	2	3	2	3	-	-	-	3	-	-	2	2	2	3

Unit-1 INTRODUCTION TO BLOCKCHAIN **9 Periods**

Blockchain- Public Ledgers, Blockchain as Public Ledgers - Block in a Blockchain, Transactions- The Chain and the Longest Chain - Permissioned Model of Blockchain, Cryptographic -Hash Function, Properties of a hash function-Hash pointer and Merkle tree

Unit-2 BITCOIN AND CRYPTOCURRENCY **9 Periods**

A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts , Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay

Unit-3 BITCOIN CONSENSUS **9 Periods**

Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases.	
Unit-4 HYPERLEDGER FABRIC & ETHEREUM	**9 Periods**
Architecture of Hyperledger Fabric v1.1 – Membership Service Provider (MSP) – Peers, Orderers and Channels – Consensus mechanisms in Hyperledger Fabric (Solo, Kafka, Raft) – Chain code concepts, lifecycle and endorsement policy – Ethereum: Ethereum network – Ethereum Virtual Machine (EVM) – Transaction fee – Mist Browser – Ether – Gas – Solidity – Ethereum accounts – Smart contract deployment process – Ethereum clients – Security issues and best practices in Ethereum smart contracts.	
Unit-5 BLOCKCHAIN APPLICATIONS	**9 Periods**
Smart contracts, Truffle Design and issue- DApps- NFT. Blockchain Applications in Supply Chain Management, Logistics, Smart Cities, Finance and Banking, Insurance,etc- Case Study.	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Bashir and Imran, Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks, 2017. 2. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly, 2014.	1. Daniel Drescher, “Blockchain Basics”, First Edition, Apress, 2017. 2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016. 3. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015 4. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Blockchain”, Packt Publishing 5. Handbook of Research on Blockchain Technology, published by Elsevier Inc. ISBN: 9780128198162, 2020.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	

* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24CSO05	Course Name	MACHINE LEARNING USING PYTHON FOR BEGINNERS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Python Programming	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the fundamental concepts and techniques of Machine Learning.
- Provide knowledge of Python programming and libraries used for Machine Learning.
- Enable students to understand and apply supervised and unsupervised learning algorithms.
- Familiarize students with model evaluation techniques and performance metrics.
- Develop the ability to design simple Machine Learning applications and understand ethical issues.

			Program Outcomes (PO)											Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the fundamentals of Machine Learning, its types, workflow and applications.	U	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-2:	Use Python programming and libraries for data analysis and visualization.	AP	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-3:	Implement supervised learning algorithms for regression and classification problems.	AP	1	1	1	1	-	-	-	-	-	2	-	-	1	1	1
CO-4:	Apply unsupervised learning techniques for clustering and dimensionality reduction.	AP	2	2	2	2	2	-	-	-	-	2	-	-	2	2	2
CO-5:	Build, evaluate and interpret Machine Learning models	AN	3	2	2	2	3	-	-	-	-	2	-	-	3	3	3

Unit-1 INTRODUCTION TO MACHINE LEARNING **9 Periods**

What is Machine Learning – Artificial Intelligence vs Machine Learning vs Deep Learning – Types of Machine Learning: Supervised Learning, Unsupervised Learning, Semi-Supervised Learning, Reinforcement Learning – Applications of Machine Learning – Machine Learning Workflow – Overview of Python for Machine Learning – Installation of Anaconda and Jupyter Notebook – Introduction to NumPy, Pandas and Matplotlib..

Unit-2 PYTHON BASICS FOR MACHINE LEARNING **9 Periods**

Python Fundamentals – Variables, Data Types and Operators – Control Statements (Conditional and Looping Statements) – Functions and Modules – Working with NumPy: Arrays, Indexing and Slicing, Mathematical Operations – Working with Pandas: Series and DataFrame – Data Loading using CSV Files – Data Cleaning and Preprocessing – Data Visualization using Matplotlib and Seaborn.

Unit-3 SUPERVISED LEARNING TECHNIQUES **9 Periods**

Introduction to Supervised Learning – Regression Techniques: Simple Linear Regression, Multiple Linear Regression – Classification Techniques: Logistic Regression, k-Nearest Neighbors (KNN), Decision Tree Classifier – Model Training and Testing – Performance Evaluation Metrics: Accuracy, Precision, Recall, F1-Score – Confusion Matrix.

Unit-4 UNSUPERVISED LEARNING TECHNIQUES	9 Periods
Introduction to Unsupervised Learning – Clustering Techniques: K-Means Clustering, Hierarchical Clustering – Dimensionality Reduction: Principal Component Analysis (PCA) – Association Rule Learning (Overview) – Data Visualization for Clusters – Use Cases and Applications.	
Unit-5 MODEL EVALUATION	**9 Periods**
Model Validation Techniques – Train-Test Split – Cross-Validation – Overfitting and Underfitting – Bias–Variance Tradeoff – Introduction to Scikit-Learn Library – End-to-End Machine Learning Pipeline- Ethical Issues and Limitations of Machine Learning.	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Ethem Alpaydin, *Introduction to Machine Learning*, 3rd Edition, MIT Press, 2014. 2. Sebastian Raschka and Vahid Mirjalili, *Python Machine Learning*, 3rd Edition, Packt Publishing, 2019. 3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow*, 2nd Edition, O'Reilly Media, 2019.	1. Tom M. Mitchell, *Machine Learning*, McGraw-Hill, 1997. 2. Andreas C. Müller and Sarah Guido, *Introduction to Machine Learning with Python*, O'Reilly Media, 2016. 3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press, 2016.

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSO06	Course Name	MULTIMEDIA AND COMPUTER GRAPHICS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	C++,JAVA	**Co- requisite Courses**	Nil	**Progressive Courses**	Game Development
Course Offering Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Introduce the fundamentals of illumination, colour models, and basic output primitives used in computer graphics.
- Develop understanding of 2D geometric transformations, viewing techniques, and clipping algorithms.
- Explain 3D object representation, transformations, projections, and visible surface detection.
- Familiarize with multimedia systems, architectures, file handling, and compression techniques.
- Provide knowledge of hypermedia concepts, authoring systems, and graphics applications using tools like Blender.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain illumination concepts, colour models, and the working of basic graphic primitives.	U	3	2	3	1	3	-	-	-	-	-	1	2	3	1	2
CO-2:	Apply 2D transformations and clipping techniques to modify and display 2D objects.	AP	3	3	2	2	3	-	-	-	-	-	1	2	3	1	2
CO-3:	Apply 3D transformations and surface representation techniques for visualizing 3D objects.	AP	3	2	3	2	3	-	-	-	-	-	1	2	3	1	2
CO-4:	Apply multimedia system concepts and data formats to design media-rich applications.	AP	3	3	3	2	3	-	-	-	-	1	1	2	3	1	2
CO-5:	Apply hypermedia principles and Blender tools to create integrated multimedia content.	AP	3	3	3	2	3	-	-	-	-	1	1	2	3	1	2

Unit-1	**ILLUMINATION AND COLOR MODELS**	**9 Periods**
Light sources - basic illumination models — halftone patterns and dithering techniques; Properties of light - Standard primaries and chromaticity diagram; Intuitive colour concepts - RGB colour model - YIQ colour model - CMY colour model - HSV colour model - HLS colour model; Colour selection. Output primitives — points and lines, line drawing algorithms, loading the frame buffer, line function; circle and ellipse generating algorithms; Pixel addressing and object geometry, filled area primitives		
Unit-2	**TWO-DIMENSIONAL GRAPHICS**	**9 Periods**
Two dimensional geometric transformations — Matrix representations and homogeneous coordinates, composite transformations; Two-dimensional viewing — viewing pipeline, viewing coordinate reference frame; window-to-viewport coordinate transformation, Two dimensional viewing functions; clipping operations — point, line, and polygon clipping algorithms		

Unit-3	THREE-DIMENSIONAL GRAPHICS	9 Periods
Three dimensional concepts; Three-dimensional object representations — Polygon surfaces- Polygon tables- Plane equations - Polygon meshes; Curved Lines and surfaces, Quadratic surfaces; Blobby objects; Spline representations — Bezier curves and surfaces -B-Spline curves and surfaces. TRANSFORMATION AND VIEWING: Three dimensional geometric and modeling transformations — Translation, Rotation, Scaling, composite transformations; Three-dimensional viewing — viewing pipeline, viewing coordinates, Projections, Clipping; Visible surface detection methods.		
Unit-4	**MULTIMEDIA SYSTEM DESIGN & MULTIMEDIA FILE HANDLING**	**9 Periods**
Multimedia basics − Multimedia applications − Multimedia system architecture − Evolving technologies for multimedia − Defining objects for multimedia systems − Multimedia data interface standards − Multimedia databases. Compression and decompression − Data and file format standards − Multimedia I/O technologies − Digital voice and audio − Video image and animation − Full motion video − Storage and retrieval technologies.		
Unit-5	**HYPERMEDIA**	**9 Periods**
Multimedia authoring and user interface - Hypermedia messaging -Mobile messaging − Hypermedia message component − Creating hypermedia message − Integrated multimedia message standards − Integrated document management − Distributed multimedia systems. **CASE STUDY: BLENDER GRAPHICS** Blender Fundamentals — Drawing Basic Shapes — Modelling — Shading & Textures.		
		Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Donald Hearn and Pauline Baker M, —Computer Graphics", Prentice Hall, New Delhi, 2007 [UNIT I — III] 2. Andleigh, P. K and Kiran Thakrar, —Multimedia Systems and Design‖, PHI, 2003. [UNIT IV,V]	1. 1 Judith Jeffcoate, —Multimedia in practice: Technology and Applications‖, PHI, 1998. 2. Foley, Vandam, Feiner and Hughes, —Computer Graphics: Principles and Practice‖, 2nd Edition, Pearson Education, 2003. 3. Jeffrey McConnell, —Computer Graphics: Theory into Practice‖, Jones and Bartlett Publishers,2006. 4. Hill F S Jr., "Computer Graphics", Maxwell Macmillan , 1990. 5. Peter Shirley, Michael Ashikhmin, Michael Gleicher, Stephen R Marschner, Erik Reinhard, KelvinSung, and AK Peters, —Fundamentals of Computer Graphics‖, CRC Press, 2010. 6. William M. Newman and Robert F.Sproull, —Principles of Interactive Computer Graphics‖ Mc Graw Hill 1978. https://www.blender.org/support/tutorials/

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**60%**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	

* The expected levels for Bloom’s Taxonomy should be:
  - Lower-order thinking skills: not more than 40%
  - Higher-order thinking skills: not less than 60%

Course Code	24CSO07	Course Name	INTRODUCTION TO APP DEVELOPMENT	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	C,Data Structures, Object-Oriented Programming	**Co- requisite Courses**	Software Engineering, UI/UX Design, Web Technologies	**Progressive Courses**	DevOps
Course Offerin Department	Computer Science and Engineering	**Data Book / Codes Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To learn development of native applications with basic GUI Components
- To develop cross-platform applications with event handling
- To develop applications with location and data storage capabilities
- To develop web applications with database access
- To evaluate and compare app frameworks based on key non-functional characteristics for effective application development.

			Program Outcomes (PO)												ProgramSpecific Outcome(PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Develop Native applications with GUI Components.	**CO1**	2	2	1	2	3	-	-	-	1	1	2	1	2	3	3
CO-2:	Develop hybrid applications with basic event handling.	**CO2**	2	1	3	2	2	-	-	-	3	2	2	3	3	2	1
CO-3:	Implement cross-platform applications with location and data storage capabilities.	**CO3**	2	2	2	1	2	-	-	-	1	1	1	1	1	1	2
CO-4:	Implement cross platform applications with basic GUI and event handling.	**CO4**	1	3	1	1	3	-	-	-	1	1	3	2	1	3	1
CO-5:	Develop web applications with cloud database access.	**CO5**	1	1	3	1	3	-	-	-	1	1	2	1	3	2	1

Unit-1 FUNDAMENTALS OF MOBILE & WEB APPLICATION DEVELOPMENT **9 Periods**

Basics of Web and Mobile application development, Native App, Hybrid App, Cross-platform App, Progressive Web Applications (PWA), Responsive Web Design, Client–Server architecture, RESTful web services and APIs, and basic UI/UX design principles.

Unit-2 NATIVE APP DEVELOPMENT USING JAVA **9 Periods**

Native Web App, Benefits of Native App, Scenarios to create Native App, Tools for creating Native App, Cons of Native App, Popular Native App Dev elopment Frameworks, Java & Kotlin for Android, Swift & Objective-C for iOS, Basics of React Native, Native Components, JSX, State, Props

Unit-3 HYBRID APP DEVELOPMENT **9 Periods**

Hybrid Web App, Benefits of Hybrid App, Criteria for creating Native App, Tools for creating Hybrid App, Cons of Hybrid App, Popular Hybrid App Development Frameworks, Ionic, Apache Cordova	
Unit-4 CROSS-PLATFORM APP DEVELOPMENT USING REACT-NATIVE	**9 Periods**
What is Cross-platform App, Benefits of Cross-platform App, Criteria for creating Cross-platform App, Tools for creating Cross-platform App, Cons of Cross-platform App, Popular Cross- platform App Development Frameworks, Flutter, Xamarin, React-Native, Basics of React Native, Native Components, JSX, State, Props	
Unit-5 NON-FUNCTIONAL CHARACTERISTICS OF APP FRAMEWORKS	**9 Periods**
Comparison of different app frameworks, Build performance, App performance, Debugging capabilities, Time to market, Maintainability, Ease of development, UI/UX support, Reusability, Security features, Scalability, and Community support and ecosystem.	
	Total Theory: 45 Periods

	Text Books	References
Learning Resources	1. Head First Android Development, Dawn Griffiths and David Griffiths, O'Reilly Media, Sebastopol, California, 1st Edition, 2015. 2. Apache Cordova in Action, Raymond K. Camden, Manning Publications Co., Shelter Island, New York, 2015. 3. Full Stack React Native: Create Beautiful Mobile Apps with JavaScript and React Native, Anthony Accomazzo, Houssein Djirdeh, Sophia Shoemaker, Devin Abbott, Fullstack.io, California, 2018	1. Android Programming for Beginners, John Horton, Packt Publishing Ltd., Birmingham, UK, 2nd Edition, 2018. 2. Native Mobile Development, Shaun Lewis and Mike Dunn, O'Reilly Media, Sebastopol, California, 2014. 3. Building Cross-Platform Mobile and Web Apps for Engineers and Scientists: An Active Learning Approach, Pawan Lingras, Matt Triff, and Rucha Lingras, Springer International Publishing, Cham, Switzerland, 2018. 4. Apache Cordova 4 Programming, John M. Wargo, Pearson Education, Indianapolis, USA, 2015. 5. React Native Cookbook, Daniel Ward, Packt Publishing Ltd., Birmingham, UK, 2nd Edition, 2018

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24CSO08	Course Name	DATA ANALYTICS	Course Category	T	Open Elective Courses	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes Standards	Nil		

Course Objective: ***The purpose of learning this course is to:***

- Understand the fundamentals of data analytics and its lifecycle.
- Introduce methods of data collection, preprocessing, and visualization.
- Apply basic statistical techniques for analysing engineering data.
- Familiarize students with analytical tools such as Excel/Python/Power BI.
- Apply data analytics concepts to domain-specific engineering problems..

			Program Outcomes (PO)												Program Specific Outcome (PSO		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the concepts and lifecycle of data analytics.	U	3	2	-	-	-	-	-	2	-	-	-	1			
CO-2:	Understand different types and sources of data and perform basic data cleaning, transformation, normalization, and visualization using Excel.	U	3	3	-	2	3	-	-	-	-	-	-	1			
CO-3:	Apply statistical techniques to analyze engineering datasets	AP	3	3	-	2	-	-	-	-	-	-	-	1			
CO-4:	Use analytical tools (Excel/Python/Power BI) for data analysis tasks	AP	3	2	2	2	3	-	-	-	-	-	-	1			
CO-5:	Analyze and interpret domain-specific engineering problems using data analytics methods.	AN	3	3	2	2	2	2	1	2	2	-	1	2			

Unit-1	**INTRODUCTION TO DATA ANALYTICS**	**9 Periods**
Data and Information – Need for Data Analytics – Types of Analytics (Descriptive, Diagnostic, Predictive, Prescriptive) – Data Analytics Lifecycle – Applications in Core Engineering Domains – Overview of Big Data – Ethical Issues in Data Analytics.		
Unit-2	**DATA COLLECTION AND PREPROCESSING**	**9 Periods**

Types of Data – Structured and Unstructured Data – Data Sources (Sensors, IoT, Databases, Surveys) – Data Cleaning – Handling Missing Values – Data Transformation – Data Normalization – Introduction to Data Visualization – Charts and Graphs using Excel.	
Unit-3 STATISTICAL METHODS FOR DATA ANALYTICS	**9 Periods**
Measures of Central Tendency – Measures of Dispersion – Correlation and Covariance – Probability Basics – Hypothesis Testing (Concept) – Simple Linear Regression (Concept and Applications).	
Unit-4 DATA ANALYTICS TOOLS	**9 Periods**
Introduction to Excel for Analytics – Data Sorting, Filtering, Aggregation – Pivot Tables – Introduction to Python (Basic Concepts) – Introduction to Pandas – Data Importing and Exploration – Basic Visualization – Introduction to Dashboards (Power BI – Concept).	
Unit-5 APPLICATIONS OF DATA ANALYTICS IN ENGINEERING	**9 Periods**
Predictive Maintenance – Quality Control Analytics – Energy Consumption Analysis – Supply Chain Analytics – Smart Systems and IoT Data Analytics – Case Studies.	
	Total Theory: 45 Periods

	Text Books	**References**
Learning Resources	1. Radha Shankarmani, M. Vijayalakshmi, *Data Analytics*, Wiley India Pvt. Ltd., New Delhi, First Edition, 2022. 2. Anil Maheshwari, *Data Analytics Made Easy*, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, First Edition, 2017. 3. James R. Evans, *Business Analytics: Methods, Models and Decisions*, Pearson Education, 2nd Edition, 2017.	1. Seema Acharya, Subhashini Chellappan, *Big Data and Analytics*, Wiley India Pvt. Ltd., New Delhi, First Edition, 2015. 2. Arun K. Pujari, *Data Mining Techniques*, Universities Press (India) Pvt. Ltd., Hyderabad, Third Edition, 2010. 3. Foster Provost, Tom Fawcett, *Data Science for Business*, O'Reilly Media Inc., USA, First Edition, 2013. 4. Wes McKinney,Python for *Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, O'Reilly Media, 2nd Edition, 201

Learning Assessment		
Continuous Learning Assessment (CLA) (40% weightage)		**End Semester Examination (60% weightage)**
Average of Internal Test (20%)	**Critical Thinking Assessment (20%)**	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

MANDATORY COURSES - 4

Course Code	24MC401	Course Name	JAPANESE LANGUAGE	Course Category	P	Employability Enhancement Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities (First Year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To develop basic Japanese language skills in listening, speaking, reading, and writing.
- To understand and use simple everyday expressions and sentence structures confidently.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		***BL***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Exhibit competency in Japanese writing systems and fundamental phonetic patterns.	AP										2		2			
CO-2:	Formulate and comprehend simple Japanese sentences for everyday communicative situations.	AN									1	3		2			
CO-3:	Utilize core vocabulary and commonly used expressions at the Japanese Basic proficiency level.	AP									1	3		2			
CO-4:	Comprehend and apply essential grammatical structures to express ideas with clarity and accuracy.	AN									1	3		2			
CO-5:	Demonstrate effective performance in listening, reading, and language-use activities appropriate to Japanese Basic proficiency.	C									2	3		3			

List of Topics	**60 Periods**

1. Introduction to Hiragana writing system.
2. Introduction to Katakana writing system.
3. Basic pronunciation rules and sound patterns.
4. Numbers, greetings, and classroom expressions.
5. Common daily expressions for simple conversations.
6. Basic sentence structures and word order.
7. Describing people, objects, and places.
8. Asking and answering about locations.
9. Usage of particles and basic counters.
10. Vocabulary expansion and introduction to basic Kanji (common nouns and places).
11. Verb usage in polite form for daily routines.
12. Making requests, asking permissions, and travel/food-related expressions.
13. Expressing likes, dislikes, abilities, invitations, and plans.
14. Use of adjectives, past tense forms, and commonly tested JLPT basic Kanji.

15. Comprehensive revision, listening and reading practice, mock tests, and JLPT exam strategies.

	Text Books	References
Learning Resources	1. Minna no Nihongo I – Main Textbook, 2nd Edition, 3A Corporation, Tokyo, 2012 2. Marugoto: Japanese Language and Culture – Starter A1 (Katsudoo & Rikai), The Japan Foundation, Sanshusha Publishing, 2013.	1. Genki I: An Integrated Course in Elementary Japanese, 3rd Edition, Eri Banno, Yoko Ikeda, Yutaka Ohno, Chikako Shinagawa & Kyoko Tokashiki, Japan Times Publishing, 2020. 2. Japanese for Busy People I, 4th Edition, AJALT (Association for Japanese-Language Teaching), Kodansha International, 2022.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		
Written Test (20%)	**Proctored Test (Two test during assessment schedule) (40%)**	**Performance (Reading Test + Assigment + self Introduction in Japanese) (40%)**

Course Code	24MC402	Course Name	German Language	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce basic German vocabulary and pronunciation.
- To develop simple speaking and writing skills.
- To teach very basic grammar structures.
- To help students communicate in daily situations.
- To build confidence in elementary level conversations.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand and use basic German words and expressions.	U						2				3		2			
CO-2:	Introduce themselves and talk about daily activities.	AP						2				3		2			
CO-3:	Form simple sentences using basic grammar.	AP						2				3		2			
CO-4:	Communicate in simple everyday situations.	AP						2				3		2			
CO-5:	Write short and simple messages.	AP						3				3		2			

Unit-1	**Basic Communication**	***6 Periods***
Alphabet; numbers; days and months; introducing oneself and others; simple sentences; personal pronouns; verbs *sein* (to be) and *haben* (to have); basic articles; simple plural forms.		
Unit-2	**Daily Life and Surroundings**	***6 Periods***
Family; hobbies; food and drinks; city places; transport; giving simple directions; basic negation (*nicht*, *kein*); simple commands; introduction to accusative case.		
Unit-3	**Time, Activities and Social Interaction**	***6 Periods***
Daily routine; telling time; fixing simple appointments; basic prepositions (*am, um*); modal verbs (basic use); possessive words; simple past of *sein* and *haben*.		
Unit-4	**Communication and Living Spaces**	***6 Periods***
Writing short messages; contacts; rooms and furniture; colours; basic dative case; simple prepositions.		
Unit-5	**Professions, Health and Travel**	***6 Periods***
Professions; clothes; body and health words; simple perfect tense (introduction); weather words; holidays and travel expressions; basic modal verb usage.		
	Total:	**30 Periods**

	Text Books	References
Learning Resources	1. NETZWERK Deutsch als Fremdsprache A1(Goyal, New Delhi, 2015)	1. Schulz-Griesbach: Deutsch als Fremdsprache. Grundstufe in einem Band (for Grammar) PRACTICE MATERIAL https://www.goethe.de/en/spr/kup/prf/prf/sd1/ueb.html http://www.deutschkurse-passau.de/JM/images/stories/SKRIPTEN/a1_skript_gr.pdf https://www.schubert-verlag.de/aufgaben/arbeitsblaetter_a1_z/a1_arbeitsblaetter_index_z.htm

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MC403	**Course Name**	Korean Language	**Course Category**	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce learners to the Korean writing system and pronunciation.
- To develop basic listening, speaking, reading and writing skills in Korean.
- To enable learners to communicate in simple everyday situations.
- To build foundational knowledge of Korean grammar and sentence patterns.
- To promote intercultural awareness and confidence in using a foreign language.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand Hangul letters and basic pronunciation rules.	U						2				3		2			
CO-2:	Understand basic greetings, numbers, and simple sentence structure.	U						2				3		2			
CO-3:	Understand the use of basic grammar such as particles and present tense verbs.	U						2				3		2			
CO-4:	Apply simple sentence patterns to ask and answer basic questions.	AP						2				3		2			
CO-5:	Apply basic expressions in everyday communication situations.	AP						3				3		2			

Unit-1	**Fundamentals of Korean Language**	***6 Periods***
Fundamentals of Korean: Introduction to Hangul: consonants and vowels, Basic pronunciation and syllable formation.		
Unit-2	**Basics of Communication**	***6 Periods***
Common greetings and self-introductions, Numbers (Sino-Korean and Native Korean basics), Basic sentence structure (Subject-Object-Verb), Simple expressions		
Unit-3	**Essential Grammar**	***6 Periods***
Essential Grammar and Vocabulary: Particles (은/는, 이/가, 을/를) and usage, Basic verbs and present tense conjugation, Sentence patterns: affirmative, negative, interrogative.		
Unit-4	**Functional Language**	***6 Periods***
Common adjectives and descriptive sentences, expressing possession and location, asking simple questions (어디, 뭐, 누구), Talking about time, dates, and schedules, counting objects.		
Unit-5	**Everyday Communication and Cultural Context**	***6 Periods***
Everyday Korean Communication: Polite speech levels and honorifics introduction, Ordering food, shopping phrases, Simple directions and transportation vocabulary, Listening practice with short dialogues, Cultural notes on etiquette and communication.		
	Total:	**30 Periods**

<table>
<tr><td rowspan="2">Learning Resources</td><td>Text Books</td><td>References</td></tr>
<tr><td>1. 최은규, 진문이, 오은영, 송지현(Eunkyu Choi, Moon-e Jin, Eunyoung Oh, & Gihyun Song),
2. Seoul National University Language Education Institute. (2013, 2021). SNU (Seoul National University) Korean 1A student’s book. 서울대 한국어 1A. Two ponds.</td><td>1. 최은규, 진문이, 오은영, 송지현(Eunkyu Choi, Moon-e Jin, Eunyoung Oh, & Gihyun Song),
2. Seoul National University Language Education Institute. (2013, 2021). SNU (Seoul National University) Korean 1A Workbook. Seoul: Two ponds.
3. Seoul National University Language Education Institute. (2019). 사랑해요 한국어, I Love Korean 1Student’s Book. Seoul National University Press.</td></tr>
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<table>
<tr><td colspan="3">Learning Assessment</td></tr>
<tr><td colspan="2">Continuous Learning Assessment (CLA) (100% weightage)</td><td rowspan="2">End Semester Examination
(00% weightage)</td></tr>
<tr><td>Average of Internal Test
(0%)</td><td>Critical Thinking Assessment
(100%)</td></tr>
<tr><td colspan="3">* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%</td></tr>
</table>

Course Code	24MC404	Course Name	French Language	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce students to basic French pronunciation and vocabulary.
- To develop simple listening and speaking skills in French.
- To help students form basic sentences in present tense.
- To enable students to communicate in everyday situations.
- To create basic awareness of French culture and polite expressions.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Recognize and pronounce basic French words and greetings.	U						2				3		2			
CO-2:	Introduce themselves and others using simple sentences.	U						2				3		2			
CO-3:	Use basic present tense verbs in communication.	U						2				3		2			
CO-4:	Ask and answer simple questions in daily situations.	U						2				3		2			
CO-5:	Demonstrate basic conversational skills in common real-life	U						3				3		2			

Unit-1	**Basics of French**	***6 Periods***
French alphabet and simple pronunciation; basic greetings (Bonjour, Salut, Merci); introducing oneself (Je m'appelle…, Je suis…); simple classroom expressions.		
Unit-2	**Simple Words and Sentences**	***6 Periods***
Numbers (0–30); days of the week; subject pronouns (je, tu, il/elle); very simple sentences; introduction to être (am/is/are).		
Unit-3	**Talking About Self and Family**	***6 Periods***
Family words (père, mère, frère); simple describing words (grand, petit); expressing likes and dislikes (J'aime…, Je n'aime pas…); basic negative form (ne…pas).		
Unit-4	**Daily Life Communication**	***6 Periods***
Simple daily activities (manger, aller, étudier); telling age and time (very basic); asking simple questions (Qui?, Où?, Quoi?); short simple dialogues.		
Unit-5	**Practical Communication**	***6 Periods***
Food and shopping words; ordering in a café; asking simple directions; polite words (s'il vous plaît); very short speaking and listening practice.		
	Total:	**30 Periods**

	Text Books	**References**
Learning Resources	1. Alter Ego - Méthode de Français, A1 (2006): Berthet, Hugot et al., Hachette 2. Alter Ego – Cahier d'activités, A1 (2006): Berthet, Hugot et al., Hachette	1. Écho - Méthode de Français, A1 (2013): Girardet, Pecheur, CLE International 2. Écho - Cahier personnel d'apprentissage, A1 (2013): Girardet, Pecheur, CLE International 3. A votre service – 1, A1 (2011): Chanderasekar, Hanga et al., Hachette

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		

Course Code	24MC405	Course Name	Hindi Language	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To introduce learners to the Hindi alphabet and pronunciation.
- To develop basic vocabulary related to daily life and surroundings.
- To enable learners to form simple sentences using basic verbs and expressions.
- To improve listening and speaking skills in simple conversational Hindi.
- To build confidence in reading and understanding elementary Hindi texts.

			Program Outcomes (PO)												Program Specific Outcome (PSO)		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Recognize and pronounce Hindi letters and basic sounds.	U						2				3		2			
CO-2:	Identify and use basic Hindi vocabulary related to daily life.	U						2				3		2			
CO-3:	Construct simple sentences using common verbs and expressions.	AP						2				3		2			
CO-4:	Communicate in basic everyday situations using simple Hindi.	AP						2				3		2			
CO-5:	Read and comprehend short and simple Hindi passages.	AN						3				3		2			

Unit-1	**Introduction and Basic Communication**	***6 Periods***
Basic greetings and phrases – Introduction to Hindi letters (Part I & II) – Simple vocabulary related to food, drinks, countries and nationalities.		
Unit-2	**Alphabet and Everyday Vocabulary**	***6 Periods***
Hindi letters (Part III, IV & V) – Numbers (Part I) – Vocabulary related to family, weather, school and education.		
Unit-3	**Grammar and Daily Expressions**	***6 Periods***
Basic verbs and sentence formation – Hobbies and interests – Animals and pets – Places in the city – Fruits and vegetables.		
Unit-4	**Functional Language and Descriptions**	***6 Periods***
Hindi letters (Part VI, VII, VIII & IX) – Clothes and colours – Numbers (Part II) – Simple descriptive and conversational practice.		
Unit-5	**Practice and Revision**	***6 Periods***
Comprehensive revision of alphabet, numbers, vocabulary and grammar – Listening, speaking and reading practice for everyday situations.		
	Total:	**30 Periods**

Learning Resources	Text Books	References
	1. Snell, Rupert & Simon Weightman – Teach Yourself Hindi – McGraw Hill. 2. Usha R. Jain – Introduction to Hindi Grammar – University of California Press.	1. McGregor, R.S. – Outline of Hindi Grammar – Oxford University Press. 2. Elementary Hindi Learning Materials (Instructor prepared notes).

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

* The expected levels for Bloom’s Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MC406	Course Name	Industrial Safety	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Mechanical Engineering	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To Understand the Introduction and basic Terminologies of safety.
- To enable the students to learn about the Important Statutory Regulations and standards
- To enable students to Conduct and participate the various safety activities in the industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Understand the basic concept of safety.	U	2	2				3	2	2	3	3		3			
CO-2:	Obtain knowledge of Statutory Regulations and standards.	U	2	2				3	2	3	3	2		3			
CO-3:	Know about the safety Activities of the Working Place.	U	2	3	1	1		2	2	2	3	2		2			
CO-4:	Analyze on the impact of Occupational Exposures and their Remedies	AN	2	3	1	2		3	2	2	3	2		3			
CO-5:	Obtain knowledge of Risk Assessment Techniques.	U	2	2	2	1	1	3	2	2	3	2		3			

Unit-1 **SAFETY TERMINOLOGIES** ***6 Periods***

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment-Health and Safety Policy-Material Safety Data Sheet MSDS

Unit-2 **STANDARDS AND REGULATIONS** ***6 Periods***

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

Unit-3 **SAFETY ACTIVITIES** ***6 Periods***

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

Unit-4 **WORKPLACE HEALTH AND SAFETY** ***6 Periods***

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

Unit-5 **HAZARD IDENTIFICATION TECHNIQUES** ***6 Periods***

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

Total: 30 Periods

Learning Resources	Text Books	References
	1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER 2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control. McGraw-Hill Education	1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition. 2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition. 3. Dan Petersen (2003) Techniques of Safety Management: A System Approach. 4. Alan Waring. (1996). Safety management system: Chapman &Hall, England 5. Society of Safety Engineers, USA

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	

* The expected levels for Bloom's Taxonomy should be:
- Lower-order thinking skills: not more than 40%
- Higher-order thinking skills: not less than 60%

Course Code	24MC408	Course Name	State, Nation Building and Politics in India	Course Category	T	Mandatory Courses	L	T	P	C
							2	0	0	0

Pre-requisite Courses	Nil	**Co- requisite Courses**	Nil	**Progressive Courses**	Nil
Course Offering Department	Science & Humanities (First year)	**Data Book / Codes / Standards**	Nil		

Course Objective: ***The purpose of learning this course is to:***

- To understand the evolution, nature, and role of the State and political systems.
- To examine the development of the Indian nation-state and constitutional framework.
- To analyze the structure and functioning of the organs of government.
- To evaluate the challenges of nation-building and democratic governance in India.
- To develop critical awareness of contemporary political developments and civic responsibilities.

			Program Outcomes (PO)												**Program Specific Outcome (PSO)**		
Course Outcomes (CO): ***At the end of this course, learners will be able to:***		**BL**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1:	Explain the concepts of State, nation, sovereignty, and globalization.	U						3		2		1		2			
CO-2:	Describe the structure and functioning of the Executive, Legislature, and Judiciary in India.	U						3		2		2		2			
CO-3:	Analyze the historical evolution of the Indian national movement and constitutional development.	AN						3		2		2		2			
CO-4:	Assess the challenges of nation-building, federalism, and democratic governance.	E						3	2	3		2		2			
CO-5:	Critically evaluate contemporary political changes and demonstrate responsible citizenship.	E						3	2	3	2	3		2			

Unit-1 **State, Nation and Sovereignty**	***6 Periods***
Understanding the need and role of State and politics - Development of the Nation-State - Concept of Sovereignty - Sovereignty in a Globalized World	
Unit-2 **Organs of the State and Forms of Government**	***6 Periods***
Organs of the State: Executive, Legislature, Judiciary - Separation of Powers - Forms of Government: Unitary and Federal - Parliamentary and Presidential Systems	
Unit-3 **The Idea of India and National Movement**	***6 Periods***
The Idea of India - 1857 and the National Awakening - Formation of Indian National Congress (1885) - Development of National Movement and its Legacies	
Unit-4 **Constitution and Nation-Building**	***6 Periods***
Constitution Making and the Constitution of India - Goals, Objectives and Philosophy of the Constitution - Why a Federal System? - National Integration and Nation-Building - Challenges of Nation-Building: State versus Democracy	
Unit-5 **Contemporary Indian Political System**	***6 Periods***
New Social Movements - Changing Nature of the Indian Political System - Future Scenario - What Can We Do?	
	Total: 30 Periods

Learning Resources	Text Books	References
	1. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi. 2. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012. 3. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition. 4. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.	1. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991. 2. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition. 3. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

Learning Assessment		
Continuous Learning Assessment (CLA) (100% weightage)		**End Semester Examination (0% weightage)**
Average of Internal Test (0%)	***Critical Thinking Assessment (100%)***	
* The expected levels for Bloom's Taxonomy should be: - Lower-order thinking skills: not more than 40% - Higher-order thinking skills: not less than 60%		