New Prince Shri Bhavani College Of Engineering and Technology

(An Autonomous Institution)

CURRICULUM
&
SYLLABUS
(1 to 8 SEMESTERS)

(REGULATION 2023)

FOR

B.E. – ELECTRONICS AND COMMUNICATION ENGINEERING

(CHOICE BASED CREDIT SYSTEM)

(Applicable to the students admitted from the Academic Year 2023 – 24)

SEMESTER – I								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
THEORY COURSES								
1	HS	U23EN101	Technical English - I	3	0	0	3	3
2	BS	U23MA101	Engineering Mathematics	3	1	0	4	4
3	BS	U23PH101	Engineering Physics	3	0	0	3	3
4	BS	U23CY101	Engineering Chemistry	3	0	0	3	3
5	ES	U23CP101	Programming in C	3	0	2	5	4
6	ES	U23BE101	Basic Electrical and Instrumentation Engineering	3	0	0	3	3
7	HS	U23TA101	தமிழர் மரபு / Heritage of Tamils	1	0	0	1	1
PRACTICAL COURSES								
8	BS	U23PC101	Physics and Chemistry Laboratory	0	0	3	3	1.5
9	HS	U23EN102	Professional Communication Laboratory	0	0	3	3	1.5
10	SIP	U23IP101	Induction programme	0	0	0	2 weeks	0
TOTAL CREDITS								24

SEMESTER – II								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
THEORY COURSES								
1	HS	U23EN201	Technical English - II	3	0	0	3	3
2	BS	U23MA201	Vector Calculus & Complex Functions	3	1	0	4	4
3	BS	U23PH201	Physics for Electrical and Electronics Engineers	3	0	0	3	3
4	ES	U23EG101	Engineering Graphics	2	0	4	6	4
5	ES	U23PY201	Python Programming	3	0	2	5	4
6	PC	U23EC201	Electronic Devices	3	0	0	3	3
7	HS	U23TA201	தமிழரும் தொழில்நுட்பமும்/ Tamils and Technology	1	0	0	1	1
PRACTICAL COURSES								
8	ES	U23EP101	Engineering Practices Laboratory	0	0	3	3	1.5
9	PC	U23EC202	Circuits and Devices Laboratory	0	0	3	3	1.5
TOTAL CREDITS								25

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SEMESTER – III								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	C
THEORY COURSES								
1	BS	U23MA303	Transforms and Random Processes	3	1	0	4	4
2	ES	U23CS306	Object Oriented Programming with Data Structures	3	0	2	5	4
3	PC	U23EC301	Digital Principles and Computer Organization	3	0	2	5	4
4	PC	U23EC302	Signals and Systems	3	1	0	4	4
5	PC	U23EC303	Electronic Circuits	3	0	0	3	3
6	MNC	U23MX01	Personal Values	2	0	0	2	0
PRACTICAL COURSES								
8	PC	U23EC304	Circuit Design and Simulation Laboratory	0	0	3	3	1.5
EMPLOYABILITY ENHANCEMENT COURSE								
9	EEC	U23EEC301	Employability Skills - I	0	0	2	2	1
TOTAL CREDITS								21.5

SEMESTER – IV								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	C
THEORY COURSES								
1	PC	U23EC401	Integrated Circuits and its Applications	3	0	2	5	4
2	PC	U23EC402	Control Systems	3	0	0	3	3
3	PC	U23EC403	Electromagnetic Field and Waves	3	0	0	3	3
4	PC	U23EC404	Microcontroller and its Applications	3	0	0	3	3
5	PC	U23EC405	Principles of Discrete Time Signal Processing	3	0	2	5	4
6	PC	U23EC406	Communication Systems	3	0	2	5	4
EMPLOYABILITY ENHANCEMENT COURSE								
6	EEC	U23EEC401	Employability Skills - II	0	0	2	2	1
TOTAL CREDITS								22

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SEMESTER – V								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	C
THEORY COURSES								
1	PC	U23CB501	Cyber Security	3	0	2	5	4
2	PC	U23EC501	VLSI Design	3	0	2	5	4
3	PC	U23EC502	Transmission lines and RF Systems	3	0	0	3	3
4	PC	U23EC503	Artificial Intelligence and Machine Learning	3	0	2	5	4
5	PC	U23MG501	Professional Ethics and IPR	2	0	0	2	2
6	PEC	U23PEECXX	Professional Elective - I					3
7	MNC	U23MX02	Environmental Sciences and Sustainability	2	0	0	2	0
8	HS	U23FLXX	Foreign Language Elective	2	0	0	2	2
EMPLOYABILITY ENHANCEMENT COURSE								
9	EEC	U23EEC501	Employability Skills - III	0	0	2	2	1
TOTAL CREDITS								23

SEMESTER – VI								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	C
THEORY COURSES								
1	PC	U23EC601	Antennas and Wave Propagation	3	0	0	3	3
2	PC	U23EC602	Wireless Communication	3	0	0	3	3
3	PEC	U23PEECXX	Professional Elective - II					3
4	PEC	U23PEECXX	Professional Elective - III					3
5	PEC	U23PEECXX	Professional Elective - IV					3
6	OE	U23OEXX	Open Elective - I					3
EMPLOYABILITY ENHANCEMENT COURSES								
7	PC	U23EC603	Wireless Communication Laboratory	0	0	3	3	1.5
8	EEC	U23EC604	Mini Project	0	0	3	2	1
9	EEC	U23EEC601	Employability Skills - IV	0	0	2	2	1
10	EEC	U23EEC102	Internship	0	0	0	0	1
TOTAL CREDITS								22.5

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SEMESTER – VII								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	C
THEORY COURSES								
1	PC	U23EC701	Embedded Systems and IOT Design	3	0	0	3	3
2	PC	U23EC702	Optical Communication and Networks	3	0	0	3	3
3	PC	U23EC703	Computer Communication Networks	3	0	0	3	3
4	HS	U23MG701	Project Management and Finance	2	0	0	2	2
5	PEC	U23PEECXX	Professional Elective - V					3
6	PEC	U23PEECXX	Professional Elective - VI					3
7	OEC	U23OEXX	Open Elective - II					3
PRACTICAL COURSES								
8	PC	U23EC704	Embedded Systems Laboratory	0	0	3	3	1.5
9	PC	U23EC705	Optical and Microwave Communication Laboratory	0	0	3	3	1.5
10	EEC	U23EC706	Comprehensive Review	0	0	2	2	1
TOTAL CREDITS								24

SEMESTER – VIII								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	C
EMPLOYABILITY ENHANCEMENT COURSE								
1	EEC	U23EC801	Project Work	0	0	16	16	8
TOTAL CREDITS								8

TOTAL CREDITS: 170

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PROFESSIONAL ELECTIVE COURSES: VERTICALS															
Course Code	Vertical I Semiconductor Chip Design and Testing	Course Code	Vertical II Signal Processing	Course Code	Vertical III RF Technologies	Course Code	Vertical IV Bio Medical Technologies	Course Code	Vertical V Cyber Security and Networking	Course Code	Vertical VI Sensor Technologies and IoT	Course Code	Vertical VII Space Technologies	Course Code	Vertical VIII High Speed Communications
U23PEEC01	Wide Bandgap Devices	U23PEEC07	Adaptive Signal Processing	U23PEEC13	RF Transceivers	U23PEEC19	Wearable Devices	U23PEEC25	Cloud Infrastructure and Services	U23PEEC31	IoT Based System Design	U23PEEC37	Avionics Systems	U23PEEC43	Millimeter Wave Communication
U23PEEC02	Advanced Digital System Design	U23PEEC08	Image Processing	U23PEEC14	Microwave Engineering	U23PEEC 20	Bio Medical Signal Processing	U23PEEC26	Cryptography and Cyber Security	U23PEEC32	IoT Processors	U23PEEC38	Positioning and Navigation Systems	U23PEEC44	Advanced Wireless Communication Techniques
U23PEEC03	Low Power IC Design	U23PEEC09	Speech Processing	U23PEEC15	MICs and RF System Design	U23PEEC 21	Therapeutic Equipment	U23PEEC27	Deep Learning Techniques	U23PEEC33	Wireless Sensor Network Design	U23PEEC39	Satellite Communication	U23PEEC45	4G/5G Communication Networks
U23PEEC 04	VLSI Testing and Design for Testability	U23PEEC10	Video Analytics	U23PEEC 16	EMI/EMC Pre Compliance Testing	U23PEEC22	Medical Imaging Systems	U23PEEC28	Computer Vision	U23PEEC34	MEMS Design	U23PEEC40	Remote Sensing	U23PEEC46	Software Defined Networks
U23PEEC05	Analog IC Design	U23PEEC11	DSP Architecture and Programming	U23PEEC17	RFID System Design and Testing	U23PEEC23	Brain Computer Interface and Applications	U23PEEC29	Security in IoT	U23PEEC35	Industrial IoT and Industry 4.0	U23PEEC41	Rocketry and Space Mechanics	U23PEEC47	Massive MIMO Networks
U23PEEC06	Electronics Circuit Board Design	U23PEEC12	Advanced Digital Signal Processing	U23PEEC18	Signal Integrity	U23PEEC24	Robotics in Medicine	U23PEEC30	Blockchain Technologies	U23PEEC36	Fundamentals of Nano Electronics	U23PEEC42	Radar Technologies	U23PEEC48	High Performance Computer Networks

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: SEMICONDUCTOR CHIP DESIGN AND TESTING								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
1	PE	U23PEEC01	Wide Bandgap Devices	2	0	2	4	3
2	PE	U23PEEC02	Advanced Digital System Design	2	0	2	4	3
3	PE	U23PEEC03	Low Power IC Design	2	0	2	4	3
4	PE	U23PEEC04	VLSI Testing and Design for Testability	3	0	0	3	3
5	PE	U23PEEC05	Analog IC Design	2	0	2	4	3
6	PE	U23PEEC06	Electronics Circuit Board Design	2	0	2	4	3

VERTICAL 2: SIGNAL PROCESSING								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
1	PE	U23PEEC07	Adaptive Signal Processing	2	0	2	4	3
2	PE	U23PEEC08	Image Processing	2	0	2	4	3
3	PE	U23PEEC09	Speech Processing	2	0	2	4	3
4	PE	U23PEEC10	Video Analytics	3	0	0	3	3
5	PE	U23PEEC11	DSP Architecture and Programming	2	0	2	4	3
6	PE	U23PEEC12	Advanced Digital Signal Processing	2	0	2	4	3

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VERTICAL 3: RF TECHNOLOGIES								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
1	PE	U23PEEC13	RF Transceivers	2	0	2	4	3
2	PE	U23PEEC14	Microwave Engineering	2	0	2	4	3
3	PE	U23PEEC15	MICs and RF System Design	2	0	2	4	3
4	PE	U23PEEC16	EMI/EMC Pre Compliance Testing	2	0	2	4	3
5	PE	U23PEEC17	RFID System Design and Testing	2	0	2	4	3
6	PE	U23PEEC18	Signal Integrity	2	0	2	4	3

VERTICAL 4: BIO MEDICAL TECHNOLOGIES								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
1	PE	U23PEEC19	Wearable Devices	3	0	0	3	3
2	PE	U23PEEC20	Bio Medical Signal Processing	3	0	0	3	3
3	PE	U23PEEC21	Therapeutic Equipment	3	0	0	3	3
4	PE	U23PEEC22	Medical Imaging Systems	3	0	0	3	3
5	PE	U23PEEC23	Brain Computer Interface and Applications	3	0	0	3	3
6	PE	U23PEEC24	Robotics in Medicine	3	0	0	3	3

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VERTICAL 5: CYBER SECURITY AND NETWORKING								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
1	PE	U23PEEC25	Cloud Infrastructure and Services	2	0	2	4	3
2	PE	U23PEEC26	Cryptography and Cyber Security	2	0	2	4	2
3	PE	U23PEEC27	Deep Learning Techniques	2	0	2	4	3
4	PE	U23PEEC28	Computer Vision	2	0	2	4	2
5	PE	U23PEEC29	Security in IoT	3	0	0	3	3
6	PE	U23PEEC30	Blockchain Technologies	2	0	2	4	3

VERTICAL 6: SENSOR TECHNOLOGIES AND IOT								
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Total Contact Periods	Credits
1	PE	U23PEEC31	IoT Based System Design	2	0	2	4	3
2	PE	U23PEEC32	IoT Processors	2	0	2	4	3
3	PE	U23PEEC33	Wireless Sensor Network Design	2	0	2	4	3
4	PE	U23PEEC34	MEMS Design	2	0	2	4	3
5	PE	U23PEEC35	Industrial IoT and Industry 4.0	2	0	2	4	3
6	PE	U23PEEC36	Fundamentals of Nano Electronics	3	0	0	3	3

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VERTICAL 7: SPACE TECHNOLOGIES								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
1	PE	U23PEEC37	Avionics Systems	3	0	0	3	3
2	PE	U23PEEC38	Positioning and Navigation Systems	3	0	0	3	3
3	PE	U23PEEC39	Satellite Communication	3	0	0	3	3
4	PE	U23PEEC40	Remote Sensing	3	0	0	3	3
5	PE	U23PEEC41	Rocketry and Space Mechanics	3	0	0	3	3
6	PE	U23PEEC42	Radar Technologies	3	0	0	3	3

VERTICAL 8: HIGH SPEED COMMUNICATIONS								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
1	PE	U23PEEC43	Millimeter Wave Communication	3	0	0	3	3
2	PE	U23PEEC44	Advanced Wireless Communication Techniques	3	0	0	3	3
3	PE	U23PEEC45	4G/5G Communication Networks	2	0	2	4	3
4	PE	U23PEEC46	Software Defined Networks	2	0	2	4	3
5	PE	U23PEEC47	Massive MIMO Networks	2	0	0	4	3
6	PE	U23PEEC48	High Performance Computer Networks	3	0	0	3	3

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SET I - OPEN ELECTIVES for ECE							
SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	Total Contact Periods	Credits
1	U23OE101	Algebra and Number Theory	3	0	0	3	3
2	U23OE102	Probability and Queueing Theory	3	0	0	3	3
3	U23OE103	Probability and Random Processes	3	0	0	3	3
4	U23OE104	Linear Algebra	3	0	0	3	3
5	U23OE105	Everyday Physics	3	0	0	3	3
6	U23OE106	Consumer Awareness on Appliances	3	0	0	3	3
7	U23OE107	Bio Physics	3	0	0	3	3
8	U23OE108	Astrophysics	3	0	0	3	3
9	U23OE109	Introduction to Nanoscience and Nanotechnology	3	0	0	3	3
10	U23OE110	Green Technology	3	0	0	3	3
11	U23OE111	The Environment and Society	3	0	0	3	3
12	U23OE112	Industrial corrosion and Prevention	3	0	0	3	3
13	U23OE113	English Through Media	3	0	0	3	3
14	U23OE114	English for Employability Skills	3	0	0	3	3
15	U23OE115	Inventions and Applications	3	0	0	3	3
16	U23OE116	Public Policy and Governance	3	0	0	3	3
17	U23OE122	Fundamentals of Electric and Hybrid Vehicle	3	0	0	3	3
18	U23OE123	Introduction to PLC Programming	3	0	0	3	3
19	U23OE124	Energy Management and Auditing	3	0	0	3	3
20	U23OE125	Fundamentals of Robotics	3	0	0	3	3
21	U23OE126	Medical Instrumentation	3	0	0	3	3
22	U23OE127	Program Language Principles	3	0	0	3	3
23	U23OE128	Data Warehousing and Data Mining	3	0	0	3	3
24	U23OE129	Foundations of Soft Computing Techniques	3	0	0	3	3
25	U23OE130	Fundamentals of Cloud Computing	3	0	0	3	3
26	U23OE131	Human Computer Interaction	3	0	0	3	3
27	U23OE132	Web Development Fundamentals	3	0	0	3	3
28	U23OE133	Network Management Systems	3	0	0	3	3
29	U23OE134	Fundamentals of Mobile Computing	3	0	0	3	3
30	U23OE135	Electronic Commerce	3	0	0	3	3
31	U23OE136	Machine Learning using Python	2	0	2	4	3
32	U23OE137	Applied Design Thinking	3	0	0	3	3
33	U23OE138	Fire Safety Engineering	3	0	0	3	3
34	U23OE139	Functional Materials	3	0	0	3	3
35	U23OE140	Fundamentals of Aeronautical Engineering	3	0	0	3	3
36	U23OE141	Industrial Design & Rapid Prototyping Techniques	3	0	0	3	3

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SET II - OPEN ELECTIVES for ECE							
SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	Total Contact Periods	Credits
1	U23OE201	Statistics and Numerical Methods	3	0	0	3	3
2	U23OE202	Resource Management Techniques	3	0	0	3	3
3	U23OE203	Graph Theory	3	0	0	3	3
4	U23OE204	Operations Research	3	0	0	3	3
5	U23OE205	Scientific Principles in Historical Monuments	3	0	0	3	3
6	U23OE206	Non-Conventional Energy Sources	3	0	0	3	3
7	U23OE207	Environmental Physics	3	0	0	3	3
8	U23OE208	Entrepreneurship Development	3	0	0	3	3
9	U23OE209	Basics of Bioenergy and Biofuels	3	0	0	3	3
10	U23OE210	Food Science	3	0	0	3	3
11	U23OE211	Fundamentals of Crop Production	3	0	0	3	3
12	U23OE212	Water Pollution and Control Management	3	0	0	3	3
13	U23OE213	Personality Development	3	0	0	3	3
14	U23OE214	Workplace Communication	3	0	0	3	3
15	U23OE215	English for Competitive Examinations	3	0	0	3	3
16	U23OE216	English for Professional Excellence	3	0	0	3	3
17	U23OE222	Industrial Safety	3	0	0	3	3
18	U23OE223	Renewable Energy Technologies	3	0	0	3	3
19	U23OE224	Introduction to Smart Grid	3	0	0	3	3
20	U23OE225	Basics of Power Plant Engineering	3	0	0	3	3
21	U23OE226	Automotive Electronics	3	0	0	3	3
22	U23OE227	Foundation of AI & Problem solving	3	0	0	3	3
23	U23OE228	Introduction to R Programming	3	0	0	3	3
24	U23OE229	Foundations of NLP	3	0	0	3	3
25	U23OE230	Foundations of Speech Recognition	3	0	0	3	3
26	U23OE231	Essentials of Data Science and Analytics	3	0	0	3	3
27	U23OE232	Fundamentals of Network Security	2	0	2	4	3
28	U23OE233	Cyber Laws and Ethics	3	0	0	3	3
29	U23OE234	Trust Management in E-Commerce	3	0	0	3	3
30	U23OE235	Linux Fundamentals	2	0	2	4	3
31	U23OE236	Cyber Threat Intelligence	3	0	0	3	3
32	U23OE237	Nanomaterials and applications	3	0	0	3	3
33	U23OE238	Plastic Materials for Engineers	3	0	0	3	3
34	U23OE239	Production and Operations Management for Entrepreneurs	3	0	0	3	3
35	U23OE240	Quality Engineering	3	0	0	3	3
36	U23OE241	Reverse Engineering	3	0	0	3	3

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U23EN101	TECHNICAL ENGLISH - I	L	T	P	C
	(Common to all branches)	3	0	0	3

Prerequisites: **Fundamentals of Analytical Skills in English**

COURSE OBJECTIVES:

- To enhance reading comprehension skills for technical articles to grasp and interpret complex concepts.
- To prepare students' for effective communication and writing in technical and professional contexts.
- To develop the ability to write persuasive job applications and structured resumes effectively.

UNIT I **INTRODUCTION** 9

Reading – Requirement for Reading – reading short technical texts from journals and newspapers; **Writing** –Compare and Contrast Essay; Email Writing; **Grammar** – Parts of Speech, Mixed Tenses, Prepositional phrases; **Vocabulary Development** – Contextual meaning of words.

UNIT II **READING AND LANGUAGE DEVELOPMENT** 9

Reading – Reading Advertisements, User Manuals, Brochures; **Writing** - Process Writing, Interpreting charts & graphs; **Grammar** – Active and Passive Voice transformations, Infinitive and Gerunds; **Vocabulary Development** – Vocabulary used in formal & informal letters / emails and reports.

UNIT III **TECHNICAL WRITING AND GRAMMAR** 9

Reading – Reading Longer texts both general and technical, practice in speed reading; **Writing** – Writing responses to complaints, Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay; **Grammar** – Error correction; If Clauses, Compound Words, Punctuation; **Vocabulary Development** – Sentence Completion.

UNIT IV **REPORT WRITING** 9

Reading – Reading for detailed comprehension: Skimming and Scanning; **Writing**- Recommendations, Writing Reports – Accident Report, Survey Report, Minutes of a meeting; **Grammar** – Reported Speech, Modals; **Vocabulary Development** – Technical Vocabulary.

UNIT V **GROUP DISCUSSION AND JOB APPLICATIONS** 9

Reading – Reading and understanding Technical Articles; **Writing** – Writing Job Application – Resume Preparation (via email and hard copy); **Grammar** – Numerical Adjectives, Relative Clauses, Idioms and Phrases; **Vocabulary Development** – Verbal Analogies.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1 Veena Selvam, "English for Science and Technology", Cambridge University Press, 2021.

2 N P Sudharshana,m, C Saveetha, "English for Technical Communication", Cambridge University Press, New Delhi, 2016.

REFERENCES:

1 E Suresh Kumar, "Engineering English", Orient Black swan, Hyderabad, 2015.

2 Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles and Practice", Oxford University Press, New Delhi, 2014.

3 Marion Grussendorf, "English for Presentations", Oxford University Press, 2007.

ONLINE RESOURCES:

1 https://iimskills.com/coursera-technical-writing-course/

2 https://www.udemy.com/course/easy-english-grammar-course

3 https://www.coursera.org/learn/introduction-to-research-for-essay-writing

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Write essays and emails.

CO2 Describe any process, interpretation of charts and graphs both general and technically.

CO3 Write letters and responses to complaints.

CO4 Write Recommendations, minutes and reports of events.

CO5 Write Job application with Resume.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	3	-	3	-	1
CO2	3	-	-	-	-	-	-	3	-	3	-	1
CO3	3	-	-	-	-	-	-	3	-	3	-	1
CO4	3	-	-	-	-	-	-	3	-	3	-	1
CO5	3	-	-	-	-	-	-	3	-	3	-	1

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U23MA101	ENGINEERING MATHEMATICS (Common to all branches)	L T P C 3 1 0 4

Prerequisites: Fundamental Concepts on Matrices and Calculus

COURSE OBJECTIVES:

- To enhance the utilization of matrix algebra techniques that is needed by engineers for practical applications in engineering.
- To familiarize the students with differential calculus and functions of several variables.
- To acquaint the students with the mathematical tools required for the assessment of multiple integrals and their practical applications.

UNIT I **MATRICES** **12**

Symmetric and orthogonal matrices – Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton theorem (Without proof) Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II **DIFFERENTIAL CALCULUS** **12**

Representation of functions – Limit of a function – Continuity – Derivatives – Differentiation rules (sum, product, quotient, chain rules) – Implicit differentiation – Logarithmic differentiation – Applications: Maxima and Minima of functions of one variable.

UNIT III **FUNCTIONS OF SEVERAL VARIABLES** **12**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV **INTEGRAL CALCULUS** **12**

Definite and Indefinite integrals – Substitution rule – Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions – Improper integrals.

UNIT V **MULTIPLE INTEGRALS** **12**

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.

TOTAL: 60 PERIODS

TEXT BOOKS:

1 S K Pundir, Bhupander Singh, "Differential Calculus", Pragathi Prakashan Publishers Pvt. Ltd., 2023.

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2 B S Grewal, "Higher Engineering Mathematics", 45th Edition, Khanna Publishers, 2018.

REFERENCES:

1 R K Jain, S R K Iyengar, "Advanced Engineering Mathematics", 6th Edition, Narosa Publications, 2021.
2 Ravish R Singh, Mukul Bhatt, "Advanced Engineering Mathematics", 2nd Edition, Tata McGraw Hill, 2020.
3 H C Taneja, "Advanced Engineering Mathematics", Dreamtech Press, 2019.
4 T K V Iyengar, M V A A N Prasad, B Krishna Gandhi, "Engineering Mathematics", Special Edition, S. Chand & Company Ltd., 2023.

ONLINE RESOURCES :

1 http://nptel.ac.in/courses/111105035/10

2 http://nptel.ac.in/courses/111105035/5

3 http://nptel.ac.in/courses/111105035/17

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply Cayley-Hamilton theorem and orthogonal transformation for different process of matrices.
CO2 Analyze the differentiation rules to find the extreme values of functions.
CO3 Apply the concepts of partial derivatives and total derivatives in Taylor's series, Jacobians and maxima and minima of functions.
CO4 Evaluate definite and improper integrals using techniques of integration
CO5 Evaluate area and volume using double and triple integrals.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	-	-	-	-	-
CO2	3	3	1	2	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	3	3	2	3	-	-	-	1	-	-	-	1
CO5	3	3	2	3	-	-	-	1	-	-	-	1

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U23PH101	ENGINEERING PHYSICS (Common to all branches)	L	T	P	C
		3	0	0	3

Prerequisites: Fundamentals of Mechanics and Optics

COURSE OBJECTIVES:

- To enable the students effectively understand concepts of mechanics and elastic properties of materials.
- To gain knowledge about thermal physics, ultrasonics, lasers, optical fibres with applications.
- To introduce the basics of quantum mechanics, crystal structures and imperfections.

UNIT I **MECHANICS AND ELASTICITY** 9

Center of mass (CM) – Rotational kinematics – Moment of Inertia (M.I.) – Theorems of M.I.:parallel and perpendicular axes theorems – M.I. of continuous bodies – Conservation of angular momentum – Elasticity – Hooke's law – Stress-Strain diagram – Poisson's ratio – Factors affecting elasticity – Bending moment – Depression of a cantilever –Young's modulus by uniform bending – I-shaped girders.

UNIT II **THERMAL PHYSICS AND ULTRASONICS** 9

Modes of heat transfer – Thermal conductivity – Newton's law of cooling – Lee's disc method – Radial heat flow – Rubber tube method – Characteristics and Production of ultrasonics by magnetostriction and piezoelectric methods – Acoustic grating – Non-destructive testing – Medical applications: Sonogram.

UNIT III **LASERS AND FIBRE OPTICS** 9

Laser: characteristics and properties – Einstein's coefficients derivation – Population inversion –Types of lasers: Nd-YAG laser, CO_2 laser, semiconductor laser – Applications of lasers – Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle – Classification of optical fibres (material, refractive index, mode) – Optical-fibre communication system (Block diagram only).

UNIT IV **QUANTUM MECHANICS** 9

Black body radiation – Photons and light waves – Electrons and matter waves – Compton effect: Theory and experimental verification – The Schrodinger equation: Time dependent and time independent forms – Physical significance of wave function –Particle in an infinite potential well:1D – Electron microscopes: Scanning Electron Microscope and Transmission Electron Microscope.

UNIT V **CRYSTAL PHYSICS** 9

Lattice – Bravais lattice – Lattice planes – Miller indices – d-spacing in cubic lattice– Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP crystal structures – Crystal imperfections: point, line and surface defects.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1 D. Kleppner, R Kolenkow, "An Introduction to Mechanics", Tata McGraw Hill, 2017.

2 Arthur Beiser, Shobhit Mahajan, S Rai Choudhury, "Concepts of Modern Physics", Tata McGraw Hill, 2017.

REFERENCES:

1 R. Wolfson, "Essential University Physics", Volume 1 & 2, 4th Edition, Pearson Education, 2020.

2 K Thyagarajan, A Ghatak, "Lasers: Fundamentals and Applications", 2nd Edition, Laxmi Publication, 2019.

3 P K Palanisamy, "Materials Science", Scitech Publication India Pvt. Ltd., 2015.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=physics

2 https://archive.nptel.ac.in/courses/115/102/115102124/

3 https://onlinecourses.nptel.ac.in/noc24_ph17/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend the basics of mechanics and elastic properties of materials.

CO2 Explain the thermal physics concepts, production and applications of ultrasonic waves.

CO3 Apply the basic concepts of lasers and optical fibre in various fields.

CO4 Describe the basics of quantum mechanical phenomenon and electron microscopes.

CO5 Explain the fundamentals of crystal structures and imperfections.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	1	1	1	-	-	-	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

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U23CY101	ENGINEERING CHEMISTRY (Common to all branches)	L	T	P	C
		3	0	0	3

Prerequisites: Fundamentals of Basic Chemistry

COURSE OBJECTIVES:

- To make the students conversant with water treatment techniques and the electrochemical reactions.
- To facilitate the understanding of fuel classification, preparation, combustion and environmental impact.
- To acquire a deep understanding of renewable energy sources and nano materials, their properties and applications.

UNIT I WATER AND ITS TREATMENT 9

Water: Sources and impurities, hardness, alkalinity. Boiler troubles: Scale and sludge. Treatment of boiler feed water: Internal treatment (sodium aluminate and calgon conditioning) and External treatment Ion exchange demineralization process, Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination), Desalination of brackish water: Reverse Osmosis.

UNITII ELECTRO CHEMISTRY AND DEVICE CORROSION 9

Electrochemistry: Introduction, Electrochemical cells – electrolytic cell – reversible and irreversible cells. Electrode potential – Oxidation and reduction Potentials – emf, Nernst equation and applications. Reference electrodes – Calomel electrode – Electro chemical series – its applications.

Device Corrosion: Introduction- chemistry of IC and PCB – causes of corrosion on IC, PC-miniaturization and complex material utilization- forms of corrosion – anodic and cathodic corrosion-Prevention of corrosion.

UNITIII FUELS AND COMBUSTION 9

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method), Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking – octane number, diesel oil – cetane number; Power alcohol and biodiesel.

Combustion of Fuels: Introduction: Calorific value – higher and lower calorific values, Theoretical calculation of calorific value; Flue gas analysis – ORSAT Method. CO_2 emission and carbon foot print.

UNIT IV ENERGY SOURCES AND STORAGE DEVICES 9

Solar energy conversion: Principle, working and applications of solar cells; recent developments in solar cell materials. Wind energy; Geothermal energy. Hydrogen as fuel: Sources of hydrogen – Hydrogen production methods – electrolysis, limitations and applications.

Storage Devices: Batteries – Types of batteries, Primary battery – dry cell, Secondary battery – lead acid battery and lithium – ion battery; Electric vehicles working principles.

UNIT V NANO CHEMISTRY 9

Basics: Distinction between molecules, nanomaterials and bulk materials; Types of nanomaterials: Definition, properties and uses of nano particles and nanotube. Preparation

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of nano materials: laser ablation, chemical vapours deposition, electrochemical deposition and electro spinning. An application of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Jain P C, Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company Pvt. Ltd., New Delhi, 2021.

2 Chatla Naga Babu, G Kanthimathi, "Text Book of Engineering Chemistry", 1st Edition, AG Publishing House, 2023.

REFERENCES:

1 Reza K Haghi, Fransico Torrens, "Engineering Technology and Industrial Chemistry with Applications", Apple Academic Press, 2021.

2 Anna Klinkova, "Nano Chemistry", 1st Edition, Springer. 2023.

3 Stroud N, "Fundamentals of Engineering Chemistry", American Academic Publishers, 2023.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_ch27/preview

2 https://nptel.ac.in/courses/105107207

3 https://onlinecourses.nptel.ac.in/noc19_mm21/preview

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the type of factors present in boilers and the method used to treat hard water.

CO2 Apply the principles of electrochemistry to corrosion process and the applications of protective coatings to overcome the corrosion.

CO3 Summarize the various solid, liquid and gaseous fuels manufacturing methods and basic reactions involved in combustion reaction.

CO4 Describe the types of batteries their reactions and the significance of storage renewable energy resource.

CO5 Apply the basic concepts of nanomaterials and its application in various sectors.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	-	-	1	1	-	-	-	-	1
CO2	3	2	1	-	-	1	1	-	-	-	-	1
CO3	2	2	1	-	-	1	1	1	-	-	-	1
CO4	2	2	1	-	-	1	1	-	-	-	-	1
CO5	3	2	1	-	-	1	-	-	-	-	-	1

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U23CP101	PROGRAMMING IN C (Common to all Branches)	L T P C 3 0 2 4

Prerequisites: **Mathematical Fundamentals**

COURSE OBJECTIVES:

- To understand the basic construct of C Language and develop C programming of these construct.
- To develop C program using arrays, strings and modular applications using functions.
- To develop applications in C using pointers, structures and union.

UNIT I **BASICS OF C PROGRAMMING** **9**

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. Illustrative Programs: Use of Variables in expression and their evaluation, Temperature Conversion (Fahrenheit to Celsius) Problem.

UNIT II **DECISION MAKING AND LOOPING** **9**

Simple if Statements, The if.else statements, Nesting of if...else statements, else...if Ladder, switch Statements, goto Statements, while, do...while, for Statements , Illustrative Problems: EB Bill Computations, Determination of Average Cost and the range of the values , and Square root of a Series , Student Grade System.

UNIT III **ARRAYS AND STRINGS** **9**

Introduction to Arrays: Declaration, Initialization – One dimensional array – Two dimensional arrays – String operations: length, compare, concatenate, copy – Selection sort, linear and binary search. Illustrative Programs: palindrome Checking using arrays and String, Concatenation of strings.

UNIT IV **FUNCTIONS AND POINTERS** **9**

Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion, Binary Search using recursive functions – Pointers – Pointer operators, Parameter passing: Pass by value, Pass by reference. Illustrative Program: Fibonacci Series, Towers of Hanoi.

UNIT V **STRUCTURES AND UNION** **9**

Structure - Nested structures – Array of structures – Self-referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility. Illustrative Program: To Print name and address of Employee, Generate Student Mark List.

45 PERIODS

PRACTICAL EXERCISES:

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.

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6. Functions and Pointers: Passing parameters by (value, reference), passing arrays to function, Recursion using pointers.
7. Structures and Unions: Nested Structures, Arrays of Structures and Unions

30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 Reema Thareja, "Programming in C", Oxford University Press, 2nd Edition, 2018.

2 Brian W Kernighan, Dennis M Ritchie, "The C Programming language", 3rd Edition, Prentice Hall of India, 2019.

REFERENCES:

1 Paul Deitel, Harvey Deitel, "C How to Program with an Introduction to C++", 8th Edition, Pearson Education, 2018.

2 Yashwant Kanetkar, "Let us C", 17th Edition, BPB Publications, 2020.

3 Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", 2nd Edition, Oxford University Press, 2013.

4 Anita Goel, Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2016.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_cs40/preview

2 https://onlinecourses.swayam2.ac.in/cec24_cs05/preview

3 https://onlinecourses.swayam2.ac.in/nou24_cs06/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe knowledge on C Programming constructs.

CO2 Apply the simple applications in C using decision making and looping.

CO3 Design the various applications using arrays and strings.

CO4 Write and implement modular applications in C using functions and Pointers.

CO5 Apply the User defined concept in C using Structures and Unions.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	1	1	-	1
CO2	3	3	3	3	-	-	-	1	1	1	-	1
CO3	3	3	3	3	-	-	-	1	1	1	-	1
CO4	3	3	3	3	1	-	-	1	1	1	-	1
CO5	3	3	3	3	1	-	-	1	1	1	-	1

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U23BE101	BASIC ELECTRICAL AND INSTRUMENTATION ENGINEERING	L	T	P	C
		3	0	0	3

Prerequisites: Basics of Physics and Mathematics

COURSE OBJECTIVES:

- To introduce the basics of DC and AC electric circuits and analysis.
- To provide knowledge on the principles of DC and AC electrical machines.
- To introduce the functional elements and working of measuring instruments.

UNIT I **DC CIRCUITS** 9

Energy sources (Dependent & Independent) – Ohm's law – Kirchhoff 's laws – Voltage division and current division rules - Nodal & Mesh analysis of simple circuits – Network Theorems: Superposition, Thevenin, Norton and Maximum Power transfer Theorems

UNIT II **AC CIRCUITS** 9

Average and RMS Value – Complex Impedance – Phasor diagram – Measurements of Real and Reactive Power, Power Factor, Energy – Mesh current and node voltage analysis – Three phase 3-wire and 4-wire circuits with star and delta connected balanced and unbalanced Loads.

UNIT III **DC MACHINES AND TRANSFORMERS** 9

DC Generator: Constructional Features – EMF Equation – Types – Characteristics – Applications, DC Motor: Working Principle – Torque Equation – Types – Characteristics – Speed Control – Applications, Transformer: Construction – Working Principle – Types– EMF Equation - Connections of Three Phase Transformer - Autotransformer – Applications

UNIT IV **AC ELECTRICAL MACHINES** 9

Three Phase Induction Motor: Principle of Operation – Construction – Types – Speed Control – Single Phase Induction Motor: Construction – Types – Starting Methods. Alternator: Working Principle – Equation of Induced EMF – Synchronous Motor: Working Principle – Starting Methods – Torque Equation.

UNIT V **MEASUREMENTS AND INSTRUMENTATION** 9

Functional Elements of an Instrument – Standards and Calibration - Operating Principle – Types: Moving Coil and Moving Iron Meters, Energy Meter – Instrument Transformers: CT and PT – DSO – Block diagram – Data Acquisition System

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Kothari D. P. and I. J. Nagrath, "Basic Electrical and Electronics Engineering", 2nd Edition, Tata McGraw Hill, 2020.

2 S K Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, 2nd Edition, 2017.

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REFERENCES:

1 D C Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, 2nd Edition, 2019.

2 E Hughes, "Electrical and Electronics Technology", Pearson Education, 2010.

4 Roman Malaric, "Instrumentation and Measurement in Electrical Engineering", Arcler Education Inc., 2016.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/108105112.

2 https://www.udemy.com/course/basic-electrical-engineering-electrical-engineering.

3 https://www.coursera.org/learn/electronics.

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply basic laws and theorems in DC electrical circuits

CO2 Solve AC electrical circuits using basic laws

CO3 Explain the construction, working and applications of DC Machines and Transformers

CO4 Describe the construction, working and applications of AC Machines

CO5 Summarize the operating principles of measuring instruments

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	1	-	-	-	1
CO2	2	2	1	1	-	-	-	1	-	-	-	1
CO3	2	2	1	1	-	-	-	1	-	-	-	-
CO4	2	2	1	1	-	-	-	1	-	-	-	-
CO5	2	2	1	1	-	-	-	1	-	-	-	1

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U23TA101	தமிழர் மரபு	L	T	P	C
	(Common to all Branches)	1	0	0	1

நோக்கம்:

- பாரம்பரியக் கலாச்சாரத்தின் நுண்ணறிவையும் மற்றும் கட்டிடக்கலையின் அற்புதங்களில் நடைபெறும் பொறியியல் நுட்பங்களை எடுத்துரைப்பதாகும்.
- தமிழ்மொழி, பண்பாடு, கலைகள், மரபுகளின் வரலாற்றைப் பற்றி எடுத்துரைப்பதன் நோக்கமாகும்.
- அந்தணர்க்கும் அரசர்க்கும் கல்வியையும், வணிகர்களுக்கு வியாபாரத்தையும், வேளாண் மக்களுக்கு உழவுத்தொழிலையும் தமிழர் மரபின் எடுத்துரைப்பதாகும்.

அலகு – 1 **மொழி மற்றும் இலக்கியம்** 3

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு – 2 **மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை** 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு – 3 **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்** 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு – 4 **தமிழர்களின் திணைக்கோட்பாடுகள்** 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு – 5 **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு** 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறபகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுய மரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL: 15 PERIODS

TEXT BOOKS:

1. முனைவர் ஆ. பூபாலன் "தமிழர் மரபு", வி.ஆர்.பி. வெளியீடு புதிய பாடத்திட்டம் 2023 – 24 அண்ணா பல்கலைக்கழகம்.

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2. முனைவர் ஆ. ஹேமமாலினி "தமிழர் மரபு", வி.ஆர்.பி. வெளியீடு புதிய பாடத்திட்டம் 2023 – 24 அண்ணா பல்கலைக்கழகம்.

REFERENCES:

1. முனைவர் கே.கே. பிள்ளை "தமிழக வரலாறு, மக்களும், பண்பாடும்,", வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம், 1972.
2. முனைவர் இல. சுந்தரம், "பொருநை, ஆற்றங்கரை நாகரிகம்,", வெளியீடு: தொல்லியல் துறை மற்றும் தமிழ்நாடு அரசுத் துறை, 2022.
3. Dr. S. V. சுப்பிரமணியன், னுச.மு.னு. திருநாவுக்கரசு "தமிழர்களின் வரலாற்று பாரம்பரியம்", சர்வதேச தமிழ் ஆய்வு நிறுவனம், 2022.

ONLINE RESOURCES:

1. https://unacademy.com/lesson/introduction-and-administrative-system-of-cultural-heritage-of-tamil-in-tamil/ATMT6TK4
2. https://unacademy.com/lesson/society-and-sangam-literature-in-tamil/ C5QL4L0Q
3. https://unacademy.com/lesson/classical-tamil-literature-epigraphy-and-hero-stones-in-tamil/817FIREX

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 மொழிகள், இலக்கியங்கள் மற்றும் காப்பியங்கள் பற்றி தொகுக்க இயலும்.
Summarize about languages, literatures and scripts.

CO2 நடுகற்கள், நவீன சிற்பங்கள், ஐம்பொன் சிலைகள், மற்றும் இசைக் கருவிகள் பற்றி விளக்க இயலும்.
Explain middle stone, modern sculptures, panchaloga idols and musical instruments.

CO3 நாட்டுப்புறத் தெய்வங்கள், கலைகள் மற்றும் வீர விளையாட்டுகள் பற்றி விளக்க இயலும்.
Explain about the folk gods, arts and heroic sports.

CO4 தமிழர்களின் திணைக்கோட்பாடுகள் பற்றி தொகுக்க இயலும்.
Summarize the political theories of tamils.

CO5 இந்திய தேசிய இயக்கம், மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு பற்றி தொகுக்க இயலும்.
Summarize Indian national movement contribution of Tamils to Indian culture.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	1	-	-	-	-	-	-	-	-	-	-	-
CO4	1	-	-	-	-	-	-	-	-	-	-	-
CO5	1	-	-	-	-	-	-	-	-	-	-	-

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U23PC101	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
	(Common to all branches)	0	0	3	1.5

Prerequisites: Principles of Physics and Chemistry

COURSE OBJECTIVES:

- To provide an experimental foundation for the theoretical concepts introduced in the lectures.
- To teach how to make careful experimental observations and how to think about and draw conclusions from such data.
- To help students understand the role of direct observation in physics and chemistry to distinguish between inferences based on theory and the outcomes of experiments.

PHYSICS LABORATORY

LIST OF EXPERIMENTS (Any FIVE Experiments)

1. Determination of Young's modulus by Non uniform bending method.
2. Determination of Rigidity modulus of wire and moment of inertia using torsional pendulum.
3. Determination of Young's modulus by Simple harmonic oscillations of cantilever.
4. Determination of Wavelength of the Laser using grating.
5. Determination of Numerical aperture and acceptance angle in an optical fiber.
6. Determination of velocity of sound and compressibility of liquid –Ultrasonic Interferometer.
7. Determination of thickness of a thin sheet of wire–Air wedge.

CHEMISTRY LABORATORY

LIST OF EXPERIMENTS (Any FIVE Experiments)

1. Determination of total, temporary and permanent hardness of water by EDTA method.
2. Determination of chloride content of water sample by Argentometric method.
3. Determination of alkalinity in water sample.
4. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method.
5. Determination of strength of given hydrochloric acid using pH meter.
6. Conductometric titration of strong acid Vs strong base.
7. Conductometric titration of barium chloride Vs sodium sulphate.
8. Estimation of iron content of the given solution by using potentiometer.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

CO1 Calculate the Young's modulus by non-uniform bending, simple harmonic oscillations by Torsion Pendulum.

CO2 Calculate the thickness of a thin wire by air wedge and velocity of sound, compressibility of liquid using ultra sonic interferometer.

CO3 Calculate the wavelength, acceptance angle and numerical aperture using laser.

CO4 Estimate the amount of Hardness, chloride, alkalinity in water samples.

CO5 Estimate the amount of acid, iron content present in a given solution by using pH, conductivity and potentiometric titration.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	1	1	2	-	1
CO2	3	2	1	1	-	-	-	1	1	2	-	1
CO3	3	2	1	1	-	-	-	1	1	2	-	1
CO4	3	3	1	3	-	-	-	1	1	2	-	1
CO5	3	3	1	3	-	-	-	1	1	2	-	1

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U23EN102	PROFESSIONAL COMMUNICATION LABORATORY (Common to all branches)	L	T	P	C
		0	0	3	1.5

Prerequisites: Basic Communication Skills

COURSE OBJECTIVES:

- To enhance their employability and career prospects by equipping them with soft skills.
- To emphasize the importance of interview etiquette and prepare for job interviews.
- To cultivate a general awareness of current affairs to engage in a professional world.

UNIT I 9

Introduction to basic Communication Skills of learning – Listening – Empathetic Listening- Key role in Organizational communication; Speaking – role plays – asking about routine actions and expressing opinions.

UNIT II 9

Introduction to Soft Skills – Hard skills & soft skills - employability and career Skills – Grooming as a professional with values – Time Management – General awareness of Current Affairs.

UNIT III 9

Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice – presenting the visuals effectively – 5 minute presentations.

UNIT IV 9

Introduction to Group Discussion – Participating in group discussions – understanding group dynamics – brainstorming the topic – questioning and clarifying – GD strategies- activities to improve GD skills.

UNIT V 9

Interview etiquette – dress code – body language – attending job interviews – telephone/Skype interview -one to one interview & panel interview – FAQs related to job interviews.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply communication proficiency by mastering empathetic listening and speaking skills.

CO2 Apply soft skills fostering comprehensive competence.

CO3 Apply effective techniques to deliver presentations in all aspects.

CO4 Apply effective strategies for active participation in Group Discussion.

CO5 Apply interview etiquette to navigate various interview formats for Job Interviews.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	1	-	-	1	1	1	-	1
CO2	1	-	-	-	1	-	-	1	1	1	-	1
CO3	1	-	-	-	1	-	-	1	1	1	-	1
CO4	1	-	-	-	1	-	-	1	1	1	-	-
CO5	1	-	-	-	1	-	-	1	1	1	-	1

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U23EN201	TECHNICAL ENGLISH - II (Common to all branches)	L	T	P	C
		3	0	0	3

Prerequisites: Basics of Communication discourse

COURSE OBJECTIVES:

- To develop a high level of proficiency in the English language, encompassing LSRW skills to engage effectively.
- To equip students with a strong foundation in English grammar and vocabulary to understand technical texts.
- To foster critical thinking skills including the ability to evaluate texts critically.

UNIT I **GENERAL READING AND FREE WRITING** 9

Listening –Short texts (Listening to Audio & Video) Types of Listening – formal and informal conversations – Telephone conversation; Listening to voicemail & messages; **Speaking** – Basics in speaking – speaking on given topics & situations – recording speeches and strategies to improve; **Reading** – Critical Reading – finding key information in a given text – shifting facts from opinions; **Writing** – free writing on any given topic – autobiographical writing, developing hints, Note – Making; **Grammar** – Tenses; **Vocabulary Development** – Word Formation.

UNIT II **LISTENING AND SUMMATION** 9

Listening – Listening to podcasts / anecdotes / event narration, documentaries and interviews with celebrities; **Speaking** – Narrating personal experiences / events / Reporting and summarizing documentaries / podcasts / interviews; **Reading** – Reading biographies, travelogues, newspaper reports, Excerpts from literature and travel & technical blogs. **Writing** –Short Report on an event (field trip etc.) **Grammar** – Question types: Wh / Yes or No; **Vocabulary Development** – One word substitution.

UNIT III **SPEAKING AND ANALYSIS SKILLS** 9

Listening – Dialogues & Conversations, focused audio track – **Speaking** – Role Play – Asking about routine actions and Expressing Opinions – Group Interaction – Speaking in formal situations (teachers, officials, foreigners); **Reading** – Reading longer texts & Making a Critical Analysis of the given text; **Writing** – Types of Paragraphs and Essays – Rearrangement of Jumbled sentences; **Grammar** - Cause & Effect Expressions; **Vocabulary Development** – Synonyms & Antonyms.

UNIT IV **READING AND LANGUAGE PROGRESSION** 9

Listening – Listening to Dialogues or conversations and completing exercises based on them; **Speaking** – Speaking about one – speaking about one's friend; **Reading** – Comprehension, Reading Different Types of Texts – magazines; **Writing** – Letter Writing - formal or informal letters – E Mails – Conventions of personal email; **Grammar** – Discourse Markers (connectives & sequence words); **Vocabulary development** – Homonyms and Homophones.

UNIT V **COMPREHENSIVE WRITING** 9

Listening –Listening to Speeches / Presentations, Listening to broadcast and telecast from

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Radio and TV; **Speaking** – Participating in Conversations – short group conversations – Making presentations on given topics; **Reading** –Email communication – Reading the attachment files having a poem / joke / proverb; **Writing** – Creative writing, Poster making, dialogue writing; **Grammar** – Degrees of Comparison, Fixed / Semi-Fixed Expressions; **Vocabulary Development** Abbreviations & Acronyms (as used in technical contexts).

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Venkatraman G, "Effective Technical Communication" 1st Edition, Pearson Education, 2022.

2 Lakshminarayanan K R, "English for Communication", Scitech Publications, 2022.

REFERENCES:

1 Raman, Meenakshi, Sharma, Sangeetha, "Technical Communication Principles and Practice", Oxford University Press, New Delhi, 2015.

2 Sharma Sangeetha, Mishra Binod, "Communication Skills for Engineers and Scientists", 2nd Edition, Prentice Hall of India, 2023.

3 Ruchi Agarwal, "Academic Writing for Students: A Practical Guide", Eliva Press, 2024.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_hs05/preview
2 https://www.coursera.org/specializations/creative-writing
3 https://www.coursera.org/courses-writing

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply the concepts of writing in an effective way.

CO2 Write concise reports in a professional context.

CO3 Write different kinds of Paragraphs and Essays.

CO4 Write Email and formal / informal letters without grammatical errors.

CO5 Analyze collaborative work through writing process.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	3	-	3	-	1
CO2	3	-	-	-	-	-	-	3	-	3	-	1
CO3	3	-	-	-	-	-	-	3	-	3	-	1
CO4	3	-	-	-	-	-	-	3	-	3	-	1
CO5	3	-	-	-	-	-	-	3	-	3	-	1

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U23MA201	VECTOR CALCULUS AND COMPLEX FUNCTIONS (Common to all branches)	L	T	P	C
		3	1	0	4

Prerequisites: Engineering Mathematics

COURSE OBJECTIVES:

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems
- To make the students to understand the vector calculus such as divergence, curl needed, for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas.

UNIT I DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Linear differential equation with variable coefficients – Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients – Undetermined coefficients.

UNIT II BASICS OF VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and curl – Vector identities – Irrotational and solenoidal vector fields – Work done by a force – Conservative force field.

UNIT III APPLICATIONS OF VECTOR CALCULUS 12

Line integral over a plane curve – Surface integral – Area of a curved surface – Volume integral – Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT IV ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in cartesian and polar coordinates – Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by functions $(z + a, az, z^2, 1/z)$ – Bilinear transformation

UNIT V COMPLEX INTEGRATION 12

Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi – circular contour (without poles on real axis).

TOTAL: 60 PERIODS

TEXT BOOKS:

1 B S Grewal, "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, 2020.

2 E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition, 2020.

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REFERENCES:

1 H K Dass, "Advanced Engineering Mathematics", S. Chand & Company Ltd., 20th Edition, 2019.
2 Ravish R Singh, Mukul Bhatt, "Advanced Engineering Mathematics", 2nd Edition, Tata McGraw Hill, 2020.
3 H C Taneja, "Advanced Engineering Mathematics", Dreamtech Press, 2019.
4 T K V Iyengar, M V A A N Prasad, B Krishna Gandhi, "Engineering Mathematics", Special Edition, S. Chand & Company Ltd., 2023.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/111105134
2 https://nptel.ac.in/courses/111107111
3 https://nptel.ac.in/courses/111103070

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Solve higher order differential equations of different types for engineering applications.

CO2 Explain the concepts of vector calculus.

CO3 Evaluate line, surface and volume integrals in various vector fields using Greens, Stokes and Gauss theorems.

CO4 Analyze the properties and mappings for constructing analytic functions.

CO5 Evaluate the complex and contour integral using Cauchy's theorem.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	1	-	-	-	-
CO2	3	2	1	1	-	-	-	1	-	-	-	-
CO3	3	3	2	3	-	-	-	1	-	-	-	-
CO4	3	3	2	2	-	-	-	1	-	-	-	-
CO5	3	3	2	3	-	-	-	1	-	-	-	-

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U23PH201 PHYSICS FOR ELECTRICAL AND ELCTRONICS ENGINEERS L T P C

Prerequisites: Engineering Physics 3 0 0 3

COURSE OBJECTIVES:

- To enable the students effectively understand the characteristics, and properties of the conductor, semiconductor.
- To instil knowledge on physics of magnetic and superconducting materials.
- To inculcate an idea of significance of optoelectronic devices, new engineering materials and their applications.

UNIT I ELECTRICAL PROPERTIES OF MATERIALS 9

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – success and failures of Classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals- energy bands in solids.

UNIT II SEMICONDUCTOR PHYSICS 9

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – compound semiconductors-direct and indirect band gap – n-type and p-type semiconductor: derivation of carrier concentration – variation of Fermi level with temperature and impurity concentration-Hall effect –Determination of Hall coefficient, applications- experimental verification of Hall effect – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment –– magnetic properties of Dia, Para, Ferro, anti-Ferro and ferrite materials – Domain theory – Hysteresis – soft and hard magnetic materials – Superconductivity: properties – Type I and Type II superconductors – BCS theory of Superconductivity (Qualitative) – High temperature superconductors – Applications of superconductors: SQUID, cryotron, magnetic levitation.

UNIT IV OPTICAL PROPERTIES OF MATERIALS 9

Classification of optical materials – carrier generation and recombination processes – Absorption emission and scattering of light in metals, insulators and semiconductors (concepts) – opto electronic devices: photo detectors, solar cell, LED, organic LED, Laser diodes – Optical data storage techniques.

UNIT V NEW ENGINEERING MATERIALS 9

Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application – Metallic glasses: properties, preparation and applications – Nanomaterials: quantum Structures: Q–dot, wire, well- single electron phenomenon: coulomb blockade effect – Single electron transistor – Carbon Nano tubes (CNT): properties and applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 S O Kasap, "Principles of Electronic Materials and Devices ", Tata McGraw Hill, 2020.

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2 Donald A Neamen, "Semiconductor Physics and Devices Basic Principles", Jain Book Agency, 2024.

REFERENCES:

1 D W Snoke, "Solid-state Physics: Essential Concepts", 2nd Edition, Cambridge University Press, 2020.

2 Kelly S Potter, Joseph Simmons, "Optical Materials", 2nd Edition, Elsevier, 2021.

3 Visakh P M, Artem Semkin, R Balakrishnan, S Lazovic, "Nanotechnology in Electronics: Materials, Properties, Devices", John Wiley & Sons, 2022.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc24_ph05/preview

2 https://onlinecourses.nptel.ac.in/noc24_ph02/preview

3 https://onlinecourses.nptel.ac.in/noc21_ph14/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the electrical properties of materials based on classical, quantum free electron theories.

CO2 Describe the fundamentals of semiconductor Physics.

CO3 Summarize various types of magnetic and superconducting materials and its applications.

CO4 Apply the optical properties of materials in functioning of optoelectronic devices.

CO5 Explain the various new engineering materials, nano electronic devices and its applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	1
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	1	-	1	1	-	-	-	-	1
CO5	2	2	-	-	-	1	1	-	-	-	-	1

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U23EG101	ENGINEERING GRAPHICS (Common to all branches)	L T P C 2 0 4 4

Prerequisites: Nil

COURSE OBJECTIVES:

- To prepare the students for drawing freehand sketch of simple objects and engineering curves.
- To prepare the students for drawing orthographic projection of solids, section of solids and development of lateral surfaces of various solids.
- To prepare the students for drawing pictorial projections like isometric and perspective projection of simple solids.

UNIT I **PLANE CURVES** **6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

UNIT II **PROJECTION OF POINTS, LINES AND PLANE SURFACES** **6+12**

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. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III **PROJECTION OF SOLIDS AND FREE HAND SKETCHING** **6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object 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.

UNIT IV **SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES** **6+12**

Sectioning of simple solids in 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 (without Cut out) — Prisms, pyramids cylinders and cones.

UNITV **ISOMETRIC AND PERSPECTIVE PROJECTIONS** **6+12**

Principles of isometric projection — isometric scale - isometric projections 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: 90 PERIODS

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TEXT BOOKS:

1 Bhatt N D, Panchal V M, "Engineering Drawing", Charotar Publishing House, 54th Edition, 2023.
2 Natrajan K V, "A Text Book of Engineering Graphics", 36th Edition, Dhanalakshmi Publishers, 2023.

REFERENCES:

1 Gopalakrishna K R, "Engineering Drawing" (Vol. I&II Combined), Subhas Publications, 27th Edition, 2017.
2 Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International Private Limited, 2008.
3 Parthasarathy N S, Vela Murali, "Engineering Graphics", Oxford University Press, 2015.
4 Basant Agarwal and Agarwal C. M, "Engineering Drawing", Tata McGraw Hill, 2nd Edition, 2019.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/112/102/112102304/
2 https://nptel.ac.in/courses/112103019
3 https://onlinecourses.nptel.ac.in/noc24_ar02/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Draw the various curves used in engineering practices.
CO2 Draw the projections of straight lines which are inclined to both the planes.
CO3 Draw the projections of solids inclined to one plane and parallel to other plane.
CO4 Draw the projections of sectioned solids and draw the development of lateral surfaces of a solid.
CO5 Draw the isometric projections and perspective projections of simple solids.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	1	-	1	-	-
CO2	3	3	3	3	-	-	-	1	-	1	-	-
CO3	3	3	3	3	-	-	-	1	-	1	-	-
CO4	3	3	3	3	-	-	-	1	-	1	-	-
CO5	3	3	3	3	-	-	-	1	-	1	-	-

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U23PY201	PROBLEM SOLVING AND PYTHON PROGRAMMING (Common to all Branches)	L	T	P	C
		3	0	2	4

Prerequisites: Programming in C

COURSE OBJECTIVES:

- To understand the basics of algorithmic problem solving using Python conditionals and loops
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data and to input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING **9**

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), Towers of Hanoi, insert a card in a list of sorted cards.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS **9**

Python interpreter and interactive mode, debugging; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points,

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS **9**

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, Strings: string slices, immutability, string functions and methods, Lists as arrays, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES **9**

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; Illustrative programs: histogram, Retail bill preparation, sorting.

UNIT V FILES, MODULES, PACKAGES **9**

Files and exceptions: text files, reading and writing files, format operator; errors and exceptions, handling exceptions, modules, packages; Illustrative programs: GCD, setting offset in a file, wordcount, copyfile, voter's age, validation, marks range validation.

45 PERIODS

PRACTICAL EXERCISES:

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing)
2. Python programming using simple statements and expressions (exchange the values of two variables, compute Simple Interest).
3. Scientific problems using Conditionals and Iterative loops. (Prime factor of an Integer, Bin to Decimal, Octal and Hexa).
4. Implementing programs using Functions. (Factorial, largest number in alist).
5. Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters).
6. Implementing operations of lists, tuples, and dictionaries.

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7a Implementing operations of file handling. (Copy from one file to another, word count).

7b Implementing real-time/technical applications using Exception handling. (Divide by zero error, voter's age validity, student mark range validation).

30 PERIODS

TOTAL: 75 PERIODS

TEXT BOOKS:

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.

REFERENCES:

1 Paul Deitel, Harvey Deitel, "Python for Programmers", 1st Edition, Pearson Education, 2021.

2 G Venkatesh, 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 Modelling and Understanding Data", 3rd 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, Tata McGraw Hill, 2018.

ONLINE RESOURCES

1 http://www.digimat.in/nptel/courses/video/106106212/L01.html

2 https://onlinecourses.swayam2.ac.in/cec24_cs03/preview

3 https://onlinecourses.swayam2.ac.in/cec24_cs01/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Solve simple computational problems using notations.

CO2 Write python programs using statements and Expressions.

CO3 Apply control flow and functional concepts in a user define problems.

CO4 Apply python data structures - list, tuples and dictionaries for compound data.

CO5 Describe file handling and exceptional handling in python for solving problems.

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	1	1	1	-	1
CO2	3	3	3	3	1	-	-	1	1	1	-	1
CO3	3	2	1	2	1	-	-	1	1	1	-	1
CO4	3	2	1	2	1	-	-	1	1	1	-	1
CO5	2	2	1	1	1	-	-	1	1	1	-	1

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U23EC201	ELECTRONIC DEVICES	L	T	P	C
Prerequisites:	**Basic Electrical and Instrumentation Engineering**	3	0	0	3

COURSE OBJECTIVES:

- To understand and gain the knowledge of semiconductor properties and formation of PN Junction diode, Zener diode BJT, FET, power and display devices and its characteristics.
- To understand and gain the knowledge of Bipolar Junction Transistors, Field Effect Transistors and Special Semiconductor Devices.
- To understand and gain the knowledge of Power Devices and Display Devices.

UNIT I **SEMICONDUCTOR DIODE** **9**

PN junction diode, Current equations, Energy Band diagram, Diffusion, and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes, Zener diode – Characteristics, Half wave and Full wave Rectifier circuits.

UNIT II **BIPOLAR JUNCTION TRANSISTORS** **9**

NPN – PNP – Operations – Early effect – Current equations – Input and Output characteristics of CE, CB, CC – Hybrid – π model – h-parameter model, Ebers Moll Model, Multi Emitter Transistor.

UNIT III **FIELD EFFECT TRANSISTORS** **9**

JFETs – Drain and Transfer characteristics, Current Equations – Pinch off voltage and its Significance – MOSFET– Characteristics – Threshold voltage – Channel lengthmodulation, DMOSFET, E-MOSFET – Characteristics.

UNIT IV **SPECIAL SEMICONDUCTOR DEVICES** **9**

Metal-Semiconductor Junction – MESFET, DUAL GATE MOSFET, Schottky barrier diode – Varactor diode – Tunnel diode – Gallium Arsenide device, LASER diode, LDR.

UNIT V **POWER DEVICES AND DISPLAY DEVICES** **9**

UJT, SCR, DIAC, TRIAC, Power BJT – Power MOSFET – DMOS – VMOS, LED, LCD, Phototransistor, Opto-Coupler, Solar cell, CCD.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Donald A Neaman, "Semiconductor Physics and Devices", 4th Edition, Tata McGraw Hill, 2021.
2 Salivahanan S, Suresh Kumar A, "Electronic Devices and Circuits", 5th Edition, Tata McGraw Hill, 2022.

REFERENCES:

1 Robert Boylestad, Louis Nashelsky, "Electron Devices and Circuit Theory", Pearson Education, 10th Edition, 2008.
2 Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2017.

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3 Jacob Millman, Christos C Halkias, Satyabrata Jit, "Electronic Devices and Circuits", Tata McGraw Hill, 4th Edition, 2015.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/108108112.

2 https://www.udemy.com/course/basic-electronics-k.

3 https://www.classcentral.com/course/introtoelectronics-2466.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend the operation and characteristics of the PN junction and Zener Diode.

CO2 Explain the operation and characteristics of Bipolar junction transistor.

CO3 Explain the operation and characteristics of JFET and MOSFET.

CO4 Summarize the operations and applications of special semiconductor devices.

CO5 Comprehend the basic concepts of Power devices and Display devices.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO4	2	2	1	1	-	-	-	1	-	-	-	1	3	2
CO5	2	2	1	1	-	-	-	1	-	-	-	1	3	2

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U23TA201	தமிழரும் தொழில்நுட்பமும்	L	T	P	C
	(Common to all Branches)	1	0	0	1

நோக்கம்:

- அறிவியல் மற்றும் பொறியியல் சார்ந்த அறிவுத்திறனைப் பெருக்குவதன் மூலம் உலக அளவில் அவர்களின் தரத்தை உயர்த்துவதன் நோக்கமாகும்.
- தமிழர் தொழில்நுட்பம் ஏனைய நாகரிகங்களுக்கு இணையான வளர்ச்சியைக் கொண்டதே இதன் நோக்கமாகும்.
- வேளாண்மை, கட்டிடக்கலை, இசைக்கருவிகள், கப்பற்கலை, போர்க்கலை என பல துறைகளில் தமிழர் தொழில்நுட்பத்தை சிறந்து விளங்குவதே நோக்கமாகும்.

அலகு – 1 **நெசவு மற்றும் பானைத் தொழில்நுட்பம்** 3

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறில் குறியீடுகள்.

அலகு – 2 **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்** 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை வடிவமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர்காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோவில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு – 3 **உற்பத்தித் தொழில்நுட்பம்** 3

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எ.கு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு – 4 **வேளாண்மை மற்றும் நீர்பாசனத் தொழில்நுட்பம்** 3

அணை, - ஏரி, குளங்கள், மதகு - சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பொருங்கடல் குறித்த பண்டைய அறிவு - அறிவு சார் சமூகம்.

அலகு – 5 **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்** 3

அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

TOTAL: 15 PERIODS

TEXT BOOKS:

1. முனைவர் ஆ. பூபாலன் "தமிழரும் தொழில்நுட்பமும்" வி.ஆர்.பி. வெளியீடு புதிய பாடத்திட்டம் 2023 - 2024 அண்ணா பல்கலைக்கழகம்.
2. முனைவர் ஆ. ஹேமமாலினி "தமிழரும் தொழில்நுட்பமும்" வி.ஆர்.பி. வெளியீடு புதிய பாடத்திட்டம் 2023 - 2024 அண்ணா பல்கலைக்கழகம்.

REFERENCES:

1. முனைவர் கே. கே. பிள்ளை "தமிழக வரலாறு, மக்களும், பண்பாடும்," வெளியீடு:

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தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம், 1972.

2 முனைவர் இல. சுந்தரம், "பொருநை, ஆற்றங்கரை நாகரிகம்," வெளியீடு: தொல்லியல் துறை மற்றும் தமிழ்நாடு அரசுத் துறை, 2022.

3 Dr. S. V. சுப்பிரமணியன், ஐச.மு.ஐ. திருநாவுக்கரசு "தமிழர்களின் வரலாற்று பாரம்பரியம்", சர்வதேச தமிழ் ஆய்வு நிறுவனம், 2022.

ONLINE RESOURCES:

1 https://youtu.be/7qTXrUs02fs?si=SBBluhJu1i14o6yw

2 https://youtu.be/A0mxzo4f-s4?si=1C92FLv93BliZ2pn

3 https://youtu.be/Qia72HEV_uE?si=dp06r09Gi1SsKEyQ

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 தமிழின் தொன்மையான வரலாறு மற்றும் தொழில் நுட்பத்தை தொகுக்க இயலும்.
Summarize the ancient history and technology of Tamil.

CO2 சங்க கால வாழ்க்கை முறை மற்றும் கட்டிடக்கலை நுட்பங்களைப் பற்றி விளக்க இயலும்.
Explain the lifestyle and architectural techniques of the sangam period.

CO3 பண்டைய தமிழ் மக்களின் வணிக நடை முறைகள் மற்றும் நாணய பரிமாற்றம் பற்றி விளக்க இயலும்.
Explain the business practices and currency exchange of ancient Tamil people.

CO4 சங்க காலத்தில் வேளாண்மை மற்றும் நீர்பாசனத் தொழில்நுட்ப முறைகளைப் பற்றி தொகுக்க இயலும்.
Summarize the Agriculturen and Irrigation Technology in sangam period.

CO5 கணினி பயன்பாடுகளில், தமிழின் தொழில்நுட்ப வளர்ச்சியினைப் பற்றி விளக்க இயலும்.
Explain the computer applications in Tamil technological development.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	1	-	-	-	-	-	-	-	-	-	-	-
CO4	1	-	-	-	-	-	-	-	-	-	-	-
CO5	1	-	-	-	-	-	-	-	-	-	-	-

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U23EP101	ENGINEERING PRACTICES LABORATORY (Common to all branches)	L	T	P	C
		0	0	3	1.5

Prerequisites: Nil

COURSE OBJECTIVES:

- Drawing pipeline plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planning; making joints in wood materials used in common household woodwork.
- Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping In parts; Assembling simple mechanical assembly of common household equipment's; Making a tray out of metal sheet using sheet metal work.
- Wiring various electrical joints in common household electrical wire work. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & MECHANICAL)

PART I CIVIL ENGINEERING PRACTICES

I. PLUMBING WORK:

1. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
2. Preparing plumbing line sketches.
3. Laying pipe connection to the delivery side of a pump.
4. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

II. WOOD WORK:

1. Sawing,
2. Planing
3. Making joints like T-Joint Mortise joint, Tenon joint, and Dovetail joint.
4. Studying joints in door panels and wooden furniture.
5. Studying common industrial trusses using models.

PART II MECHANICAL ENGINEERING PRACTICES

I. WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

II. BASIC MACHINING WORK:

a) (Simple) Turning.
b) (Simple) Drilling.
c) (Simple) Tapping.

III. ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an air conditioner.

IV. SHEET METAL WORK:

a) Making of a square tray.

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V. FOUNDRY WORK:

a) Demonstrating basic foundry operations.

GROUP B (ELECTRICAL AND ELECTRONICS)

PART III 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.

PART IV ELECTRONICS ENGINEERING PRACTICES

I. SOLDERING WORK:

a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

a) Assembling and testing electronic components on a small PCB.

II. ELECTRONIC EQUIPMENT STUDY:

a) Study an element of smart phone.
b) Assembly and dismantle of LED TV.
c) Assembly and dismantle of computer/ laptop.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply the basic concept of Plumbing and carpentry in various Residential buildings.
CO2 Apply the concept of arc welding in welding of steel plate.
CO3 Analyze the basics of machining operations and sheet metal works.
CO4 Apply the various electrical joints in common household electrical wire work.
CO5 Apply the basic concept of assemble and testing of simple electronic components on PCB.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	1	-	1	1	1	-	-
CO2	3	2	1	2	-	1	-	1	1	1	-	-
CO3	3	3	2	2	-	1	-	1	1	1	-	-
CO4	3	2	1	2	-	1	-	1	1	1	-	-
CO5	3	2	1	2	-	1	-	1	1	1	-	-

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U23EC202 **CIRCUITS AND DEVICES LABORATORY**

L	T	P	C
0	0	3	1.5

Prerequisites: Nil

COURSE OBJECTIVES:

- To gain the hands on experience for basic electronic devices.
- To gain practical experience on electric circuits and verification of theorems.
- To simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab

LIST OF EXPERIMENTS

1. Characteristics of PN Junction diode.
2. Characteristics of Zener diode
3. Input – output characteristics of BJT in common emitter mode.
4. Input – output characteristics of BJT in common base mode.
5. Characteristics of JFET.
6. Characteristics of SCR.
7. Characteristics of Half Wave & Full Wave Rectifier.
8. Verifications of KVL & KCL.
9. Determination of Resonance Frequency of Series & Parallel RLC Circuits.
10. Experimental verification of Thevenin theorem.
11. Experimental verification of Superposition theorem
12. Simulation of Maximum Power Transfer and Reciprocity theorem.
13. Simulation of RL, RC and RLC transient circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the characteristics of PN Diode, Zener Diode, BJT, JFET and SCR.

CO2 Design series and parallel RLC circuit and obtain its frequency response.

CO3 Analyze the transient behaviour of the given RL, RC, RLC circuits.

CO4 Analyze the characteristics of Half Wave & Full Wave Rectifier.

CO5 Analyze and Verify Thevenin, Superposition, Maximum power, and Reciprocity theorems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	2	2	2	-	-	3	2
CO2	3	3	3	3	2	-	-	2	2	2	-	-	3	2
CO3	3	3	2	2	2	-	-	2	2	2	-	-	3	2
CO4	3	3	2	2	-	-	-	2	2	2	-	-	3	2
CO5	3	3	2	2	2	-	-	2	2	2	-	-	3	2

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U23MA303	TRANSFORMS AND RANDOM PROCESSES	L	T	P	C
Prerequisites:	**Engineering Mathematics**	3	1	0	4

COURSE OBJECTIVES:

- To understand the principles and applications of Fourier series for periodic functions and Fourier transform for non-periodic functions in signal processing and analysis.
- To introduce the concepts of probability, random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.

UNIT I **FOURIER SERIES** **12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis.

UNIT II **FOURIER TRANSFORMS** **12**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Convolution theorem – Parseval's identity.

UNIT III **RANDOM VARIABLES AND DISTRIBUTIONS** **12**

Probability – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT IV **TWO – DIMENSIONAL RANDOM VARIABLES** **12**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation– Transformation of random variables.

UNIT V **RANDOM PROCESSES** **12**

Classification – Stationary process – Markov process – Poisson process.

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Grewal B S, "Higher Engineering Mathematics", 45th Edition, Khanna Publishers, 2020.
2 C Ibe Oliver, "Fundamentals of Applied Probability and Random Processes", 2nd Edition, Elsevier Publisher, 2019.

REFERENCES:

1 Geoffrey Grimmett, David Stirzaker, "Probability and Random Processes", 4th Edition, OUP Oxford, 2020.
2 Anthony Croft, Robert Davison, "Mathematics for Engineers", 5th Edition, Pearson Education, 2019.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/111103021

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2 https://ocw.mit.edu/courses/18-440-probability-and-random-variables-spring-2014/

3 https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/pages/part-iii-random-processes/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze periodic functions, expressing them as infinite sums of sinusoids.

CO2 Solve the mathematical principles of Fourier transforms.

CO3 Apply the concept of probability and standard distributions in real life problems.

CO4 Analyze the concepts of two-dimensional random variables.

CO5 Apply the concept of random processes in engineering disciplines.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	-	-	-	1	-	-	-	1	1	-
CO2	3	2	1	1	-	-	-	1	-	-	-	1	1	-
CO3	3	2	1	1	-	-	-	1	-	-	-	1	1	-
CO4	3	3	1	2	-	-	-	1	-	-	-	1	1	-
CO5	3	2	1	1	-	-	-	1	-	-	-	1	1	-

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U23CS306	OBJECT ORIENTED PROGRAMMING WITH DATA STRUCTURES	L	T	P	C
		3	0	2	4

Prerequisites: Programming in C, Problem Solving and Python Programming

COURSE OBJECTIVES:

- To enable the students to learn the basic concepts of Java programming
- To have an overview of interfaces, packages, multithreading and exceptions.
- To familiarize students with basic data structures and their use in algorithms.

UNIT I INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers.

UNIT II INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

UNIT III EXCEPTION HANDLING AND MULTITHREADING 9

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication Suspending –Resuming, and Stopping Threads

UNIT IV ABSTRACT DATA TYPES 9

Abstract Data Types (ADTs)-List ADT-Array based implementation-linked list implementation-singly linked list-doubly linked list-circular linked list-Stack ADT operations-Applications- Queue ADT-operations-Applications of Queues.

UNIT V TREES 9

Trees-Binary Trees- representation - Operations on Binary Trees- Traversal of a Binary Tree -Binary Search Trees, Graphs-Representation of Graphs - Traversal in Graph - Dijkstra's Algorithm, Depth-First vs Breadth-First Search

45 PERIODS

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 12th Edition, Tata McGraw Hill, 2022.
2. James Cutajar, "Beginning Java Data Structures and Algorithms", 4th Edition, Packt Publishing, 2018.

REFERENCES:

1 Cay S Horstmann, "Core Java Fundamentals", Volume 1, 11th Edition, Prentice Hall, 2018

2 Y Daniel Liang, "Introduction To Java Programming, Comprehensive", 10th Edition, Pearson Education, 2018.

3 Michael T Goodrich, Roberto Tamassia, Michael H Goldwasser, Subhasish Banerjee, "Data Structures and Algorithms in Java", 6th Edition, Wiley & Sons, 2022.

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ONLINE RESOURCES:

1 https: //onlinecourses.nptel.ac.in/noc23_cs74/
2 https://nptel.ac.in/courses/106106127/
3 https://nptel.ac.in/courses/106105191/

PRACTICAL EXCERCISES:

1. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
2. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.
3. Write a program to Check Prime Number using Interface.
4. Implement exception handling and creation of user defined exceptions.
5. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
6. Solve problems by using sequential search and binary search.
7. Develop stack and queue data structures using classes and objects

30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend the basic concepts of Java programming
CO2 Summarize interfaces, packages, multithreading and exception
CO3 Apply features of exception handling and multithreading in Java program.
CO4 Apply basic data structures concepts and their algorithms.
CO5 Explain data structure concepts trees for modelling given problem.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	1	1
CO2	3	2	2	2	1	2	-	2	2	-	-	2	1	1
CO3	3	2	2	2	1	2	-	2	2	-	-	2	1	1
CO4	3	3	3	3	1	2	-	2	2	-	-	2	1	1
CO5	3	3	3	3	1	2	-	2	2	-	-	2	1	1

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U23EC301 **DIGITAL PRINCIPLES AND COMPUTER ORGANIZATION** **L T P C**

Prerequisites: Nil **3 0 2 4**

COURSE OBJECTIVES:

- To present the fundamentals of digital circuits and simplification methods
- To bring out the analysis and design procedures for synchronous and asynchronous Sequential circuits.
- To understand the basic structure and operation of a digital computer.

UNIT I **BASIC CONCEPTS** **9**

Review of number systems-representation-conversions, Review of Boolean algebra – theorems, sum of product and product of sum simplification, canonical forms min term and max term, Simplification of Boolean expressions-Karnaugh map, Implementation of Boolean expressions using universal gates.

UNIT II **COMBINATIONAL LOGIC CIRCUITS** **9**

Problem formulation and design of combinational circuits – Code-Converters (Binary to Gray code, Gray to Binary, BCD to Excess-3 code,Excess-3 to BCD), Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Mux/Demux, Case study: Digital trans-receiver Parity Generator/Checker, Seven Segment display decoder

UNIT III **SEQUENTIAL CIRCUITS** **9**

Latches, Flip flops – SR, JK, T, D, Master/Slave FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, Counters, Shift registers, Stable and Unstable states, output specifications, Hazards, Essential Hazards, Design of Hazard free circuits.

UNIT IV **COMPUTER FUNDAMENTALS** **9**

Functional Units of a Digital Computer: Von Neumann Architecture and Harvard Architecture – Operation and Operands of Computer Hardware Instruction – Instruction Set Architecture (ISA): Memory Location, Address and Operation – Instruction and Instruction Sequencing – Addressing Modes.

UNIT V **PROCESSOR AND MEMORY** **9**

Instruction Execution – Building a Data Path- Pipelining- basic memory, static ROM, PROM, EPROM, EEPROM, Cache Memories: Mapping and Replacement Techniques – Virtual Memory – DMA.

45 PERIODS

PRACTICAL EXERCISES:

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.

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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 and shift register.

30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 M Morris Mano, Michael D Ciletti, "Digital Design: With an Introduction to the Verilog HDL, VHDL and System Verilog", 6th Edition, Pearson Education, 2020.

2 David A Patterson, John L Hennessy, "Computer Organization and Design, The Hardware/Software Interface", 6th Edition, Morgan Kaufmann, 2020.

REFERENCES:

1 Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", 6th Edition, Tata McGraw Hill, 2022.

2 William Stallings, "Computer Organization and Architecture – Designing for Performance", 11th Edition, Pearson Education, 2022.

3 M Morris Mano, "Digital Logic and Computer Design", 6th Edition, Pearson Education, 2018.

ONLINE RESOURCES

1 https://archive.nptel.ac.in/courses/117/105/117105078

2 https://www.coursera.org/courses?query=computer%20architecture

3 https://onlinecourses.nptel.ac.in/noc21_ee39/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply Boolean Algebra and Simplification procedures relevant to digital logic.
CO2 Design various combinational digital circuits using logic gates.
CO3 Design synchronous and asynchronous sequential digital circuits using logic gates.
CO4 Summarize the basic structure and operation of a digital computer.
CO5 Analyze the data path unit of processor and concept of various memories.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	2	2	2	-	1	2	2
CO2	3	3	3	3	1	-	-	2	2	2	-	1	2	2
CO3	3	3	3	3	1	-	-	2	2	2	-	1	2	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	-	2	2

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U23EC302	SIGNALS AND SYSTEMS	L	T	P	C
Prerequisites:	**Engineering Mathematics**	3	1	0	4

COURSE OBJECTIVES:

- To understand the basic properties of signals and systems
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 12

Standard signals – Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids – Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals – Classification of systems – CT systems and DT systems – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 12

Fourier series for periodic signals – Fourier Transform – properties – Laplace Transforms and properties.

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 12

Impulse response – convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems – Systems connected in series / parallel.

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 12

Sampling theorem – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT – Z Transform & Properties.

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 12

Impulse response – Difference equations-Convolution sum – Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems – DT systems connected in series and parallel.

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Alan Oppenheim, Alan Willsky, S. Nawab, "Signals and Systems", 2nd Edition, Pearson Education, 2015.

2 K Deergha Rao, "Signals and Systems", Birkhauser, 2018.

REFERENCES:

1 S Palani, "Signals and Systems" Springer, 2nd Edition, 2022.

2 Sanjay Sharma, "Signals and Systems with MATLAB programs", 9th Edition, S K Kataria & Sons, 2021.

3 Khalid Sayood, "Signals and Systems A One Semester Modular Course" Springer,, 2021.

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ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee28/preview

2 https://www.edx.org/learn/engineering/iitbombay-signals-and-systems-part-1

3 https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee28/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the properties of signals and systems

CO2 Analyze continuous time signals.

CO3 Analyze linear time invariant continuous time systems.

CO4 Analyze discrete time signals.

CO5 Analyze Linear Time Invariant discrete time systems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	-	-	-	-	-	-	1	2	1
CO2	3	3	2	2	1	-	-	-	-	-	-	1	1	1
CO3	3	3	2	2	1	-	-	-	-	-	-	1	1	1
CO4	3	3	2	2	1	-	-	-	-	-	-	1	2	1
CO5	3	3	2	2	1	-	-	-	-	-	-	1	2	1

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U23EC303	ELECTRONIC CIRCUITS	L	T	P	C
Prerequisites:	Electronic Devices	3	0	0	3

COURSE OBJECTIVES:

- To understand and gain the knowledge of BJT and MOSFET Amplifiers.
- To understand and gain the knowledge of Differential Amplifier, Tuned Amplifiers and Feedback Amplifiers.
- To understand and gain the knowledge of Oscillators, Power Amplifiers and DC/DC Converters.

UNIT I **BJT AND MOSFET AMPLIFIERS** **9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET small signal model– Analysis of CS,CG and Source follower – Gain and frequency response- High frequency analysis.

UNIT II **DIFFERENTIAL AMPLIFIER AND TUNED AMPLIFIERS** **9**

Differential amplifier – Common mode and Difference mode analysis –small signal tuned amplifiers –Analysis of capacitor coupled single tuned amplifier – double tuned amplifier - effect of cascading single tuned and double tuned amplifiers on bandwidth – Stagger tuned amplifiers - Stability of tuned amplifiers.

UNIT III **FEEDBACK AMPLIFIERS** **9**

Feedback Concepts – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers – analysis of series-series, shunt-shunt, series-shunt and shunt-series feedback amplifiers.

UNIT IV **OSCILLATORS** **9**

Barkhausen criterion for oscillation – phase shift, Wien bridge - Hartley & Colpitt's oscillators -- crystal oscillators – oscillator amplitude stabilization.

UNIT V **POWER AMPLIFIERS AND DC/DC CONVERTERS** **9**

Power amplifiers- class A-Class B-Class AB-Class C-Power amplifiers–DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 David A Bell, "Electronic Devices and Circuits", 5th Edition, Oxford Higher Education press, 2014.

2 Salivahanan S, Suresh Kumar A, "Electronic Devices and Circuits", 5th Edition, Tata McGraw Hill, 2022.

REFERENCES:

1 Robert Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory", 11th Edition, Pearson Education, 2015.

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2 Sedha R S, "A textbook book of Applied Electronics", S Chand & Co., 2017.

3 Geetam Tomar, Ashish Bagwari, "Fundamentals of Electronic Devices and Circuits", Springer, 2020.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108108112.
2. https://www.udemy.com/course/basic-electronics-k.
3. https://www.classcentral.com/course/swayam-semiconductor-devices-and-circuits-1997.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze Gain and frequency response of BJT and MOSFET Amplifiers.

CO2 Analyze Differential Amplifier and Tuned Amplifiers.

CO3 Analyze the characteristics of Feedback Amplifiers.

CO4 Analyze the different types of oscillators.

CO5 Analyze Power Amplifiers and DC/DC Converters.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	1	-	-	-	-	2	2
CO2	3	3	2	2	-	-	-	1	-	-	-	-	2	2
CO3	3	3	2	2	-	-	-	1	-	-	-	-	2	2
CO4	3	3	2	2	1	-	-	1	-	-	-	1	2	2
CO5	3	3	2	2	1	-	-	1	-	-	-	1	2	2

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U23MX01 **PERSONAL VALUES** L T P C

Prerequisites: Nil 2 0 0 0

COURSE OBJECTIVES:

- To understand the values through practical activities.
- To understand about physical and mental well-being.
- To know about meditation methods.

UNIT I **SELF CONCEPT** 6

Understanding self-Concept – Identify Yourself – Who am I – an individual, Engineer, citizen – Attitude – Measuring Behaviour – Change of Behaviour – Personality – Characteristics in personal, professional life.

UNIT II **INDIVIDUAL VALUES** 6

Personal Values – Attributes –Courage – Creativity, Honesty, Perfection, Simplicity, and Responsibility – Measuring personal values.

UNIT III **MORAL VALUES** 6

Understanding self-Concept – Identify Yourself – Who am I – an individual, engineer, and citizen – Attitude – Measuring Behaviour – Change of Behaviour – Personality – Characteristics in personal, professional life. Personal Values – Attributes –Courage – Creativity, Honesty, Perfection, Simplicity, Responsibility – Measuring personal values
Moral – Understanding right and wrong – Positive thoughts – Respect to others – Doing good to society.

UNIT IV **PHYSICAL AND MENTAL WELL-BEING** 6

Health – Physical fitness –Mental vigour – Diet management – Yoga – Meditation – Peaceful life – Happiness in life Goal Setting – Decision making skill – Overcome of Barriers – Success – Mental strength and weakness.

UNIT V **DECISION MAKING** 6

Goal Setting – Decision making skill – Overcome of Barriers – Success – Mental strength and weakness.

TOTAL: 30 PERIODS

REFERENCES:

1 Barun K. Mitra, "Personality Development and Soft Skills", Oxford University Press, 2016.
2 B. N. Ghosh, "Managing Soft Skills for Personality Development", Tata McGraw Hill, 2012.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Become an individual in knowing the self.

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CO2 Acquire and express Personal Values, Spiritual values and fitness.

CO3 Practice simple physical exercise and breathing techniques.

CO4 Practice Yoga asana which will enhance the quality of life.

CO5 Practice Meditation and get benefitted.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	1	-	-	-	1
CO2	-	-	-	-	-	-	-	1	-	-	-	1
CO3	-	-	-	-	-	-	-	1	-	-	-	1
CO4	-	-	-	-	-	-	-	1	-	-	-	1
CO5	-	-	-	-	-	-	-	1	-	-	-	1

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U23EC304	CIRCUIT DESIGN AND SIMULATION LABORATORY	L	T	P	C
Prerequisites:	**Circuits and Devices Laboratory**	0	0	3	1.5

COURSE OBJECTIVES:

- To gain hands on experience in designing electronic circuits.
- To learn simulation software used in circuit design.
- To learn the fundamental principles of amplifier circuits and oscillators.

LIST OF EXPERIMENTS:

Design and analysis of the following circuits:

1 Frequency response of CB and CC amplifiers. .
2 Frequency response of CE and CS amplifiers.
3 CMRR measurement of Differential Amplifier.
4 Frequency response of Series and Shunt feedback amplifiers.
5 RC Phase shift oscillator
6 Hartley Oscillator.
7 Design Colpitts Oscillator.
8 Single Tuned Amplifier.

Simulation using SPICE (Using Transistor):

1 Wein Bridge Oscillator
2 Double tuned Amplifiers
3 Stagger tuned Amplifiers
4 Analysis of power amplifier

TOTAL : 30 PERIODS

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Design various types of feedback amplifiers.

CO2 Design and analyse various types of oscillators

CO3 Design CB,CS,CE amplifiers with frequency response

CO4 Design and simulate various oscillators using spice tool.

CO5 Design and simulate various amplifiers using spice tool.

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO2	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO3	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO4	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO5	3	3	3	3	1	-	-	2	1	2	-	1	3	2

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U23EEC301	EMPLOYABILITY SKILLS – I	L	T	P	C
Prerequisites: Nil		0	0	2	1

COURSE OBJECTIVES:

- To educate and enrich the students on quantitative aptitude, logical reasoning and written communication.

UNIT I **QUANTITATIVE APTITUDE – PART 1** 6

Numbers: Number system – Squaring of Numbers – Square Roots – Cube Roots – Divisibility – HCF, LCM – Decimals – Clocks.

UNIT II **QUANTITATIVE APTITUDE – PART 2** 6

Averages – problem on Ages – Ratio & Proportion – Mixture and Allegations.

UNIT III **LOGICAL REASONING – PART – 1** 6

Alphabet Test Series – Number Test Series– Analogies – Odd Words – Statement & Conclusions – Blood Relations – Odd man out.

UNIT IV **EFFECTIVE ENGLISH – SPOKEN ENGLISH** 6

Basic Rules of Grammar – Parts of Speech – Tenses – Verbs – Sentences construction – Vocabulary – idioms & phrases – Synonyms – Antonyms – Dialogues and conversation – Exercise (Speaking).

UNIT V **WRITTEN COMMUNICATION – PART 1** 6

Usage of noun, pronoun, adjective (Comparative Forms), Verb, Adjectives, Adverb, Tenses, Articles and Preposition – Change of Voice – Change of Speech.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. R S Aggarwal, "Quantitative Aptitude", Revised Edition, S Chand & Co Ltd., 2017.
2. R S Aggarwal, "A Modern Approach to Verbal and Non-verbal Reasoning", S Chand & Co Ltd., 2018.

REFERENCES:

1. Abhijit Guha, "Quantitative Aptitude", 3rd Edition, Tata McGraw Hill, 2009.
2. Raj N Bakshmi, "English Grammar Practice," 1st Edition, Orient Black Swan, 2009.
3. M Ashra Rizvi, "Effective Technical Communication," 2nd Edition, Tata McGraw Hill, 2017.
4. Norman Lewis, "Word Power Made Easy", W.R. Goyal Publishers, 2020.

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U23EC401 INTEGRATED CIRCUITS AND ITS APPLICATIONS

L	T	P	C
3	0	2	4

Prerequisites: Electronic Circuits

COURSE OBJECTIVES:

- To learn the basic building blocks and characteristics of Operational Amplifiers and its Application.
- To learn the theory and application of analog multipliers, PLL and Timer ICs and also ADC and DAC.
- To introduce the concepts of waveform generation and some special function ICs.

UNIT I OPERATIONAL AMPLIFIERS 9

Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations, Operational Amplifiers – LF155 and TL082.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIER 9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT III ANALOG MULTIPLIER, PLL AND TIMER ICS 9

Analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization, Timer IC 555 and Multivibrators using 555 IC.

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R - 2R Ladder types – switches for D/A converters, high speed sample and-hold circuits, A/D Converters – specifications - Flash type – Successive Approximation type – Single Slope type – Dual Slope type – A/D Converter using Voltage-to-Time Conversion.

UNIT V WAVEFORM GENERATORS AND VOLTAGE REGULATORS 9

Sine-wave generators, Triangular wave generator and Sawtooth wave generator, ICL8038 function generator, IC Voltage regulators: Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator – Monolithic switching regulator, Low Drop – Out (LDO) Regulators, Switched capacitor filter IC MF10.

45 PERIODS

PRACTICAL EXCERCISES

1. Design an Inverting, non-inverting amplifiers, voltage Follower, differentiator and integrator using IC741.
2. Construct a Schmitt trigger using IC741.
3. Design a 2nd order low pass and high pass filters using IC741 and draw its frequency response.
4. Construct a voltage regulator using IC 78xx series.
5. Design and construct R-2R ladder type Digital to Analog Converter and Flash type Analog to Digital Converter.

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6 Design and Simulate full wave precision rectifier using Op-amp, and astable and monostable multivibrator using 555 Timer.

7 Design and simulate using PSPICE Voltage Controlled Oscillator, Analog Multiplier, and PLL as frequency multiplier.

30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 D Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 6th Edition, New Age International Pvt. Ltd., 2022.

2 Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th Edition, Tata McGraw Hill, 2016

REFERENCES:

1 Shrikrishna Yawale, Sangita Yawale, "Operational Amplifier – Theory and Experiments", Springer Publication, 2022.

2 S Salivahanan, V S Kanchana Bhaskaran, "Linear Integrated Circuits", Tata McGraw Hill, 3rd Edition, 2018.

3 Ramakant A Gayakwad, "OPAMP and Linear ICs", 4th Edition, Pearson Education, 2021.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc20_ee13/preview

2 https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_quick_guide.htm

3 https://freevideolectures.com/course/2915/linear-integrated-circuits

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the configurations and performance characteristics of IC741, IC LF155 and TL082.

CO2 Design the applications of operational amplifiers.

CO3 Design the applications of PLL and VCO.

CO4 Analyse the characteristics of ADC and DAC using IC 741.

CO5 Design waveform generators and voltage regulators.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	2	3	1
CO2	3	3	3	3	2	-	-	2	2	2	-	2	3	1
CO3	3	3	3	3	2	-	-	2	2	2	-	2	3	1
CO4	3	3	2	2	2	-	-	2	2	2	-	2	3	1
CO5	3	3	3	3	2	-	-	2	2	2	-	2	3	1

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U23EC402	CONTROL SYSTEMS	L	T	P	C
Prerequisites:	**Transforms and Random Processes**	3	0	0	3

COURSE OBJECTIVES:

- To introduce the components and their representation of control systems
- To learn various methods for analysing the time response, frequency response and stability of the systems.
- To learn the various approach for the state variable analysis.

UNIT I SYSTEMS COMPONENTS AND THEIR REPRESENTATION 9

Control System: Terminology and Basic Structure – Feed forward and Feedback control theory – Electrical and Mechanical Transfer Function Models – Block diagram Models – Signal flow graphs models – DC and AC servo Systems-Synchronous – Multivariable control system

UNIT II TIME RESPONSE ANALYSIS 9

Transient response – steady state response – Measures of performance of the standard first order and second order system – effect on an additional zero and an additional pole – steady error constant and system- type number – PID control – Analytical design for PD, PI, PID control systems

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9

Closed loop frequency response-Performance specification in frequency domain – Frequency response of standard second order system – Bode Plot – Polar Plot – Nyquist plots – Design of compensators using Bode plots – Cascade lead compensation – Cascade lag compensation – Cascade lag-lead compensation

UNIT IV CONCEPTS OF STABILITY ANALYSIS 9

Concept of stability – Bounded – Input Bounded – Output stability – Routh stability criterion – Relative stability-Root locus concept – Guidelines for sketching root locus –Nyquist stability criterion.

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation – Conversion of state variable models to transfer functions – Conversion of transfer functions to state variable models-Solution of state equations – Concepts of Controllability and Observability – Stability of linear systems – Equivalence between transfer function and state variable representations – State variable analysis of digital control system – Digital control design using state feedback.

TOTAL: 45PERIODS

TEXT BOOKS:

1 M Gopal, "Modern Control System Theory", 4th Edition, New Age International Publishers, 2021.

2 I Gopal J Nagrath, M Gopal, "Control System Engineering", New Academic Science Publishers, 2020.

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REFERENCES:

1 Gibson, John E, Tuteur, Franz B., "Control System Components" Control System Theory", Wiley & Sons, 2021.

2 Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Pearson Education, 2015.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=control%20systems

2 https://onlinecourses.nptel.ac.in/noc19_de04/preview

3 https://github.com/shaoanlu/awesome-control-engineering-online-materials

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the electrical and mechanical transfer function models.
CO2 Analyze the transient response and steady state response.
CO3 Analyze the open loop and closed loop frequency response of system by using Bode plot and polar plot.
CO4 Analyze the stability using Routh stability criterion and Root locus concept.
CO5 Analyze controllability and observability for state space model.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	1	-	-	-	-	3	2
CO2	3	3	2	3	-	-	-	1	-	-	-	-	3	2
CO3	3	3	2	3	-	-	-	1	-	-	-	-	3	2
CO4	3	3	2	3	-	-	-	1	-	-	-	-	3	2
CO5	3	3	2	3	-	-	-	1	-	-	-	-	3	2

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U23EC403 **ELECTROMAGNETIC FIELD AND WAVES** L T P C

Prerequisites: Physics for Electronic Engineers 3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of static electric field and the associated laws.
- To impart knowledge on the basics of electrostatics and magneto statics through its laws.
- To study the propagation of EM waves and significance of Time varying fields.

UNIT I **INTRODUCTION** 9

Electromagnetic model, Units and constants, Review of vector algebra, Rectangular, cylindrical and spherical coordinate systems, Line, surface and volume integrals, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stroke's theorem.

UNIT II **ELECTROSTATICS** 9

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Capacitance, Parallel, cylindrical and spherical capacitors, Electrostatic energy.

UNIT III **MAGNETOSTATICS** 9

Lorentz force equation, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity and idea of relative permeability, Calculations of magnetic field intensity for various current distribution Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torques.

UNIT IV **TIME-VARYING FIELDS AND MAXWELL's EQUATIONS** 9

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, pointing vector and the flow of power, Power flow in a coaxial cable.

UNIT V **PLANE ELECTROMAGNETIC WAVES** 9

Plane waves in lossless media, Plane waves in lossy media (low-loss dielectrics and good conductors), Group velocity, Electromagnetic Wave equation – Wave equation for conducting Medium, Wave equation for free space, Solution of Wave equation, Uniform plane waves, skin depth.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 W H Hayt, J A Buck, "Engineering Electromagnetics", Tata McGraw Hill, 9th Edition, 2020.
2 John D Ryder, "Networks Lines and Fields", Pearson Education, 2nd Edition, 2015.

REFERENCES:

1 W H Hayt and J A Buck, "Engineering electromagnetics", 9th Edition, Tata McGraw Hill, 2020.

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2 F T Ulaby, U Ravaioli, "Fundamentals of Applied Electromagnetics", 8th Edition, Pearson Education, 2020.

3 Joseph Edminister, Mahmood Nahvi, "Schaum's Outline of Electromagnetics", 5th Edition, Tata McGraw Hill, 2019.

ONLINE RESOURCES

1 https://nptel.ac.in/courses/108105112.

2 https://www.udemy.com/course/basic-electrical-engineering-electrical-engineering.

3 https://www.coursera.org/learn/electronics.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply the fundamentals of vector mathematical concepts related to electromagnetic electro static fields.

CO2 Apply the concepts of electrostatics for boundary conditions and electric energy density.

CO3 Apply the concepts of magneto statics for boundary conditions and magnetic energy density.

CO4 Describe the concepts of Faraday's law, Induced EMF and Maxwell's equation.

CO5 Explain the concept of EM waves and its propagation in lossy and loseless medium

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	3	2	1	1	-	-	-	-	-	-	-	1	2	2
CO5	3	2	1	1	-	-	-	-	-	-	-	1	2	2

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U23EC404	MICROCONTROLLER AND ITS APPLICATIONS	L	T	P	C
Prerequisites:	Digital Principles and Computer Organization	3	0	0	3

COURSE OBJECTIVES:

- To enhance the students to understand the basics and the inbuilt hardware microcontrollers.
- To learn 8051 microcontroller instruction and able to write and implement program:
- To learn and apply interfacing concepts for interfacing of the microcontroller wit other devices.

UNIT I **INTRODUCTION TO MICROCONTROLLER 8051** **9**

Brief History, Classification of MCS-51family based on their features (8051, 8052, 8031, 8751, AT89C51), Pin configuration, Processor Architecture and Instruction Set: Registers of 8051, Inbuilt RAM, Register banks, stack, on-chip and external program code memory ROM, power reset and clocking circuits, I/O port structure, Addressing modes, Instruction set and programming.

UNIT II **ON-CHIP PERIPHERAL INTERFACES** **9**

Programming with on-chip Timers, Counters, UART, RS485 transceiver. I2C and SPI protocols, Interrupts, interrupt execution sequence, programming with software and hardware interrupts.

UNIT III **INTERFACING WITH 8051** **9**

Interfacing and programming of : ADC & DAC, stepper motor, DC motor, 4x4 keyboard matrix, LCD, 7-segment LED, interfacing of different types of Memory.

UNIT IV **PIC16F877 MICROCONTROLLER** **9**

PIC16F877 – Architecture, Instructions Set, addressing modes, Assembly language Programs. PIC16F877 PERIPHERALS: Timers, CCP modules, ADC modules, configuration word.

UNIT V **APPLICATIONS OF MICROCONTROLLERS** **9**

RPM meter, event counter, temperature controller (Programs in assembly and C), Development Tools: Simulators, debuggers, cross compilers, in-circuit Emulators for the microcontrollers.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Umesh Dutta, Kamal Kishor Jha, Vikas Sharma, Shivam Gupta, "8051Microcontroller Fundamentals and Programming: Project Based Learning", Clever Fox Publishers, 2022.

2 Raj Kamal, "Embedded Systems- Architecture, Programming and Design", 3rd Edition, Tata McGraw Hill, 2017.

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REFERENCES:

1 Ramesh Gaonkar, "Fundamentals Of Microcontrollers and Applications in Embedded Systems", Tech Neo Publications, 2024.

2 Kenneth J Ayala, "The 8051 Microcontroller Architecture, Programming and Application", 4th Edition, Penram International Publications, 2009.

3 Rolin D McKinlay, Muhammad Ali Mazidi, Danny E Causey, "PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18", 2nd Edition, Pearson Education, 2021.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc20_ee42/preview

2 https://embeddedschool.in/microcontroller-programming/

3 https://coursecouponclub.com/courses/it-software/microcontroller/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the hardware architecture of 8051 microcontroller.

CO2 Summarize the on-chip peripherals inbuilt in 8051 microcontroller.

CO3 Write Assembly language programs to interface 8051 microcontroller with IO devices.

CO4 Describe the hardware architecture and modules of PIC16F877 microcontroller.

CO5 Explain development tools used to design and build functional prototype for real world applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	3	2	-	-	2	-	-	-	-	3	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO5	2	2	1	1	1	-	-	1	-	-	-	2	3	2

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U23EC405 PRINCIPLES OF DISCRETE TIME SIGNAL PROCESSING **L T P C**

Prerequisites: Signals and Systems **3 0 2 4**

COURSE OBJECTIVES:

- To understand about discrete Fourier transform and apply the concepts to linear filtering operations
- To gain the knowledge about FIR IIR and adaptive filters and their implementation in digital signal processors.
- To learn about the finite precision representation of digital filters and multirate signal processing concepts.

UNIT I **DISCRETE FOURIER TRANSFORM** **9**

Review of signals and system – Linear filtering using DFT, Filtering long data sequences – overlap save and overlap add method. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT).

UNIT II **INFINITE IMPULSE RESPONSE FILTERS** **9**

Characteristics of practical frequency selective filters, characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

UNIT III **FINITE IMPULSE RESPONSE FILTERS** **9**

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations

UNIT IV **FINITE WORD LENGTH EFFECTS** **9**

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

UNIT V **DSP APPLICATIONS** **9**

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization-DSP Architecture- Fixed and Floating point architecture principles

45 PERIODS

PRACTICAL EXERCISES:

MATLAB / equivalent software package/ DSP processor based implementation

1. Frequency Analysis using DFT.
2. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation.
3. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations.
4. Generation of various signals and random noise.

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5 Design and demonstration of FIR Filter for Low pass, High pass, Band pass and Band stop filtering.

6 Design and demonstration of Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop filtering.

7 Implement an Up-sampling and Down-sampling operation in DSP Processor.

30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 John G Proakis, Dimitris G Manolakis, "Digital Signal Processing, Principles, Algorithms & Applications", 4th Edition, Pearson Education, 2017.

2 A V Oppenheim, R W Schafer and J R Buck, "Digital Time Signal Processing", 1st Edition, Pearson Education, 2015.

REFERENCES:

1 Maurice Bellanger, Benjamin A Engel, "Digital Signal Processing: Theory and Practice", 10th Edition, John Wiley & Sons, 2024.

2 Samir I Abood, "Digital signal processing : a primer with MATLAB", CRC Press, Taylor Francis Group, 2020.

3 Li Tan, "Digital Signal Processing Fundamentals and Applications", 3rd Edition, Academic Press, Elsevier, 201.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/108105055

2 https://onlinecourses.nptel.ac.in/noc22_ee28/preview

3 https://onlinecourses.nptel.ac.in/noc21_ee20/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply DFT for the analysis of digital signals and systems.

CO2 Design FIR Filters

CO3 Design IIR Filters

CO4 Analyze the effects of finite precision representation in digital filters.

CO5 Design adaptive filters and implement multirate signal processing concepts and various filters in digital signal processors.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	-	-	3	2	3	-	2	3	2
CO2	3	3	3	3	2	-	-	3	2	3	-	2	3	2
CO3	3	3	3	3	2	-	-	3	2	3	-	2	3	2
CO4	3	3	2	2	2	-	-	3	2	3	-	2	3	2
CO5	3	3	3	3	2	-	-	3	2	3	-	2	3	2

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U23EC406	COMMUNICATION SYSTEMS	L	T	P	C
Prerequisites: Transforms and Random Process		3	0	2	4

COURSE OBJECTIVES:

- To introduce analog modulation schemes and digital techniques.
- To impart knowledge in random process and sampling & quantization.
- To know about various demodulation techniques.

UNIT I **AMPLITUDE MODULATION** **9**

Introduction: Modulation and its need– Linear modulation schemes: DSBSC, SSBSC and VSB-power spectrum – Frequency translation – Frequency division multiplexing – Super heterodyne receivers – Noise in AM receivers: coherent detection, envelope detection.

UNIT II **ANGLE MODULATION** **9**

Frequency modulation, Narrowband FM, Wideband FM – Generation of FM: indirect method – FM demodulation: frequency discriminator – Non-linear effects in FM systems – Noise in FM receivers – capture effect – pre-emphasis and de-emphasis in FM.

UNIT III **PULSE MODULATION AND BASEBAND PULSE TRANSMISSION** **9**

Sampling process – PAM – Quantization process –PCM – TDM – Delta modulation, Line coding: unipolar NRZ, Polar NRZ, Unipolar RZ, Manchester – Matched Filter as optimum receiver – Intersymbol Interference – Eye patterns – Nyquist Criterion for distortion less baseband binary transmission – Pulse shaping with raised cosine filter – Duobinary signalling.

UNIT IV **PASSBAND DIGITAL TRANSMISSION AND SPREAD SPECTRUM COMMUNICATION** **9**

Introduction – Coherent Phase shift keying: BPSK, QPSK, OQPSK, $\pi/4$ shifted QPSK –QAM-BER analysis of BPSK and QPSK-concepts of MSK-Spread Spectrum: PN sequence and its properties- Direct Sequence Spread Spectrum, Frequency Hopping Spread Spectrum.

UNIT V **INFORMATION THEORY AND CODING** **9**

Entropy and its properties – Source coding theorem : Huffman coding, LZ coding – Discrete Memory less Channel – mutual information and its properties – Channel coding theorem – information capacity theorem; Hamming codes – Convolutional codes – Trellis diagram – Viterbi algorithm.

45 PERIODS

PRACTICAL EXCERCISES:

1. Amplitude and Frequency Modulation
2. Pulse Code Modulation and Demodulation.
3. Delta Modulation and Demodulation
4. Pulse Position Modulation and Demodulation and Pulse Width Modulation and Demodulation

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5 Simulation of ASK, FSK, and BPSK Generation and Detection Schemes.
6 Simulation of DPSK, QPSK and QAM Generation and Detection Schemes.
7 Simulation of Linear Block and Cyclic Error Control coding Schemes.

30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 Simon Haykin, Michael Moher, Ajay Singh Raghuvanshi, Shweta Shah, "Communication Systems", 5th Edition, Wiley & Sons, 2022.
2 B P Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2021.

REFERENCES:

1 George Kennedy, "Electronic Communication System", 3rd Edition, Tata McGraw Hill, 2018.
Wayne Tomasi, "Electronic Communication System", 5th Edition, Pearson Education, 2013.
3 B P Lathi, Zhi Ding, Hari Mohan Gupta, "Modern Digital and Analog Communication Systems", 4th Edition, 2017.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/108/104/108104091/
2 https://www.coursera.org/learn/fundamentals-network-communications
3 https://ocw.mit.edu/courses/16-36-communication-systems-engineering-spring-2009/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze amplitude modulation techniques.

CO2 Analyze analog modulation techniques.

CO3 Analyze the concepts in baseband pulse transmission techniques.

CO4 Analyze the concept of passband digital transmission techniques.

CO5 Apply the concepts of information theory and coding techniques..

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	2	2	2	-	1	2	1
CO2	3	3	2	2	2	-	-	2	2	2	-	1	2	1
CO3	3	3	2	2	2	-	-	2	2	2	-	1	2	1
CO4	3	3	2	2	2	-	-	2	2	2	-	1	2	1
CO5	3	2	1	1	2	-	-	2	2	2	-	1	2	1

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U23EEC401	EMPLOYABILITY SKILLS – II	L	T	P	C
Prerequisites: Nil		0	0	2	1

COURSE OBJECTIVES:

- To educate and enrich the students on quantitative aptitude, logical reasoning and written communication.

UNIT I **QUANTITATIVE APTITUDE PART – 3** **6**

Percentages – Profit and Loss – Simple Interest & Compound Interest – logarithms.

UNIT II **QUANTITATIVE APTITUDE PART – 4** **6**

Algebra – Linear Equation – Quadratic equation – Polynomials – Time and Distance – Problems on train – Time and Work.

UNIT III **LOGICAL REASONING PART – 2** **6**

Coding and Decoding – Data Sufficiency – Seating Arrangement – syllogism.

UNIT IV **WRITTEN COMMUNICATION PART – 2** **6**

Sentences Formation – Sentence Completion - Sentence Correction – Jumbled Sentences – Letter Drafting – Reading Comprehension – Contextual Usage.

UNIT V **WRITTEN COMMUNICATION PART – 3** **6**

Practices: Sentence Completion – Sentence Correction – Jumbled Sentences – Synonyms and Antonyms – Using the same word as different parts of speech – Interpretation of Pictorial Representations – Editing.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. R S Aggarwal, "Quantitative Aptitude", Revised Edition, S Chand & Co Ltd., 2017.
2. R S Aggarwal, "A Modern Approach to Verbal and Non-verbal Reasoning", S Chand & Co Ltd., 2018.

REFERENCES:

1. Abhijit Guha, "Quantitative Aptitude", 3rd Edition, Tata McGraw Hill, 2009.
2. Raj N Bakshmi, "English Grammar Practice," 1st Edition, Orient Black Swan, 2009.
3. M Ashra Rizvi, "Effective Technical Communication," 2nd Edition, Tata McGraw Hill, 2017.
4. Norman Lewis, "Word Power Made Easy", W.R. Goyal Publishers, 2020.

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U23CB501 **CYBER SECURITY** L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the basics of cyber security, cyber crimes and cyber law.
- To learn about social media issues relevant to cyber security.
- To know about digital devices security, tools and technologies for cyber security.

UNIT I INTRODUCTION TO CYBER SECURITY 9

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Concept of cyber security, Issues and challenges of cyber security.

UNIT II CYBERCRIME AND CYBER LAW 9

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, financial frauds, malware and ransomware attacks, zero day and zero click attacks, Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber security in India.

UNIT III SOCIAL MEDIA OVERVIEW AND SECURITY 9

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Social media privacy, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

UNIT IV E - COMMERCE AND DIGITAL PAYMENTS 9

E- Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment, Modes of digital payments – Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions.

UNIT V DIGITAL DEVICES SECURITY, TOOLS AND TECHNOLOGIES FOR CYBER SECURITY 9

Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security.

45 PERIODS

PRACTICAL EXERCISES:

1 Checklist for reporting cyber crime at cyber crime Police Station and reporting cyber crime online.
2 Configuring security settings in Mobile Wallets and UPIs and Checklist for secure net banking.
3 Setting and configuring two factor authentication in the Mobile phone and Security patch management and updates in Computer and Mobiles.
4 Managing Application permissions in Mobile phone.
5 Wi-Fi security management in computer and mobile.

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30 PERIODS

TOTAL: 75 PERIODS

REFERENCES:

1 Ramesh Chandra Mishra, "Cyber Crime Impact in the New Millennium", Authors Press, 2010.
2 Sumit Belapure, Nina Godbole, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 1st Edition, Wiley India Pvt. Ltd., 2011.
3 Kumar K, "Cyber Laws: Intellectual Property & E-Commerce Security", Dominant Publishers, 2011.
4 Eric Cole, Ronald Krutz, James W Conley, "Network Security Bible", 2nd Edition, Wiley India Pvt. Ltd., 2011.
5 E Maiwald, "Fundamentals of Network Security", Tata McGraw Hill, 2017.

ONLINE RESOURCES

1 http://www.digimat.in/nptel/courses/video/106106212/L01.html
2 https://onlinecourses.swayam2.ac.in/cec24_cs03/preview
3 https://onlinecourses.swayam2.ac.in/cec24_cs01/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the concept of Cyber security and issues and challenges associated with it.
CO2 Explain cyber crimes, their nature, legal remedies and as to how report the crimes through available platforms and procedures.
CO3 Apply various privacy and security concerns on online Social media.
CO4 Apply concepts related cyber security aspects to E-Commerce and digital payments.
CO5 Apply Wi-Fi security management concepts in computer and mobile.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	1	-	2	1	1	-	1
CO2	2	2	1	1	-	1	-	2	1	1	-	1
CO3	3	2	1	2	1	1	-	2	1	1	-	1
CO4	3	2	1	2	1	1	-	2	1	1	-	1
CO5	3	2	1	2	1	1	-	2	1	1	-	1

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U23EC501 **VLSI DESIGN** L T P C

Prerequisites: **Digital Principles and System Organization, Electronic Circuits** 3 0 2 4

COURSE OBJECTIVES:

- To understand about MOS Transistor and CMOS fabrication and layout.
- To understand about combinational and sequential logic MoS circuits.
- To learn about Arithmetic Building Blocks.

UNIT I **MOS TRANSISTOR & SECOND ORDER EFFECTS** 9

Long-Channel I-V Characteristics, C-V Characteristics, , Simple MOS Capacitance Models, Detailed MOS Gate Capacitance Model, Detailed MOS Diffusion Capacitance Model, DC transfer Characteristics ,Non ideal I-V Effects, Mobility Degradation, Velocity Saturation, Channel Length Modulation, Threshold Voltage Effects, Leakage, Temperature & Geometry Dependence.

UNIT II **CMOS FABRICATION & LAYOUT** 9

CMOS logic, Examples of Combinational logic devices, CMOS Fabrication Process, Layout Design Rules, Gate Layouts, Stick Diagrams, Scaling, Transistor Scaling and Inter connect Scaling.

UNIT III **COMBINATIONAL MOS LOGIC CIRCUITS** 9

Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic (CVSL), Pass Transistor Logic, Transmission Gates, Dynamic CMOS Logic, Domino, Dual Rail Domino Logic.

UNIT IV **SEQUENTIAL MOS LOGIC CIRCUITS** 9

Introduction to Sequential Logic, static latches and registers, Static SR Flip-Flop, Dynamic latches and registers, Dynamic Transmission gate edge Triggered register, True single phase edge Triggered register (TSPCR), Clocked CMOS register (C2 MOS).

UNIT V **ARITHMETIC BUILDING BLOCKS** 9

Adders, Binary Adder, Ripple carry Adder, Carry bypass Adder, Carry select adder, Linear carry select adder, Square root carry select adder..

45 PERIODS

PRACTICAL EXERCISES:

1 Design and simulate basic combinational circuits using Xilinx.
2 Design and simulate basic sequential circuits using Xilinx.
3 Design and simulate a 4 bit ripple carry adder using Xilinx.
4 Design and simulate an ALU using Xilinx.
5 Design and simulate a 4 bit Multiplier using Xilinx.
6 Design and simulate a CMOS inverter.
7 Design and simulate CMOS Basic Gates.

30 PERIODS

TOTAL: 75 PERIODS

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TEXT BOOKS:

1 R Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation, 4th Edition, John Wiley & Sons, 2019.

2 Neil H E Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design - A Circuits and Systems Perspective", 4th Edition, Pearson Education, 2012.

REFERENCES:

1 Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 2nd Edition, Tata McGraw Hill, 2017.

2 Kamran Eshraghian, Dougles A Pucknell, Sholeh Eshraghian, "Essentials of VLSI Circuits and Systems", 1st Edition, Prentice Hall of India, 2005.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/108/107/108107129/

2 https://onlinecourses.nptel.ac.in/noc21_ee09/preview

3 https://archive.nptel.ac.in/courses/117/101/117101105/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend about MOS Transistors and its characteristics.

CO2 Explain CMOS fabrication and layout design.

CO3 Apply the concepts of combinational logic in CMOS circuit design.

CO4 Summarize the concepts of synchronous logic circuits.

CO5 Explain about arithmetic building blocks.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	3	2	3	-	2	3	2
CO2	2	2	1	2	2	-	-	3	2	3	-	2	3	2
CO3	3	2	1	2	2	-	-	3	2	3	-	2	3	2
CO4	2	2	1	2	2	-	-	3	2	3	-	2	3	2
CO5	2	2	1	2	2	-	-	3	2	3	-	2	3	2

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U23EC502	TRANSMISSION LINES AND RF SYSTEMS	L	T	P	C
Prerequisites:	Electromagnetic Field and Waves	3	0	0	3

COURSE OBJECTIVES:

- To introduce various types of transmission lines and its characteristics, power and impedance measurements.
- To impart the knowledge on technical knowledge in impedance matching using Smith chart.
- To know about the concepts of a RF system transceiver design.

UNIT I **TRANSMISSION LINE THEORY** **9**

General theory of Transmission lines – the transmission line – general solution – The infinite line – Wavelength, velocity of propagation – Waveform distortion – the distortion less line – Loading and different methods of loading – Line not terminated in Z 0 – Reflection coefficient – calculation of current, voltage, power delivered and efficiency of transmission – Input and transfer impedance – Open and short circuited lines – reflection factor and reflection loss.

UNIT II **HIGH FREQUENCY TRANSMISSION LINES** **9**

Transmission line equations at radio frequencies – Line of Zero dissipation – Voltage and current on the dissipation less line, Standing Waves, Nodes, Standing Wave Ratio – Input impedance of the dissipation less line – Open and short circuited lines – Power and impedance measurement on lines – Reflection losses – Measurement of VSWR and wavelength.

UNIT III **IMPEDANCE MATCHING IN HIGH FREQUENCY LINE** **9**

Impedance matching: Quarter wave transformer ,One Eighth wave line, Half wave line – Impedance matching by stubs – Single stub and double stub matching – Smith chart – Application of Smith chart, Solutions of problems using Smith chart – Single and double stub matching using Smith chart.

UNIT IV **WAVEGUIDES** **9**

Waves between parallel planes of perfect conductors – Transverse Electric waves and Transverse Magnetic waves, Characteristics of TE and TM waves, Transverse Electromagnetic waves, TM and TE waves in Rectangular waveguides.

UNIT V **RF SYSTEM DESIGN CONCEPTS** **9**

Active RF components: Semiconductor basics in RF, bipolar junction transistors, RF field effect transistors, High electron mobility transistors, Fundamentals of MMIC, Basic concepts of RF design: Filters, couplers, power dividers, Amplifier power relations, Low noise amplifiers, Power amplifiers.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 John D Ryder, "Networks Lines and Fields", Prentice Hall of India, 2018.

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2 Sriram Kalaga, Prasad Yenumula, "Design of Electrical Transmission Lines: Structures and Foundations", 1st Edition, CRC Press, 2021.
3 Annapurna Das, Sisir K Das, "Microwave Engineering", 3rd Edition, Tata McGraw Hill, 2000.

REFERENCES:

1 Michael Steer, "Microwave and RF Design Volume 2: Transmission Lines", 3rd Edition, The University of North Carolina Press", 2019.
2 D K Misra, "Radio Frequency and Microwave Communication Circuits: Analysis and Design", John Wiley & Sons, 2004.
3 Jerry C Whitaker, "The Transmission Systems Handbook", CRC Press, 2017.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/108/106/108106157/
2 https://nptel.ac.in/courses/117101056
3 https://nptel.ac.in/courses/117102012

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the characteristics of transmission lines and its losses.
CO2 Estimate the standing wave ratio and input impedance of high frequency transmission lines.
CO3 Evaluate the impedance matching in high frequency line.
CO4 Summarize the characteristics of TE and TM waves.
CO5 Design a RF transceiver system for wireless communication.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	-	-	1	-	-	-	1	2	2
CO2	3	3	2	3	-	-	-	1	-	-	-	1	2	2
CO3	3	3	2	3	1	-	-	1	-	-	-	-	2	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO5	3	3	3	3	-	-	-	1	-	-	-	1	2	2

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U23EC503	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
Prerequisites:	**Python Programming**	3	0	2	4

COURSE OBJECTIVES:

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

UNIT I **PROBLEM SOLVING** **9**

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 II **PROBABILISTIC REASONING** **9**

Acting under uncertainty – Bayesian inference – naïve bayes models, Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT III **SUPERVISED LEARNING** **9**

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 IV **ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING** **9**

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

UNIT V **NEURAL NETWORKS** **9**

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) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

45 PERIODS

PRACTICAL EXCERCISES:

1. Implementation of Uninformed search algorithms (BFS, DFS)
2. Implementation of Informed search algorithms (A*, memory-bounded A*)
3. Implement naïve Bayes models and Bayesian Networks and EM for Bayesian networks.
4. Build Regression models.
5. Build decision trees and random forests.
6. Build SVM models
7. Implement ensembling techniques and clustering algorithms

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30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 4th Edition, Pearson Education, 2021.
2 Ethem Alpaydin,"Introduction to Machine Learning", 3rd Edition, Prentice Hall of India, 2014.

REFERENCES:

1 Charu C Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.
2 Dan W Patterson, "Introduction to AI and ES", Pearson Education, 2007.
3 Kevin P Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/106/105/106105152/
2 https://nptel.ac.in/courses/106106139
3 https://onlinecourses.nptel.ac.in/noc19_cs52/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply appropriate search algorithms for problem solving.

CO2 Apply reasoning under uncertainty.

CO3 Apply Advanced Supervised and Ensemble Learning to enhance the performance of learning.

CO4 Apply probabilistic and unsupervised learning models for handling unknown pattern.

CO5 Analyze the co-occurrence of data to find interesting frequent patterns and pre-process the data before applying to any real-world problem.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	3	1	-	2	2	2	-	2	3	1
CO2	3	2	1	2	3	1	-	2	2	2	-	2	3	1
CO3	3	2	1	2	2	1	-	2	2	2	-	2	3	1
CO4	3	2	1	2	2	1	-	2	2	2	-	2	2	1
CO5	3	3	2	2	2	1	-	2	2	2	-	2	2	2

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U23MG501	PROFESSIONAL ETHICS AND IPR	L T P C
Prerequisites: Nil		2 0 0 2

COURSE OBJECTIVES:

- To enable the students to create an awareness on engineering ethics and human values.
- To know how to apply safety, responsibility and rights in workplaces.
- To install moral and social values and loyalty and to appreciate the rights of others.

UNIT I **HUMAN VALUES** **6**

Morals, Values and Ethics – Integrity – Work Ethics – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – Caring - Sharing – Honesty – Courage – Valuing Time – Cooperation – Commitment – Empathy – Self-Confidence - Character – Spirituality.

UNIT II **ENGINEERING ETHICS** **6**

Senses of 'Engineering Ethics' – variety of moral issued - types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory - Gilligan's theory – consensus and controversy – Models of Professional Roles – theories about right action - Self-interest – customs and religion – uses of ethical theories.

UNIT III **ENGINEERING AS SOCIAL EXPERIMENTATION** **6**

Engineering as experimentation – engineers as responsible experimenters – codes of ethics – a balanced outlook on law – Case study: The challenger disaster.

UNIT IV **SAFETY, RESPONSIBILITIES AND IPR** **6**

Safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – Collegiality and loyalty – respect for authority - collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – Intellectual Property Rights (IPR) – discrimination. Case studies: The Three mile island and Chernobyl disaster

UNIT V **GLOBAL ISSUES** **6**

Multinational corporations - Environmental ethics – computer ethics – weapons development – engineers as managers – consulting engineers - engineers as expert witnesses and advisors - Code of Conduct – Corporate Social Responsibility

TOTAL: 30 PERIODS

TEXT BOOKS:

1 Mike W Martin and Roland Schinzinger, "Ethics in Engineering", 4th Edition, McGraw Hill, New York 2017.

2 Govindarajan M, Natarajan S and Senthil Kumar V S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2013.

REFERENCES:

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1 John R Boatright, "Ethics and the Conduct of Business", 4th Edition, Pearson Education, New Delhi, 2017.
2 Charles D and Fleddermann, "Engineering Ethics", Pearson Education, New Jersey, 2012.
3 Charles E Harris, Michael S Protchard and Michael J Rabins, "Engineering Ethics Concepts and Cases", 4th Edition, Wadsworth Thompson Learning, United States, 2005.

Upon the completion of the course, the students will be able to

CO1 Comprehend the core human values that shape the ethical behaviour of an Engineer.

CO2 Apply ethics in the profession.

CO3 Summarize the structure and function of state government and local bodies.

CO4 Apply safety, responsibility and rights in workplaces.

CO5 Summarize the global issues with regard to ethics.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	3	-	3	2	-	2	3
CO2	-	-	-	-	-	3	-	3	2	-	2	3
CO3	-	-	-	-	-	3	-	3	2	-	2	3
CO4	-	-	-	-	-	3	-	3	2	-	2	3
CO5	-	-	-	-	-	3	-	3	2	-	2	3

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U23MX02	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	L	T	P	C
Prerequisites:	**Engineering Chemistry**	2	0	0	0

COURSE OBJECTIVES:

- 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 familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness, Eco-system 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 II ENVIRONMENTAL POLLUTION 6

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 III RENEWABLE SOURCES OF ENERGY 6

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 IV USTAINABILITY AND MANAGEMENT 6

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 – A case study.

UNIT V SUSTAINABILITY PRACTICES 6

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 transports. Sustainable energy: Non-conventional Sources, Energy Cycles, carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

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REFERENCES:

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.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the functions of environment, ecosystems and biodiversity and their conservation.
CO2 Explain the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
CO3 Comprehend renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
CO4 Summarize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
CO5 Explain the sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	1	3	1	-	-	-	1
CO2	1	-	-	-	-	1	3	1	-	-	-	1
CO3	1	-	-	-	-	1	3	1	-	-	-	1
CO4	1	-	-	-	-	1	3	1	-	-	-	1
CO5	1	-	-	-	-	1	3	1	-	-	-	1

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U23EEC501	EMPLOYABILITY SKILLS – III	L	T	P	C
Prerequisites: Nil		0	0	2	1

COURSE OBJECTIVES:

- To educate and enrich the students on quantitative aptitude, data interpretation and analysis and written communication.

UNIT I **QUANTITATIVE APTITUDE PART – 5** 6

Probability –Permutation and Combination - Calendars – Logarithm.

UNIT II **QUANTITATIVE APTITUDE PART – 6** 6

Geometry – Straight Line – Triangles – Quadrilaterals – Circle – Co-ordinate Geometry – Cube – Cone – Sphere.

UNIT III **DATA INTERPRETATION AND ANALYSIS- 1** 6

Data Interpretation based on Text – Data Interpretation based on Graphs and Tables. Graphs Column Graphs.

UNIT IV **DATA INTERPRETATION AND ANALYSIS -2** 6

Bar Graphs - Line Charts - Pie Chart - Graphs representing Area - Venn Diagram & Flow Charts.

UNIT V **LOGICAL REASONING PART – 3** 6

Syllogism – Assertion and Reasons – Statements and Assumptions – Identifying Valid Inferences – Identifying strong arguments and weak arguments – Statements and Conclusions – Cause and Effect – Deriving conclusions from passages.

TOTAL: 30 PERIODS

TEXT BOOKS:

1 R S Aggarwal, "Quantitative Aptitude", Revised Edition, S Chand & Co Ltd., 2017.

2 R S Aggarwal, "A Modern Approach to Verbal and Non-verbal Reasoning", S Chand & Co Ltd., 2018.

REFERENCES:

1 Abhijit Guha, "Quantitative Aptitude", 3rd Edition, Tata McGraw Hill, 2009.

2 Raj N Bakshmi, "English Grammar Practice," 1st Edition, Orient Black Swan, 2009.

3 M Ashra Rizvi, "Effective Technical Communication," 2nd Edition, Tata McGraw Hill, 2017.

4 Norman Lewis, "Word Power Made Easy", W.R. Goyal Publishers, 2020.

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U23EC601	ANTENNAS AND WAVE PROPAGATION	L	T	P	C
Prerequisites:	**Transmission Lines and RF Systems**	3	0	0	3

COURSE OBJECTIVES:

- To learn the concept of antenna parameters and its terminologies using measurement
- To learn the performance of antenna array and special antenna with its radiation pattern with measurement
- To learn different types of wave propagation effects on the atmospheric layers

UNIT I **FUNDAMENTALS OF ANTENNA** **9**

Radiation from Hertzian- Power radiated and radiation resistance, Half-wave dipole– Power radiated and radiation resistance –Definitions: Radiation pattern –Radiation intensity – Gain –Directive gain – Power gain –Directivity – Beam width – Bandwidth, Effective length and effective area – Relation between maximum aperture and gain –Folded dipole.

UNIT II **ANTENNA ARRAYS** **9**

Types of Arrays–Linear array with n-isotropic point sources of equal amplitude and spacing– Broadside case, End-fire case – Method of pattern multiplication –Binomial array- Yagi Uda antenna - Log periodic dipole array, Concept of phased array antenna.

UNIT III **SPECIAL AND APERTURE ANTENNAS** **9**

Helical antenna: Normal mode and axial mode of radiation - Horn antenna - Antenna with parabolic reflectors and feeding system - Microstrip patch antenna: Rectangular patch: transmission line model design procedure - Smart antennas.

UNIT IV **PROPAGATION OF RADIO WAVES** **9**

Ground wave propagation - Tropospheric wave propagation- Line of sight distance- Effective earth's radius, Field strength of tropospheric wave - Sky wave propagation – Effective dielectric constant and conductivity of ionosphere-Virtual height- Critical frequency - Maximum usable frequency – Skip distance.

UNIT V **ANTENNA MEASUREMENTS** **9**

Antenna impedance measurement – Radiation pattern measurements – Measurement of directivity, Measurement of antenna gain – Measurement of radiation resistance – Antenna efficiency – Polarization.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Balanis Constantine A, "Antenna Theory", 4th Edition, John Wiley & Sons, 2016.
2 Thomas Kaiser, "Smart Antennas: State of the Art", Hindawi, 2005

REFERENCES:

1 Kraus John D, Marhefka Ronald J, Ahmad, Khan, "Antennas and Wave Propagation", 5th Edition, Tata McGraw Hill, 2018.

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2 Prasad K.D, "Antennas and Wave Propagation", 4th Edition, Satya Prakashan Publications, New Delhi, 2019.
3 S Chandran, "Adaptive Antenna Arrays, Trends and Applications", Springer, 2009.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc23_ee130/preview
2 https://www.tutorialspoint.com/antenna_theory/index.htm
3 https://www.virtulearn.in/course/antenna-and-wave-propagation-online-classes

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the concept of antenna parameters and its terminologies using measurements.
CO2 Evaluate the performance of antenna array with its radiation pattern with measurement.
CO3 Evaluate characteristics of special antennas with measurements and simulation tool.
CO4 Describe the different types of wave propagation effects on the atmospheric layers.
CO5 Explain the concepts of antenna parameter measurements.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	2	3	2
CO2	3	3	2	2	2	-	-	1	-	-	-	2	3	2
CO3	3	3	2	2	2	-	-	1	-	-	-	2	3	2
CO4	2	2	1	1	-	-	-	1	-	-	-	2	3	2
CO5	2	2	1	1	-	-	-	1	-	-	-	2	3	2

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U23EC602 **WIRELESS COMMUNICATION** L T P C

Prerequisite: Communication Systems 3 0 0 3

COURSE OBJECTIVES:

- To study and understand the concepts wireless channels and design of a cellular system.
- To study the various digital signalling techniques and multipath mitigation techniques.
- To understand the concepts of multiple antenna techniques.

UNIT I **WIRELESS CHANNELS** 9

Large scale path loss – Path loss models: Free Space and Two-Ray models – Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

UNIT II **CELLULAR ARCHITECTURE** 9

Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations – Cellular concept – Frequency reuse – channel assignment- hand off – interference & system capacity – trunking & grade of service – Coverage and capacity improvement.

UNIT III **DIGITAL SIGNALING FOR FADING CHANNELS** 9

Structure of a wireless communication link, Principles of Offset-QPSK, pi/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.

UNIT IV **MULTIPATH MITIGATION TECHNIQUES** 9

Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms, Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.

UNIT V **MULTIPLE ANTENNA TECHNIQUES** 9

MIMO systems – spatial multiplexing – System model – Pre-coding – Beam forming – transmitter diversity, receiver diversity – Channel state information – capacity in fading and non-fading channels.

TOTAL: 45 PERIODS

TEXT BOOK :

1 Rappaport T S, "Wireless Communication, Principles and Practice", 2nd Edition, Pearson Education, 2021.

2 Andrea Goldsmith, "Wireless Communication", Cambridge University Press, 2011.

REFERENCES:

1 Andreas F Molisch, "Wireless Communications: From Fundamentals to Beyond 5G", 3rd Edition, Wiley-IEEE Press, 2022.

2 Prashant Ranjan, Ram Shringar Rao, Krishna Kumar, Pankaj Sharma, "Wireless Communication: Advancements and Challenges, 1st Edition, CRC Press, 2022.

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3 William Stallings, "Wireless Communication and Networks", 2nd Edition, Pearson Education, 2004.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee66/preview
2 https://www.coursera.org/learn/wireless-communications
3 https://web.stanford.edu/~dntse/wireless_book.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the concept and design of a cellular system.

CO2 Analyze mobile radio propagation and various digital modulation techniques.

CO3 Apply the concepts of multiple access techniques and wireless networks

CO4 Analyze the various multipath mitigation techniques in a wireless channel.

CO5 Analyze the performance of multiple antenna system in wireless channel.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	2	2	2	-	1	3	2
CO2	3	3	2	2	-	-	-	2	2	2	-	1	3	2
CO3	3	2	1	2	-	-	-	2	2	2	-	1	3	2
CO4	3	3	2	2	-	-	-	2	2	2	-	1	3	2
CO5	3	3	2	2	-	-	-	2	2	2	-	1	3	2

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U23EC603 **WIRELESS COMMUNICATION LABORATORY** L T P C

Prerequisite: Communication Systems 0 0 3 1.5

COURSE OBJECTIVES:

- To understand the concepts and design of a Cellular System.
- To understand Mobile Radio Propagation and Various Digital Modulation Techniques.
- To Understand the Concepts Of Multiple Access Techniques.

PRACTICAL EXERCISES:

1. Modelling of wireless communication systems using MATLAB (Two ray channel and Okumura – Hata model).
2. Modelling and simulation of Multipath fading channel.
3. Design, analyze and test Wireless standards and evaluate the performance measurements such as BER, PER, BLER, throughput, capacity, ACLR, EVM for 4G and 5G using MATLAB.
4. Modulation: Spread Spectrum – DSSS Modulation & Demodulation.
5. Wireless Channel equalization: Zero-Forcing Equalizer (ZFE), MMSE Equalizer (MMSEE).
6. Wireless Channel equalization: Adaptive Equalizer (ADE), Decision Feedback Equalizer (DFE).
7. Modelling and simulation of TDMA, FDMA and CDMA for wireless communication.
8. OFDM Signal Transmission and Reception
9. Simulation of Channel Estimation and Synchronization techniques
10. Modelling and simulation of MSK modulation and demodulation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze and modelling of fading effects in wireless communication system.
CO2 Evaluate the performance of various wireless standards.
CO3 Analyze the characteristics of various digital modulation techniques.
CO4 Analyze the performance of various multiple access techniques.
CO5 Analyze the characteristics of various channel equalization in wireless communication system.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	-	2	2	2	-	1	3	2
CO2	3	3	2	3	2	1	-	2	2	2	-	1	3	2
CO3	3	3	2	2	2	1	-	2	2	2	-	1	3	2
CO4	3	3	2	2	2	1	-	2	2	2	-	1	3	2
CO5	3	3	2	2	2	1	-	2	2	2	-	1	3	2

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U23EEC601 **EMPLOYABILITY SKILLS – IV**

L	T	P	C
0	0	2	1

Prerequisites: Nil

COURSE OBJECTIVES:

- To educate and enrich the students on quantitative aptitude, logical reasoning and verbal communication.

UNIT I **ADVANCED QUANTITATIVE APTITUDE – 1** **6**

Averages – problem on Ages – Ratio & Proportion – Mixture and Allegations.

UNIT II **ADVANCED QUANTITATIVE APTITUDE – 2** **6**

Percentages – Profit and Loss – Simple Interest & Compound Interest – logarithms.

UNIT III **ADVANCED QUANTITATIVE APTITUDE – 3** **6**

Algebra – Linear Equation – Quadratic equation – Polynomials – Time and Distance – Problems on train – Time and Work.

UNIT IV **ADVANCED LOGICAL REASONING** **6**

Coding and decoding – Blood relations – Direction Series – Syllogism – puzzles.

UNIT V **ADVANCED VERBAL COMMUNICATION** **6**

Error Spotting – Jumbled Sentences – Comprehension – Idioms and Phrases – Synonyms and Antonyms.

TOTAL: 30 PERIODS

TEXT BOOKS:

1 R S Aggarwal, "Quantitative Aptitude", Revised Edition, S Chand & Co Ltd., 2017.

2 R S Aggarwal, "A Modern Approach to Verbal and Non-verbal Reasoning", S Chand & Co Ltd., 2018.

REFERENCES:

1 Abhijit Guha, "Quantitative Aptitude", 3rd Edition, Tata McGraw Hill, 2009.

2 Raj N Bakshmi, "English Grammar Practice," 1st Edition, Orient Black Swan, 2009.

3 M Ashra Rizvi, "Effective Technical Communication," 2nd Edition, Tata McGraw Hill, 2017.

4 Norman Lewis, "Word Power Made Easy", W.R. Goyal Publishers, 2020.

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U23EC701	EMBEDDED SYSTEMS AND IOT DESIGN	L	T	P	C
Prerequisites:	**Microcontroller and its Applications**	3	0	0	3

COURSE OBJECTIVES:

- To understand the design process of an embedded system.
- To understand the real – time processing in an embedded system.
- To Learn the architecture and design flow of IoT.

UNIT I **EMBEDDED SYSTEMS** **9**

Embedded System Design Process – Model Train Controller – ARM Processor – Instruction Set Preliminaries – CPU – Programming Input and Output – Supervisor Mode – Exceptions and Trap – Models for programs – Assembly, Linking and Loading – Compilation Techniques – Program Level Performance Analysis.

UNIT II **PROCESSES AND OPERATING SYSTEMS** **9**

Structure of a real – time system – Task Assignment and Scheduling – Multiple Tasks and Multiple Processes – Multirate Systems – Pre emptive real – time Operating systems – Priority based scheduling – Interprocess Communication Mechanisms – Distributed Embedded Systems – MPSoCs and Shared Memory Multiprocessors. Design Example – Audio Player, Engine Control Unit.

UNIT III **EMBEDDED PROGRAMMING AND PERIPHERAL INTERFACING** **9**

Embedded C and Python Programming for Embedded Applications - Input and output devices Interface, ADC Interface - DAC Interface - PWM Generation - sensor Interface.

UNIT IV **IOT ARCHITECTURE AND PROTOCOLS** **9**

Internet – of – Things – Physical Design, Logical Design – IoT Enabling Technologies – Domain Specific IoTs – IoT and M2M – IoT System Management with NETCONF – YANG – IoT Platform Design – Methodology – IoT Reference Model – Domain Model – Communication Model – IoT Reference Architecture – IoT Protocols - MQTT, XMPP, Modbus, CANBUS and BACNet.

UNIT V **IOT SYSTEM DESIGN** **9**

Basic building blocks of an IoT device – Raspberry Pi – Board – Linux on Raspberry Pi – Interfaces – Programming with Python – Case Studies: Home Automation, Smart Cities, Environment and Agriculture.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Marilyn Wolf, "Computers as Components – Principles of Embedded Computing System Design", 3rd Edition, Morgan Kaufmann, 2012.

2 Alice James, Avishkar Seth, Subhas Chandra Mukhopadhyay, "IoT System Design Project Based Approach", Springer International Publishing, 2021.

REFERENCES:

1 Mayur Ramgir, "Internet of Things, Architecture, Implementation and Security" 1st Edition, Pearson Education, 2020.

2 Lyla B Das, "Embedded Systems: An Integrated Approach", Pearson Education, 2013.

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3 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.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/106105193
2 https://nptel.ac.in/courses/108105057
3 https://nptel.ac.in/courses/106105172

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the design model of an embedded system.

CO2 Explain the concepts of real time operating systems.

CO3 Comprehend the concepts of embedded programming to interface with the peripherals.

CO4 Summarize the architecture and protocols of IoT.

CO5 Explain about the IoT based system for any application.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO3	2	2	1	1	-	-	-	2	-	-	-	2	3	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	3	2
CO5	2	2	1	1	-	2	2	2	-	-	-	2	3	2

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U23EC702 **OPTICAL COMMUNICATION AND NETWORKS** **L T P C**

Prerequisites: Electromagnetic Field and Waves **3 0 0 3**

COURSE OBJECTIVES:

- To understand various optical fiber modes, configuration and transmission characteristics of optical fibers.
- To impart knowledge on various optical sources, detectors and transmission techniques.
- To gain knowledge about optical fiber measurements , various coupling techniques, optical communication systems and networks

UNIT I **INTRODUCTION TO OPTICAL FIBER COMMUNICATION** 9

Introduction – general optical fiber communication system – basic optical laws and definitions optical modes and configurations – mode analysis for optical propagation through fibers modes in planar wave guide-modes in cylindrical optical fiber -fiber materials – fiber fabrication techniques – fiber optic cables classification of optical fiber – single mode fiber – graded index fiber.

UNITII **TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS** **9**

Attenuation-absorption – scattering losses – bending losses – core and cladding losses-signal dispersion – inter symbol interference and bandwidth – intra model dispersion-material dispersion – waveguide dispersion-polarization mode dispersion-intermodal dispersion optimization of single mode fiber-characteristics of single mode fiber – R-I Profile cut-off wave length.

UNITIII **OPTICAL SOURCES AND OPTICAL DETECTORS** **9**

Sources: LED – LED structures surface emitting LED-Edge emitting LED – quantum efficiency and LED power-light source materials-modulation of LED – LASER diodes-modes and threshold conditions - Rate equations-external quantum efficiency – resonant frequencies – structures and radiation patterns. Detectors: PIN photo detector-Avalanche photo diodes-Photo detector noise – noise sources – SNR.

UNIT IV **OPTICAL RECEIVER, MEASUREMENTS AND COUPLING** **9**

Fundamental receiver operation – digital signal transmission-error sources – Front end amplifiers – digital receiver performance – Optical power measurement-attenuation measurement-dispersion measurement – Fiber Numerical Aperture Measurements – Fiber cut-off Wave length Measurements – Fiber diameter measurements-Source to Fiber Power Launching – Lensing Schemes for Coupling Management – Fiber to Fiber Joints – Fiber Splicing.

UNIT V **OPTICAL COMMUNICATION SYSTEMS AND NETWORKS** **9**

System design consideration Point – to – Point link design – Link power budget – rise time budget, WDM – Passive DWDM Components – Elements of optical networks – SONET/SDH Optical Interfaces – SONET/SDH Rings and Networks -Soliton.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 P Chakrabarti, "Optical Fiber Communication", Tata McGraw Hill, 2016.

2 Gred Keiser, "Optical Fiber Communication", 5th Edition, Tata McGraw Hill, 2013.

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REFERENCES:

1 John M Senior, "Optical fiber communication", 3rd Edition, Pearson Education, 2009.

2 Rajiv Ramaswami, "Optical Networks ", 3rd Edition, Elsevier , 2010

3 Govind P Agrawal, "Fiber-optic communication systems", 4th Edition, John Wiley & Sons, 2012.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee42/preview

2 https://www.edx.org/learn/engineering/purdue-university-fiber-optic-communications

3 https://www.coursera.org/specializations/optical-engineering

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the basic elements in optical fibers, different modes and configuration

CO2 Analyze the transmission characteristics associated with dispersion and polarization techniques.

CO3 Explain various types of optical sources and detectors.

CO4 Summarize the optical receiver system, measurement and coupling techniques

CO5 Describe the optical communication systems and its networks.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	1	3	2
CO2	3	3	2	2	-	-	-	1	-	-	-	1	3	2
CO3	2	2	1	1	-	-	-	1	-	-	-	1	3	2
CO4	2	2	1	1	-	-	-	1	-	-	-	1	3	2
CO5	2	2	1	1	-	-	-	1	-	-	-	1	3	2

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U23EC703 **COMPUTER COMMUNICATION NETWORKS** L T P C

Prerequisites: Communication Systems, Wireless Communication 3 0 0 3

COURSE OBJECTIVES:

- To introduce the fundamentals of Protocol layering and the design of Internetworking.
- To understand the design procedures for Routing.
- To understand the operation of a Transport and Application layer.

UNIT I **FUNDAMENTALS & LINK LAYER** 9

Overview of Data Communications- Networks – Building Network and its types – Overview of Internet – Protocol Layering – OSI Mode – Physical Layer – Overview of Data and Signals – introduction to Data Link Layer – Link layer Addressing- Error Detection and Correction.

UNIT II **MEDIA ACCESS & INTERNETWORKING** 9

Overview of Data link Control and Media access control – Ethernet (802.3) – Wireless LANs – Available Protocols – Bluetooth – Bluetooth Low Energy – WiFi – 6LowPAN–Zigbee – Network layer services – Packet Switching – IPV4 Address – Network layer protocols (IP, ICMP, Mobile IP).

UNIT III **ROUTING** 9

Routing – Unicast Routing – Algorithms – Protocols — Multicast Routing and its basics – Overview of Intradomain and interdomain protocols – Overview of IPv6 Addressing – Transition from IPv4 to IPv6.

UNIT IV **TRANSPORT LAYER** 9

Introduction to Transport layer – Protocols – User Datagram Protocols (UDP) and Transmission Control Protocols (TCP) – Services – Features – TCP Connection – State Transition Diagram – Flow, Error and Congestion Control – Congestion avoidance (DECbit, RED) – QoS – Application requirements.

UNIT V **APPLICATION LAYER** 9

Application Layer Paradigms – Client Server Programming – World Wide Web and HTTP – DNS- -Electronic Mail (SMTP, POP3, IMAP, MIME) – Introduction to Peer to Peer Networks – Need for Cryptography and Network Security – Firewalls.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 James F Kurose, Keith W Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", 8th Edition, Pearson Education, 2021.

2 Behrouz A Forouzan, "Data Communications and Networking with TCP/ IP Protocol Suite", 6th Edition Tata McGraw Hill, 2022.

REFERENCES:

1 Larry L Peterson, Bruce S Davie, "Computer Networks: A Systems Approach, 5th Edition, Morgan Kaufmann Publishers Inc., 2012.

2 William Stallings, "Data and Computer Communications", 10th Edition, Pearson

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Education, 2013.
3 Nader F Mir, "Computer and Communication Networks", 2nd Edition, Prentice Hall of India, 2014.

ONLINE RESOURCES:

1 https://www.techtarget.com/searchnetworking/definition/Data-Link-layer
2 https://www.geeksforgeeks.org/mac-address-in-computer-network/
3 https://aws.amazon.com/routing/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the concepts of the protocols and services of Data link layer.
CO2 Explain the protocols and functions associated with the transport layer services.
CO3 Analyze routing algorithms.
CO4 Explain the protocols and features of transport layer.
CO5 Analyze the working of various application layer protocols.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	1	-	-	1	1	-	1	2	1
CO2	2	2	1	1	-	1	-	-	1	1	-	1	2	1
CO3	3	3	2	2	-	1	-	1	1	1	-	1	2	1
CO4	2	2	1	1	-	1	-	1	1	1	-	1	2	1
CO5	3	3	2	2	-	1	-	1	1	1	-	1	2	1

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U23MG701	PROJECT MANAGEMENT AND FINANCE	L	T	P	C
Prerequisites:	**Basic management and finance concepts**	2	0	0	2

COURSE OBJECTIVES:

- To know about basic concepts of operational and project management
- To impart the knowledge of the project structure and process of project appraisal.
- To know about formulation of a team, implementation, monitoring and controlling a project.

UNIT I **BASIC CONCEPT** **6**

Concept and categories of project - Project development cycle - Concept, tools and techniques of project management - Logistics and supply chain management - Forms of project organizations.

UNIT II **THE VERTICAL STRUCTURE PLANE** **6**

Project identification, formulation and preparation. Market and demand estimation – Market survey techniques - Demand forecasting. Materials management - Analysis of materials input, technology, production, plant capacity, location and site, civil works, charts, layouts and work schedule. Cost of project - Means of financing, estimates of cost – Financial projections.

UNIT III **PROCESS OF PROJECT APPRAISAL** **6**

Technical, Economic, Financial, Legal and Social appraisal of the Industrial Projects Problems due to rate of discount, wage-rate, exchange rates, treatment of taxes, social cost – benefits -treatment of risk and uncertainty - sensitivity analysis and probability approach - Single as well as multiple projects - Big data analytics - PLM and SLM.

UNIT IV **PROJECT TEAM FORMULATION AND MAXIMIZING PARTICIPATION** **6**

Project Team frame works – Project Team cultures - Barriers and challenges – Selecting Team Members – Key skills of effective project leaders - Giving / receiving feedback from different members of the project.

UNIT V **IMPLEMENTATION, MONITORING AND CONTROL OF PROJECTS** **6**

Project scheduling, network techniques for resource, cost budgeting and scheduling – project management teams and coordination – Monitoring and post implementation, evaluation of the project – ERP – Project financing.

TOTAL: 30 PERIODS

TEXT BOOKS:

1 Gobalakrishnan P and Ramamoorthy V E, "Textbook of Project Management", Trinity Press, 7th Edition, 2014.

2 Harvey Maylor, "Project Management", 3rd Edition, Pearson Education, 2010.

REFERENCES:

1 James P Clements, Jack Gido, "Effective project management", 3rd Edition, Cengage Learning, 2008.

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2 Clifford F Gray, Erik W Larson, "Project Management: The Managerial Process", 3rd Edition, TMH, 2010.
3 Sadhan Choudhury, "Project Management", Tata Mc-Graw Hill Publishing Co., 1st Edition, 2007.

Upon the completion of the course, the students will be able to

CO1 Explain the concept of operational and project management.

CO2 Define the scope of a project and develop the project plan.

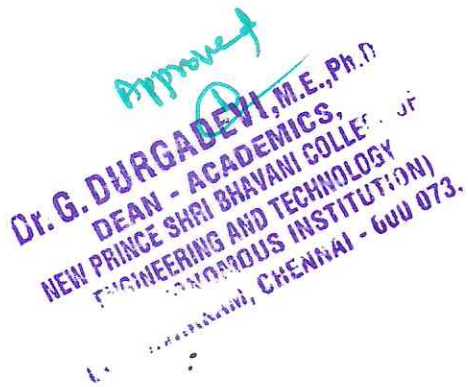
CO3 Evaluate the technical, business and social environment related to the project.

CO4 Explain team formulation and successful team management.

CO5 Design projects using tools and techniques.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	3	-	3	2	-	3	3
CO2	-	-	-	-	-	3	-	3	2	-	3	3
CO3	-	-	-	-	-	3	-	3	2	-	3	3
CO4	-	-	-	-	-	3	-	3	2	-	3	3
CO5	-	-	-	-	-	3	-	3	2	-	3	3



U23EC704 **EMBEDDED LABORATORY** L T P C

Prerequisite: Integrated Circuits and its Applications 0 0 3 1.5

COURSE OBJECTIVES:

- To learn the programming concepts using ARM.
- To interface ADC, DAC and I/Os with processor.
- To build IoT based applications.

PRACTICAL EXERCISES:

Experiments using ARM

1. Write an Assembly Language Program (ALP) to
   i) Multiply two 16-bit numbers.
   ii) Add two 32-bit numbers.
2. Write a program to add an array of 16 bit numbers and store the 32 bit result in internal RAM.
3. Write a program to arrange a series of 32 bit numbers in ascending/descending order.
4. Interfacing ADC and DAC.
5. Interfacing Keyboard and stepper motor.
6. Interfacing LED and LCD.

Experiments using IoT

7. Interfacing Analog Sensors.
8. Controlling LEDs, relay & buzzer using Blynk app.
9. Displaying humidity and temperature data on a web-based application.
10. IoT based application system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Write the basic arithmetic programs using ARM.
CO2 Write a program to interface with A/D and D/A converter.
CO3 Write a program to interface with display, keyboard and motors.
CO4 Write a program to interface sensors, I/Os and transfer the data to IoT Clouds.
CO5 Design the IoT systems for real time applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	-	2	3	3	-	2	3	2
CO2	3	3	3	3	3	2	-	2	3	3	-	2	3	2
CO3	3	3	3	3	3	2	-	2	3	3	-	2	3	2
CO4	3	3	3	3	3	3	2	2	3	3	-	3	3	3
CO5	3	3	3	3	3	3	2	2	3	3	2	3	3	3

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U23EC705	OPTICAL AND MICROWAVE COMMUNICATION LABORATORY	L	T	P	C
Prerequisite:	**Communication Systems**	0	0	3	1.5

COURSE OBJECTIVES:

- To understand the working principle of optical sources, detector and fibers.
- To understand the characteristics and measurements in optical fiber.
- To study and understand the working principle of microwave components.

PRACTICAL EXERCISES:

1 Measurement of connector, bending and fiber attenuation losses.
2 Measurement of Numerical Aperture of Fibers.
3 DC Characteristics of LED
4 DC Characteristics of PIN Photo diode
5 Fiber optic Analog Link Characterization - Frequency response
6 Fiber optic Digital Link Characterization - Frequency response and eye diagram

LIST OF MICROWAVE EXPERIMENTS

7 Measurement of VSWR and Impedance.
8 Characterization of Directional Coupler.
9 Characterization of Isolator and Circulator.
10 Gunn Diode Characteristics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze various types of losses in optical communication system.

CO2 Evaluate the performance of optical source and detector.

CO3 Analyze the characteristics of analog and digital link in optical communication.

CO4 Analyze the performance of various microwave components.

CO5 Analyze the characteristics of Gunn diode.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	-	2	2	2	-	1	3	2
CO2	3	3	2	3	2	1	-	2	2	2	-	1	3	2
CO3	3	3	2	2	2	1	-	2	2	2	-	1	3	2
CO4	3	3	2	2	2	1	-	2	2	2	-	1	3	2
CO5	3	3	2	2	2	1	-	2	2	2	-	1	3	2

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PROFESSIONAL ELECTIVE COURSES: VERTICALS															
Course Code	Vertical I Semiconductor Chip Design and Testing	Course Code	Vertical II Signal Processing	Course Code	Vertical III RF Technologies	Course Code	Vertical IV Bio Medical Technologies	Course Code	Vertical V Cyber Security and Networking	Course Code	Vertical VI Sensor Technologies and IoT	Course Code	Vertical VII Space Technologies	Course Code	Vertical VIII High Speed Communications
U23PEEC01	Wide Bandgap Devices	U23PEEC07	Adaptive Signal Processing	U23PEEC13	RF Transceivers	U23PEEC19	Wearable Devices	U23PEEC25	Cloud Infrastructure and Services	U23PEEC31	IoT Based System Design	U23PEEC37	Avionics Systems	U23PEEC43	Millimeter Wave Communication
U23PEEC02	Advanced Digital System Design	U23PEEC08	Image Processing	U23PEEC14	Microwave Engineering	U23PEEC 20	Bio Medical Signal Processing	U23PEEC26	Cryptography and Cyber Security	U23PEEC32	IoT Processors	U23PEEC38	Positioning and Navigation Systems	U23PEEC44	Advanced Wireless Communication Techniques
U23PEEC03	Low Power IC Design	U23PEEC09	Speech Processing	U23PEEC15	MICs and RF System Design	U23PEEC 21	Therapeutic Equipment	U23PEEC27	Deep Learning Techniques	U23PEEC33	Wireless Sensor Network Design	U23PEEC39	Satellite Communication	U23PEEC45	4G/5G Communication Networks
U23PEEC 04	VLSI Testing and Design for Testability	U23PEEC10	Video Analytics	U23PEEC 16	EMI/EMC Pre Compliance Testing	U23PEEC22	Medical Imaging Systems	U23PEEC28	Computer Vision	U23PEEC34	MEMS Design	U23PEEC40	Remote Sensing	U23PEEC46	Software Defined Networks
U23PEEC05	Analog IC Design	U23PEEC11	DSP Architecture and Programming	U23PEEC17	RFID System Design and Testing	U23PEEC23	Brain Computer Interface and Applications	U23PEEC29	Security in IoT	U23PEEC35	Industrial IoT and Industry 4.0	U23PEEC41	Rocketry and Space Mechanics	U23PEEC47	Massive MIMO Networks
U23PEEC06	Electronics Circuit Board Design	U23PEEC12	Advanced Digital Signal Processing	U23PEEC18	Signal Integrity	U23PEEC24	Robotics in Medicine	U23PEEC30	Blockchain Technologies	U23PEEC36	Fundamentals of Nano Electronics	U23PEEC42	Radar Technologies	U23PEEC48	High Performance Computer Networks

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U23PEEC01 **WIDE BAND GAP DEVICES**

L	T	P	C
2	0	2	3

Prerequisites: Electronic Circuits, VLSI Design

COURSE OBJECTIVES:

- To understand and gain the knowledge of wide band gap devices and its application in real world.
- To understand and gain the knowledge of Switching Characterization Of WBG and Drivers for Wide Band Gap Devices.
- To understand and gain the knowledge of High Frequency Design Complexity, PCB Designing and Applications of Wide Band Gap Devices.

UNIT I **WBG DEVICES AND THEIR APPLICATION IN REAL WORLD** **6**

Review of semiconductor basics, Operation and characteristics of the SiC Schottky Barrier Diode, SiC DMOSFET and GaN HEMT, Review of Wide band gap semiconductor technology -Advantages and disadvantages.

UNIT II **SWITCHING CHARACTERIZATION OF WBG** **6**

Turn-on and Turn-off characteristics of the device, Hard switching loss analysis, Double pulse test set-up.

UNIT III **DRIVERS FOR WIDE BAND GAP DEVICES** **6**

Gate driver, Impact of gate resistance, Gate drivers for wide band gap power devices, Transient immunity integrated gate drivers.

UNIT IV **HIGH FREQUENCY DESIGN COMPLEXITY AND PCB DESIGNING** **6**

Effects of parasitic inductance, Effects of parasitic capacitance, EMI filter design for high frequency power converters High frequency PCB design, Conventional power loop design, High frequency power loop optimization, Separation of power from signal PCB.

UNIT V **APPLICATIONS OF WIDE BAND GAP DEVICES** **6**

Consumer electronics applications, Wireless power transfer applications, Electric vehicle applications, and Renewable energy sources applications.

PRACTICAL EXERCISES: **30 PERIODS**

1. Conduct switching loss and Magnetic loss on Low side.
2. Conduct Double pulse test (DPT) and learn IEC 60747 -8/9 standards.
3. Conduct experiments for diode reverse recovery on High side.
4. Conduct Power analysis and harmonic measurement.
5. Measure Turn on /off delay and Calculate recovery softness factor, measure reverse recovery energy.

30 PERIODS
TOTAL: 60 PERIODS

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TEXT BOOKS:

1 Gauden Meneghesso, Matteo Meneghini, Enrico Zanoni, "Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion," Springer International Publishing, 2018.

2 Alex Lidow, Michel De Rooij, Johan Strydom David Reusch, John Glaser, "GaN Transistors for Efficient Power Conversion", 3rd Edition, John Wiley & Sons, 2020.

REFERENCES:

1 B Jayant Baliga, "Gallium Nitride and Silicon Carbide Power Devices," World Scientific Publishing Company Private Limited, 2017.

2 Fei Wang, Zheyu Zhang and Edward A Jones, "Characterization of Wide Bandgap Power Semiconductor Devices", Institution of Engineering and Technology, 2018.

3 Luca Corradini, Dragan Maksimovic, Paolo Mattavelli, Regan Zane, "Digital Control of High-Frequency Switched-Mode Power Converters", John Wiley & Sons, 2015.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee19/preview.

2 https://cusp.umn.edu/power-electronics/wide-band-gap-wbg-devices.

3 https://www.classcentral.com/course/swayam-semiconductor-devices-and-circuits-1997.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend the operation and practical applications of WBG devices.

CO2 Explain the switching characterization of WBG to get real life experience of double pulse test.

CO3 Explain the operation of drivers for wide bandgap devices and familiar with reliability issues.

CO4 Design a PCB and to calculate power and harmonic measurement with high frequency.

CO5 Analyze the various Applications of wide bandgap devices to calculate recovery softness factor.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO3	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO4	3	3	2	3	1	-	-	1	-	-	-	1	2	2
CO5	3	2	2	2	1	-	-	1	-	-	-	1	2	2

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U23PEEC02 **ADVANCED DIGITAL SYSTEM DESIGN** L T P C

Prerequisites: Digital Principles and Computer Organization 2 0 2 3

COURSE OBJECTIVES:

- To understand and gain the knowledge of sequential circuits and asynchronous sequential circuits design.
- To understand and gain the knowledge of fault diagnosis and testing procedure for digital circuits.
- To understand and gain the knowledge of synchronous design using programmable devices and system design using VERILOG.

UNIT I **SEQUENTIAL CIRCUIT DESIGN** 6

Analysis of Clocked Synchronous Sequential Circuits and Modelling- State Diagram, State Table, State Table Assignment and Reduction-Design of Synchronous Sequential Circuits Design of Iterative Circuits-ASM Chart and Realization using ASM.

UNIT II **ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN** 6

Analysis of Asynchronous Sequential Circuit – Flow Table Reduction-Races-State Assignment Transition Table and Problems in Transition Table- Design of Asynchronous Sequential Circuit - Static, Dynamic and Essential hazards – Mixed Operating Mode Asynchronous Circuits – Designing Vending Machine Controller.

UNIT III **FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS** 6

Fault Table Method-Path Sensitization Method – Boolean Difference Method - D Algorithm – – Tolerance Techniques – The Compact Algorithm – Fault in PLA – Test Generation - DFT Schemes – Built in Self-Test.

UNIT IV **SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES** 6

Programming Logic Device Families – Designing a Synchronous Sequential Circuit using PLA/PAL – Designing ROM with PLA – Realization of Finite State Machine using PLD – FPGA – Xilinx FPGA - Xilinx 4000.

UNIT V **SYSTEM DESIGN USING VERILOG** 6

Hardware Modelling with Verilog HDL – Logic System, Data Types And Operators For Modelling In Verilog HDL - Behavioral Descriptions In Verilog HDL – HDL Based Synthesis – Synthesis Of Finite State Machines– Structural Modelling – Compilation And Simulation Of Verilog Code – Test Bench - Realization Of Combinational And Sequential Circuits Using Verilog – Registers – Counters – Sequential Machine – Serial Adder – Multiplier- Divider .

PRACTICAL EXERCISES: **30 PERIODS**

1 Design of sequential circuits by Verilog HDL.

2 Design of asynchronous sequential circuits by Verilog HDL.

3 Design of fault diagnosis and testing procedure for combinational circuit with PLA.

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4 Design of synchronous sequential circuits by Verilog HDL.

5 Design of Serial Adders, Multiplier and Divider by Verilog HDL.

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Charles H Rothjr., "Fundamentals of Logic Design", Thomson Learning, 2013.

2 M D Ciletti, "Modeling, Synthesis and Rapid Prototyping with the Verilog HDL", Prentice Hall, 1999.

REFERENCES:

1 Parag K Lala, "Fault Tolerant and Fault Testable Hardware Design", B S Publications, 2002.

2 Parag K Lala, "Digital System Design Using PLD", B S Publications, 2003.

3 Palnitkar, "Verilog HDL – A Guide to Digital Design and Synthesis", Pearson Education, 2003.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee39/preview.

2 https://archive.nptel.ac.in/courses/117/108/117108040/

3 https://archive.nptel.ac.in/courses/108/108/108108189/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze and design of sequential circuits.

CO2 Analyse hazards and design of asynchronous sequential circuits.

CO3 Analyse and design of fault diagnosis and testing procedure for combinational circuit with PLA.

CO4 Design of Synchronous Sequential Circuit using programmable devices.

CO5 Design and use programming tools for implementing digital circuits.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	2	-	-	-	2	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	-	2	2
CO3	3	3	2	2	1	-	-	-	-	-	-	-	2	2
CO4	3	3	3	2	1	-	-	2	-	-	-	-	2	2
CO5	3	3	3	2	2	-	-	2	-	-	-	2	2	2

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U23PEEC03

LOW POWER IC DESIGN

Prerequisites: VLSI Design

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

- To understand and gain the knowledge of low power and low voltage VLSI design.
- To understand the impact of power on system performances and different design approaches.
- To understand and gain the knowledge of low power and low voltage memories.

UNIT I FUNDAMENTALS OF LOW POWER CIRCUITS 6

Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

UNIT II LOW-POWER DESIGN APPROACHES 6

Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures and Mask level Measures.

UNIT III LOW-VOLTAGE LOW-POWER ADDERS 6

Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low Voltage Low Power Design Techniques –Trends of Technology and Power Supply Voltage, Low Voltage Low-Power Logic Styles.

UNIT IV LOW-VOLTAGE LOW-POWER MULTIPLIERS 6

Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh- Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier.

UNIT V LOW-VOLTAGE LOW-POWER MEMORIES 6

Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low Power SRAM Technologies, Basics of DRAM, Self-Refres Circuit, Future Trend and Development of DRAM.

PRACTICAL EXERCISES: **30 PERIODS**

1 Modelling and sources of power consumption.

2 Power estimation at different design levels (mainly circuit, transistor, and gate).

3 Power optimization for combinational circuits.

4 Power optimization for sequential circuits.

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5 Power optimization for RT and algorithmic levels.

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Kiat-Seng Yeo, Kaushik Roy, "Low-Voltage, Low-Power VLSI Subsystems", Tata McGraw Hill, 2004.

2 Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits – Analysis and Design", Tata McGraw Hill, 2011.

REFERENCES:

1 Ming-BO Lin, "Introduction to VLSI Systems: A Logic, Circuit and System Perspective", CRC Press, 2012.

2 Gary K. Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 2002.

3 Siva G Narendran, Anatha Chandrakasan, "Leakage in Nanometer CMOS Technologies", Springer, 2005.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/106/105/106105034/

2 https://nptel.ac.in/courses/106105034

3 https://onlinecourses.nptel.ac.in/noc21_ee09/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the fundamentals of Low power circuits.

CO2 Explain the concept of architectural approaches.

CO3 Analyze Low-Voltage, Low-Power adders.

CO4 Analyze Low-Voltage, Low-Power multipliers.

CO5 Analyze Low-Voltage, Low-Power Memories.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO3	3	3	2	2	1	-	-	2	2	2	-	2	2	2
CO4	3	3	2	2	1	-	-	2	2	2	-	2	2	2
CO5	3	3	2	2	1	-	-	2	2	2	-	2	2	2

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U23PEEC04 **VLSI TESTING AND DESIGN** L T P C

Prerequisites: VLSI Design 3 0 0 3

COURSE OBJECTIVES:

- To understand and gain the knowledge of test requirements and metrics.
- To understand and gain the knowledge of scan design, BIST, memory test and test Interfaces.
- To understand and gain the knowledge of design considerations, power management during testing testability in analog Test.

UNIT I **TEST REQUIREMENTS AND METRICS** 9

Validation platforms- SOC design methodology, IP components, Integration, Clocking, I/Os and interfaces, Device modes, Logic, memories, analog, I/Os, power management; Test requirements- Test handoffs, Testers Where DUT and DFT fit into design / framework; Test- ATPG, DFT, BIST, COF, TTR; Test cost metrics and test economics; Logic fault models- SAF, TDF, PDF, Iddq, St- BDG, Dy-BDG, SDD; Basics of test generation and fault simulation- Combinational circuits, Sequential; Specific algorithmic approaches, CAD framework, Optimizations.

UNIT II **SCAN DESIGN AND BIST** 9

Scan Design- Scan design requirements, Types of scan and control mechanisms, Test pattern construction for scan, Managing scan in IPs and SOCs, Scan design optimisations, Partitioning, Clocking requirements for scan and delay fault testing, Speed of operation; BIST – Framework, Controller configurations, FSMs, LFSRs, STUMPS architecture, Scan compression and bounds, Test per cycle, Test per scan, Self-testing and self-checking circuits, Online test.

UNIT III **MEMORY TEST AND TEST INTERFACES** 9

Memory Test -Memory fault models, Functional architecture as applicable to test, Test of memories, Test of logic around memories, BIST controller configuration, DFT and architecture enhancements, Algorithmic optimisations; Test Interfaces-Test control requirements, Test interfaces - 1500, JTAG, Hierarchical, serial control, Module / IP test, SOC test, Board test, System test, Boundary scan.

UNIT IV **DESIGN CONSIDERATIONS AND POWER MANAGEMENT DURING TEST** 9

Design Considerations, Physical design congestion, Partitioning, Clocks, Test modes, Pins, Test scheduling, Embedded test, Architecture improvements, Test in the presence of security; Power management during test- Methods for low power test, ATPG methods, DFT methods, Scan methods, Low power compression, Test of power management, Implications of power excursions, Optimisations.

UNIT V **ANALOG TEST** 9

Test requirements. DFT methods. BIST methods. Test versus measurement. Defect tests versus performance tests. Tests for specific modules - PLL, I/Os, ADC, DAC, SerDes, etc. RF test requirements.

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TEXT BOOKS: **TOTAL: 45 PERIODS**

1 Vishwani Agrawal and Michael L Bushnell, "Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.

2 Jorgen Staunstrup, Wayne Wolf, "Hardware/Software Co-Design Principles and Practice", Springer US, 2010.

REFERENCES:

1 Giovanni DeMicheli, Mariagiovanna Sami, "Hardware/Software Co-Design", Springer Netherlands, 2013.

2 Patrick R Schaumont, "A Practical Introduction to Hardware/Software Co-design", 2nd Edition, Springer, 2010.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/117105137

2 https://onlinecourses.nptel.ac.in/noc20_ee76/preview

3 https://www.coursera.org/learn/vlsi-cad-logic

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the various test requirements and metrics.

CO2 Describe the types of scan and control mechanisms, scan design and BIST.

CO3 Explain the memory test, test control requirements and test interfaces.

CO4 Design considerations for physical design congestion and power management during test.

CO5 Analyze various fault detection technique in analog circuits.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	2	2
CO2	3	2	1	1	-	-	-	-	-	-	-	-	2	2
CO3	3	2	1	1	-	-	-	-	-	-	-	-	2	2
CO4	3	3	2	2	1	-	-	-	-	-	-	1	2	2
CO5	3	3	2	2	1	-	-	-	-	-	-	1	2	2

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U23PEEC05

ANALOG IC DESIGN

L	T	P	C
2	0	2	3

Prerequisites: Integrated Circuits and its Applications

COURSE OBJECTIVES:

- To understand and gain the knowledge of Single Stage Amplifiers, High Frequency and Noise Characteristics of Amplifiers.
- To understand and gain the knowledge of Feedback and Single Stage Operational Amplifiers.
- To understand and gain the knowledge of Stability, Frequency Compensation and Logic Circuit Testing.

UNIT I **SINGLE STAGE AMPLIFIERS** 6

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower, differential amplifier with active load, Cascode and Folded Cascode configurations with active load, design of Differential and Cascode Amplifiers – to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures

UNIT II **HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS** 6

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, statistical characteristics of noise, noise in Single Stage amplifiers, noise in Differential Amplifiers.

UNIT III **FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS** 6

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.

UNIT IV **STABILITY , FREQUENCY COMPENSATION** 6

Multi pole Systems, Phase Margin, Frequency Compensation, Compensation of two Stage Op Amps and slewing in two stage Op Amps, other compensation techniques.

UNIT V **LOGIC CIRCUIT TESTING** 6

Faults in Logic Circuits- Basic Concepts of Fault Detection- Design for Testability- Ad Hoc Techniques, Level-Sensitive Scan Design, Partial Scan, Built-in Self-Test.

PRACTICAL EXERCISES: **30 PERIODS**

1 Design a Cascode amplifier and analyze its performance.

2 Design a Common source amplifier and analyze its performance.

3 Design a Common drain amplifier and analyze its performance.

4 Design a Common gate amplifier and analyze its performance.

5 Design a differential amplifier with resistive load using transistors.

30 PERIODS

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TEXT BOOKS: **TOTAL: 60 PERIODS**

1 Parag K.Lala, "An Introduction to Logic Circuit Testing", Morgan & Claypool Publishers, 2009.

2 Behzad Razavi, "Design Of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2001.

REFERENCES:

1 Willey M C Sansen, "Analog Design Essentials", Springer, 2006.

2 Jacob Baker, "CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.

3 Phillip E Allen, Douglas R Holberg, "Cmos Analog Circuit Design", Oxford University Press, 2nd Edition, 2002.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/106/117106030/

2 https://onlinecourses.nptel.ac.in/noc22_ee37/preview

3 http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Design a Single Stage Amplifiers to meet user specifications.

CO2 Analyze the frequency and noise performance of amplifiers.

CO3 Design and analyze feedback amplifiers and Single Stage Operational Amplifiers.

CO4 Analyze stability and Frequency Compensation of op amp.

CO5 Analyze the various Testing experience of logic circuits.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	-	-	-	-	-	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	-	2	2
CO3	3	3	2	3	1	-	-	-	-	-	-	-	2	2
CO4	3	3	2	2	-	-	-	1	-	-	-	1	2	2
CO5	3	3	2	2	1	-	-	1	-	-	-	1	2	2

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U23PEEC06 **ELECTRONICS CIRCUIT BOARD DESIGN** L T P C

Prerequisites: Electronic Circuits, VLSI Design 2 0 2 3

COURSE OBJECTIVES:

- To understand and gain the knowledge of PCB Designing Concepts and PCB Design Considerations.
- To understand and gain the knowledge of Design considerations and Simulation of PCB.
- To understand and gain the knowledge PCB Fabrication Techniques, Circuit Tracing and Testing of PCB.

UNIT I INTRODUCTION TO PCB DESIGNING CONCEPTS 6

Types of components used in PCB – Types of PCBs – Single layer – Double layer and multi-layer PCB – Flexible PCB – PCB manufacturing basics.

UNIT II PCB DESIGN CONSIDERATIONS 6

General, mechanical and electrical considerations – Design rules for analog, digital and high frequency circuits – Electromagnetic interference/ Compatibility (EMI/ EMC).

UNIT III DESIGN AND SIMULATION OF PCB 6

Electronic Design Automation (EDA) Tools – Single layer PCB – Two layer PCB – Circuit design and simulation – Creating footprint, Placement and routing- Generating Gerber file for single layer PCB.

UNIT IV PCB FABRICATION TECHNIQUES 6

Image transfer techniques – Plating techniques: Immersion, Electro less, Electroplating – Solder Mask –Etching techniques – Mechanical operations.

UNIT V CIRCUIT TRACING AND TESTING & CASE STUDIES 6

Soldering techniques – Testing PCB – Environmental concern – Case studies: Power supply, Wien-bridge Oscillator.

PRACTICAL EXERCISES: **30 PERIODS**

1 Design of single layer circuit board using discrete components.

2 Soldering and de-soldering the components on the PCB including SMD devices.

3 Design and Simulation of 230V AC to 5V/9V/12V DC Power Supply.

4 Design and implementation of Wien-bridge Oscillator.

5 Preparation of layout from the circuit design.

30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Khandpur R.S., "Printed Circuit Board: Design, Fabrication, Assembly and Testing", 1st Edition, McGraw Hill, 2017.

2 Christopher T. Robertson, "Printed Circuit Board", 1st Edition, Prentice Hall, 2004.

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REFERENCES:

1 Mehta S.D, "Electronic Product Design", 1st Edition, S Chand Publications, New Delhi, 2011.

2 Clyde Coombs, "Printed Circuits Handbook", 6th Edition, Tata McGraw Hill Professional, 2007.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/108108031.

2 https://hillmancurtis.com/nptel-pcb-design/

3 https://onlinecourses.swayam2.ac.in/aic20_sp59/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize different types of PCB Designing Concepts and design of single layer circuit board.

CO2 Explain the PCB design considerations and design of PCB including SMD devices.

CO3 Design a circuit and Simulation of Printed Circuit Board.

CO4 Summarize different types of PCB Fabrication Techniques.

CO5 Explain the Circuit Tracing and Testing of PCB.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO3	3	3	2	3	2	-	-	2	-	-	-	2	2	2
CO4	2	2	1	1	-	-	-	2	-	-	-	2	2	2
CO5	2	2	1	1	-	-	-	2	-	-	-	2	2	2

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U23PEEC07 **ADAPTIVE SIGNAL PROCESSING** L T P C

Prerequisites: Principles of Discrete Time Signal Processing 2 0 2 3

COURSE OBJECTIVES:

- To understand about problems, algorithms and solutions for processing signals in a manner that is responsive to a changing environment
- To design systems on recursive, model-based estimation methods taking the advantage of the statistical properties of the received signals.
- To analyze the performance of adaptive filters.

UNIT I **INTRODUCTION TO ADAPTIVE SYSTEMS** 6

Definitions, Characteristics, Applications, Example of an Adaptive System. The Adaptive Linear Combiner - Description, Weight Vectors, Desired Response Performance function - Gradient & Mean Square Error.

UNIT II **DEVELOPMENT OF ADAPTIVE FILTER THEORY** 6

Introduction to Filtering - Smoothing and Prediction – Linear Optimum Filtering, Problem statement, Principle of Orthogonally - Minimum Mean Square Error, Wiener- Hopf equations, Error Performance - Minimum Mean Square Error.

UNIT III **STEEPEST DESCENT ALGORITHMS** 6

Searching the performance surface – Methods & Ideas of Gradient Search methods - Gradient Searching Algorithm & its Solution - Stability & Rate of convergence - Learning Curves Gradient Search by Newton's Method, Method of Steepest Descent, Comparison of Learning Curves.

UNIT IV **LMS Algorithm & Applications** 6

Overview - LMS Adaptation algorithms, Stability & Performance analysis of LMS Algorithms - LMS Gradient & Stochastic algorithms - Convergence of LMS algorithm. Applications: Noise cancellation – Cancellation of echoes in long distance telephone circuits, Adaptive Beam forming

UNIT V **KALMAN FILTERING** 6

Introduction to RLS Algorithm, Statement of Kalman filtering problem, The Innovation Process, Estimation of State using the Innovation Process- Expression of Kalman Gain, Filtering Examples using Kalman filtering.

30 PERIODS

PRACTICAL EXERCISES:

MATLAB/Equivalent software package based implementation

1 Real time signal enhancement using Adaptive Filter.

2 Design and verification of Matched filter.

3 Adaptive Noise Cancellation using Simulink.

4 Design of Adaptive linear combiner.

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5 Design a Kalman filter.

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Bernard Widrow, Samuel D Strearns, "Adaptive Signal Processing", 2nd Edition, Pearson Education, 2009.

2 Simon Haykin, "Adaptive Filter Theory", 4th Edition, Pearson Education, 2009.

REFERENCES:

1 Sophocles J, Orfanadis, "Optimum signal processing: An introduction", 2nd Edition, Tata McGraw Hill, 2007.

2 S Thomas Alexander, "Adaptive signal processing-Theory and Applications", Springer–Verlag, 1986.

3 James V Candy, "Signal Processing: A Modern Approach", Tata McGraw Hill, International Edition, 1988.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/105/117105075/

2 https://onlinecourses.nptel.ac.in/noc23_ee138/preview

3 https://nptel.ac.in/courses/117105075

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Understand the basic concepts of adaptive systems.

CO2 Apply mathematical models for error performance of adaptive systems.

CO3 Analyze gradient estimation based on performance surface of adaptive systems.

CO4 Analyze LMS algorithm for signal processing applications.

CO5 Design Kalman filter for adaptive noise cancellation.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	3	2	3	-	-	3	2
CO2	3	2	1	2	2	-	-	3	2	3	-	-	3	2
CO3	3	3	2	2	2	-	-	3	2	3	-	-	3	2
CO4	3	3	2	2	2	-	-	3	2	3	-	-	3	2
CO5	3	3	3	3	2	-	-	3	2	3	-	-	3	2

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U23PEEC08 **IMAGE PROCESSING** L T P C

Prerequisites: Signals and Systems 2 0 2 3

COURSE OBJECTIVES:

- To understand with digital image fundamentals.
- To understand about Image enhancement techniques in spatial and frequency domain, image restoration and image segmentation techniques.
- To understand about image compression and recognition techniques.

UNIT I **DIGITAL IMAGE FUNDAMENTALS** 6

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals – RGB, HSI models.

UNIT II **IMAGE ENHANCEMENT** 6

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering – Smoothing and Sharpening Spatial Filtering, Frequency Domain: 2D Fourier Transforms- DFT, DCT – Smoothing and Sharpening frequency domain filters. Color image enhancement.

UNIT III **IMAGE RESTORATION** 6

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.

UNIT IV **IMAGE SEGMENTATION** 6

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

UNIT V **IMAGE COMPRESSION AND RECOGNITION** 6

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes – Recognition based on matching.

30 PERIODS

PRACTICAL EXERCISES:

MATLAB/Equivalent Software Package Based Implementation

1 Image quantization and DFT analysis of images.

2 Histogram processing and Basic thresholding functions.

3 Image Enhancement and Image segmentation

4 Analysis of images with different color models.

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5 Image Compression and Restoration Techniques

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2010.

2 Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.

REFERENCES:

1 Rafael C Gonzalez, Richard E. Woods, Steven L Eddins, "Digital Image Processing Using MATLAB", 3rd Edition Tata McGraw Hill Pvt. Ltd., 2011.

2 Willliam K Pratt, "Digital Image Processing", John Willey & Sons, 2002.

3 Malay K Pakhira, "Digital Image Processing and Pattern Recognition", 1st Edition, Pearson Education, 2011.

ONLINE RESOURCES

1 https://archive.nptel.ac.in/courses/117/105/117105135/

2 https://nptel.ac.in/courses/117105079

3 https://www.nptelvideos.com/course.php?id=541

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyse sampling and quantization of digital image.

CO2 Apply the techniques of smoothing, sharpening and enhancement on images.

CO3 Apply the restoration concepts and filtering techniques.

CO4 Apply segmentation, features extraction, compression and recognition methods for colour models.

CO5 Apply image compression concepts.

CO-PO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	2	2	2	-	1	3	2
CO2	3	2	1	2	2	-	-	2	2	2	-	1	3	2
CO3	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO4	3	2	1	2	2	-	-	2	2	2	-	1	3	2
CO5	3	2	1	2	2	-	-	2	2	2	-	1	3	2

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U23PEEC09 **SPEECH PROCESSING** L T P C

Prerequisites: Signals and Systems, Communication Systems 2 0 2 3

COURSE OBJECTIVES:

- To understand the fundamentals of speech signal and extract various speech features.
- To understand different speech coding techniques for speech compression applications.
- To design speech enhancement, text-to-speech synthesis system.

UNIT I **FUNDAMENTALS OF SPEECH** 6

The Human speech production mechanism, Discrete-Time model of speech production, Speech perception – human auditory system, Phonetics – articulatory phonetics, acoustic phonetics, and auditory phonetics, Categorization of speech sounds, Spectrographic analysis of speech sounds, Pitch frequency, Pitch period measurement using spectral and cepstral domain, Formants, Evaluation of Formants for voiced and unvoiced speech.

UNIT II **SPEECH FEATURES AND DISTORTION MEASURES** 6

Significance of speech features in speech-based applications, Speech Features – Cepstral Coefficients, Mel Frequency Cepstral Coefficients (MFCCs), Perceptual Linear Prediction (PLP), Log Frequency Power Coefficients (LFPCs), Speech distortion measures–Simplified distance measure, LPC-based distance measure, Spectral distortion measure, Perceptual distortion measure.

UNIT III **SPEECH CODING** 6

Need for speech coding, Waveform coding of speech – PCM, Adaptive PCM, DPCM, ADPCM, Delta Modulation, Adaptive Delta Modulation, G.726 Standard for ADPCM, Parametric Speech Coding – Channel Vocoders, Linear Prediction Based Vocoders, Code Excited Linear Prediction (CELP) based Vocoders, Sinusoidal speech coding techniques, Hybrid coder, Transform domain coding of speech

UNIT IV **SPEECH ENHANCEMENT** 6

Classes of Speech Enhancement Algorithms, Spectral-Subtractive Algorithms – Multiband Spectral Subtraction, MMSE Spectral Subtraction Algorithm, Spectral Subtraction Based on Perceptual Properties, Wiener Filtering – Wiener Filters in the Time Domain, Wiener Filters in the Frequency Domain, Wiener Filters for Noise Reduction, Maximum-Likelihood Estimators, Bayesian Estimators, MMSE and Log – MMSE Estimator, Subspace Algorithms.

UNIT V **SPEECH SYNTHESIS AND APPLICATION** 6

A Text-to-Speech systems (TTS), Synthesizers technologies – Concatenative synthesis, Use of Formants for concatenative synthesis, Use of LPC for concatenative synthesis, HMM – based synthesis, Sinewave synthesis, Speech transformations, Watermarking for authentication of a speech, Emotion recognition from speech.

30 PERIODS

PRACTICAL EXERCISES:

1 Write a MATLAB Program to classify voiced and unvoiced segment of speech using various time- domain measures.

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2 Write a MATLAB Program to calculate the MFCC for a speech signal.

3 Implement ITU-T G.722 Speech encoder in MATLAB.

4 Write a MATLAB Program to implement Wiener Filters for Noise Reduction.

5 Design a speech emotion recognition system using DCT and WPT in MATLAB.

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Shaila D Apte, "Speech and Audio Processing", Wiley & Sons, 2012.

2 Philipos C Loizou, "Speech Enhancement Theory and Practice", 2nd Edition, CRC Press, 2013.

REFERENCES:

1 Rabiner L R, Juang B H, "Fundamentals of Speech Recognition", Pearson Education, 2003.

2 Thomas F Quatieri, "Discrete-time Speech Signal Processing – Principles and Practice", Pearson, 2012.

ONLINE RESOURCES

1 https://nptel.ac.in/courses/117105145.
2 https://onlinecourses.nptel.ac.in/noc22_ee117/preview.
3 https://www.classcentral.com/course/youtube-digital-speech-processing-47859.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the formants for voiced and unvoiced speech.

CO2 Analyze the various speech features for speech related applications

CO3 Apply an appropriate speech coder.

CO4 Design a speech enhancement system.

CO5 Design a text-to-speech synthesis system for various applications

CO-PO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	2	2	2	-	-	3	1
CO2	3	3	2	2	2	-	-	2	2	2	-	-	3	1
CO3	3	2	1	2	2	-	-	2	2	2	-	-	3	1
CO4	3	3	3	3	2	-	-	2	2	2	-	-	3	1
CO5	3	3	3	3	2	-	-	2	2	2	-	-	3	1

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U23PEEC10	VIDEO ANALYTICS	L	T	P	C
Prerequisites:	**Signals and Systems**	3	0	0	3

COURSE OBJECTIVES:

- To understand the need for video Analytics
- To understand the basic configuration of video analytics
- To understand the functional blocks of a video analytic system

UNIT I **VIDEO ANALYTIC COMPONENTS** **9**

Need for Video Analytics-Overview of video Analytics – Foreground extraction – Feature extraction classifier – Preprocessing – edge detection- smoothening- Feature space – PCA – FLD – SIFT features.

UNIT II **FOREGROUND EXTRACTION** **9**

Background estimation – Averaging – Gaussian Mixture Model – Optical Flow based – Image
Segmentation – Region growing – Region splitting – Morphological operations – erosion – Dilation Tracking in a multiple camera environment.

UNIT III **CLASSIFIERS** **9**

Neural networks (back propagation) – Deep learning networks – Fuzzy Classifier – Bayesian classifier – HMM based classifier.

UNIT IV **VIDEO ANALYTICS FOR SECURITY** **9**

Abandoned object detection- human behavioral analysis – human action recognition – perimeter security crowd analysis and prediction of crowd congestion.

UNIT V **VIDEO ANALYTICS FOR BUSINESS INTELLIGENCE & TRAFFIC MONITORING AND ASSISTANCE** **9**

Customer behavior analysis – people counting – Traffic rule violation detection – traffic congestion identification for route planning – driver assistance – lane change warning.

45 PERIODS

TEXT BOOKS:

1 Nilanjan Dey, Amira Ashour, Suvojit Acharjee, "Applied Video Processing in Surveillance and Monitoring Systems", IGI global, 2016.
2 Zhihao Chen, Ye Yang, Jingyu Xue, Liping Ye, Feng Guo, "The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite", Create Space Independent Publishing Platform, 2014.

REFERENCES:

1 Graeme A Jones, Nikos Paragios, Carlo S. Regazzoni, "Video-Based Surveillance Systems: Computer Vision and Distributed Processing", Kluwer Academic Publisher, 2001.
2 Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.

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ONLINE RESOURCES:

1 https://developer.nvidia.com/blog/free-self-paced-online-course-for-intelligent-video-analytics-now-available/
2 https://www.classcentral.com/course/udemy-video-analytics-using-opencv-and-python-she-110726
3 https://www.youtube.com/watch?v=I7jtrsbz2ts

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the basic concepts video analytic components.

CO2 Describe the principles of foreground extraction.

CO3 Describe the classifier models used in video analytics.

CO4 Explain about the security concepts of video analytics.

CO5 Design custom made video analytics system for the given target application.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	1
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	1
CO3	2	2	1	1	-	-	-	-	-	-	-	-	2	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	1
CO5	3	3	3	3	2	-	-	1	-	-	-	-	3	1

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U23PEEC11	DSP ARCHITECTURE AND PROGRAMMING	L	T	P	C
Prerequisites:	**Principles of Discrete Time Signal Processing**	2	0	2	3

COURSE OBJECTIVES:

- To understand the architecture of programmable DSP processors.
- To implement various standard DSP algorithms in DSP Processors.
- Use the Programmable DSP Processors to build real-time DSP systems.

UNIT I **ARCHITECTURES FOR PROGRAMMABLE DSP PROCESSORS** **6**

Basic Architectural features, DSP Computational building blocks, Bus architecture and memory, Data addressing capabilities, Address generation Unit, Programmability and program execution, Speed issues, Features for external interfacing.

UNIT II **TMS320C5X PROGRAMMABLE DSP PROCESSOR** **6**

Architecture of TMS320C54xx DSP processors, Addressing modes – Assembly language Instructions – Memory space, interrupts, and pipeline operation of TMS320C54xx DSP Processor, On-Chip peripherals, Block Diagram of TMS320C54xx DSP starter kit.

UNIT III **TMS320C6X PROGRAMMABLE DSP PROCESSOR** **6**

Commercial TI DSP processors, Architecture of TMS320C6x DSP Processor, Linear and Circular addressing modes, TMS320C6x Instruction Set, Assembler directives, Linear Assembly, Interrupts, Multichannel buffered serial ports, Block diagram of TMS320C67xx DSP Starter Kit and Support Tools.

UNIT IV **IMPLEMENTATION OF DSP ALGORITHMS** **6**

DSP Development system, On-chip, and On-board peripherals of C54xx and C67xx DSP development boards, Code Composer Studio (CCS) and support files, Implementation of Conventional FIR, IIR, and Adaptive filters in TMS320C54xx/TMS320C67xx DSP processors for real-time DSP applications, Implementation of FFT algorithm for frequency analysis in real-time.

UNIT V **APPLICATIONS OF DSP PROCESSORS** **6**

Voice scrambling using filtering and modulation, Voice detection and reverse playback, Audio effects, Graphic Equalizer, Adaptive noise cancellation, DTMF signal detection, Speech thesis using LPC, Automatic speaker recognition.

30 PERIODS

PRACTICAL EXERCISES:

1 Write a programme using C, Assembly and linear assembly.
2 Implement of moving average filter.
3 Implement FIR filter with a Pseudorandom noise sequence as input to a filter.
4 Implement fixed point IIR filter.
5 Write a programme to implement FFT of real-time input signal.

30 PERIODS
TOTAL: 60 PERIODS

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TEXT BOOKS:

1 Avtar Singh and S Srinivasan, "Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx", Cengage Learning India Private Limited, 2012.

2 Rulph Chassaing, Donald Reay, "Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK", 2nd Edition, Wiley & Sons India (P) Ltd, 2008.

REFERENCES:

1 B Venkataramani, M Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications", Tata McGraw Hill, 2003.

2 TMS320C5416/6713 DSK user manual at https://www.ti.com

ONLINE RESOURCES

1 http://www.digimat.in/nptel/courses/video/108101174/L01.html

2 https://archive.nptel.ac.in/courses/108/106/108106149/

3 https://onlinecourses.nptel.ac.in/noc19_ee70/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Understand the architectural features of DSP Processors.

CO2 Comprehend the organization of TMS320C54xx DSP processors.

CO3 Comprehend the organization of TMS320C64xx DSP processors.

CO4 Design and implement DSP algorithms.

CO5 Summarize the applications of DSP processors.

CO-PO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO2	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO3	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO4	3	3	3	3	2	-	-	2	2	2	-	1	3	2
CO5	2	2	1	2	2	-	-	2	2	2	-	1	3	2

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U23PEEC12	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
Prerequisites:	**Principles of Discrete Time Signal Processing**	2	0	2	3

COURSE OBJECTIVES:

- To understand the concepts of discrete time random signal processing.
- To understand about multirate signal processing and its applications.
- To apply spectrum estimation techniques, prediction theory and adaptive filtering to discrete random signals.

UNIT I **MULTIRATE SIGNAL PROCESSING** **6**

Review of Convolution, DFT and ZT, Multirate Signal Processing - Decimation, Interpolation, Sampling Rate Conversion by a rational factor – digital filter banks, sub band coding, Quadrature Mirror Filter.

UNIT II **DISCRETE TIME RANDOM PROCESSES** **6**

Stationary random processes, Autocorrelation, Rational Power Spectra, Filters for generating random Processes from white noise and inverse filter – AR, MA and ARMA processes – relationship between autocorrelation and the filter parameters.

UNIT III **LINEAR PREDICTION AND FILTERING** **6**

Linear Prediction – Forward and Backward - Wiener filters for filtering and prediction – FIR Wiener Filter – IIR Wiener Filter – Kalman Filter.

UNIT IV **ADAPTIVE FILTERING** **6**

FIR adaptive filters – adaptive filters based on steepest descent method – LMS algorithm – Variants of LMS algorithm – adaptive echo cancellation – adaptive channel equalization – RLS Algorithm.

UNIT V **SPECTRUM ESTIMATION** **6**

Estimation of power spectra from finite duration observations of signals – Non parametric methods of spectrum estimation – the Bartlett and the Welch method – Parametric spectrum estimation – AR, MA and ARMA.

30 PERIODS

PRACTICAL EXERCISES:

MATLAB/EQUIVALENT SOFTWARE PACKAGE BASED IMPLEMENTATION

1 Design and Implementation of Multirate Systems.

2 Design and Implementation of Wiener Filter.

3 Design and Implementation of FIR Linear Predictor.

4 Design of adaptive filters using LMS algorithm.

5 Spectrum Estimation using Bartlett and Welch Methods.

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30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Avtar Singh and S Srinivasan, "Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx", Cengage Learning India Private Limited, 2012.

2 Rulph Chassaing, Donald Reay, "Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK", 2nd Edition, Wiley & Sons India (P) Ltd, 2008.

REFERENCES:

1 B Venkataramani, M Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications", Tata McGraw Hill, 2003.

2 TMS320C5416/6713 DSK user manual at https://www.ti.com

ONLINE RESOURCES

1 http://www.digimat.in/nptel/courses/video/108101174/L01.html

2 https://archive.nptel.ac.in/courses/108/106/108106149/

3 https://onlinecourses.nptel.ac.in/noc19_ee70/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Understand the architectural features of DSP Processors.

CO2 Comprehend the organization of TMS320C54xx DSP processors.

CO3 Comprehend the organization of TMS320C64xx DSP processors.

CO4 Design and implement DSP algorithms.

CO5 Summarize the applications of DSP processors.

CO-PO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO2	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO3	2	2	1	2	2	-	-	2	2	2	-	1	3	2
CO4	3	3	3	3	2	-	-	2	2	2	-	1	3	2
CO5	2	2	1	2	2	-	-	2	2	2	-	1	3	2

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TEXT BOOKS:

1 John G Proakis & Dimitris G Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", 4th Edition, Pearson Education, 2007.

2 P Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc., 1993.

REFERENCES:

1 Monson H. Hayes, "Statistical digital signal processing and modelling", John Wiley & Sons, 2008.

2 Haykin, "Adaptive Filter Theory", 4th Edition, Pearson Education, 2006.

3 Sophoncles J Orfanidis, "Optimum Signal Processing ", Tata McGraw Hill, 2000.

ONLINE RESOURCES

1 https://archive.nptel.ac.in/courses/117/101/117101001/

2 https://ekeeda.com/degree-courses/electrical-engineering/advanced-digital-signal-processing

3 https://freevideolectures.com/course/3042/advanced-digital-signal-processing

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the basic concepts of multirate signal processing.
CO2 Apply the techniques of discrete time random process in signal processing.
CO3 Apply linear prediction and filtering techniques to discrete random signals for signal detection and estimation.
CO4 Analyze the algorithms used in adaptive filter design.
CO5 Apply power spectrum estimation techniques to random signals.

CO-PO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	-	-	2	2	2	-	1	3	2
CO2	3	2	1	2	2	-	-	2	2	2	-	1	3	2
CO3	3	2	1	2	2	-	-	2	2	2	-	1	3	2
CO4	3	3	2	2	1	-	-	2	2	2	-	1	3	2
CO5	3	2	1	2	2	-	-	2	2	2	-	1	3	2

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U23PEEC13	RF TRANSCEIVERS	L	T	P	C
Prerequisites:	**Transmission lines and RF Systems**	2	0	2	3

COURSE OBJECTIVES:

- To understand the fundamentals and various components of RF system design
- To understand the basic techniques needed for analysis of RF systems
- To conduct experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts

UNIT I **CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES** **6**

CMOS: Introduction to MOSFET Physics - Noise: Thermal, shot, flicker, popcorn noise - Transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR - Phase noise - Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low-IF Architectures - Transmitter: Direct-up conversion, Two-step up conversion schemes

UNIT II **IMPEDANCE MATCHING NETWORKS AND AMPLIFIERS** **6**

Review of S-parameters and Smith chart - Passive IC components - Impedance matching networks - Amplifiers: Common Gate, Common Source Amplifiers - OC Time constants in bandwidth estimation and enhancement - High frequency amplifier design - Low Noise Amplifiers: Power match and Noise match, single-ended and differential LNAs

UNIT III **FEEDBACK SYSTEMS AND POWER AMPLIFIERS** **6**

Feedback Systems: Stability of feedback systems, Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation - Power Amplifiers: General model - Class A, AB, B, C, D, E and F amplifiers

UNIT IV **FILTERS, OSCILLATORS AND MIXERS** **6**

Overview - basic resonator and filter configuration, special filter realizations, filter implementation - Basic oscillator model, high-frequency oscillator configuration, Colpitt's oscillator - basic characteristics of mixers, single and double-balanced mixers

UNIT V **PLL AND FREQUENCY SYNTHESIZERS** **6**

PLL: Linearized Model, Noise properties, Phase detectors, Loop filters and Charge pumps- Frequency Synthesizers: Integer-N frequency synthesizers - Direct Digital Frequency Synthesizers

30 PERIODS

PRACTICAL EXERCISES:

1. Measurement of S-parameters for impedance matching circuits, and RF filters using network analyzer
2. Design of RF inductor and capacitor
3. Design and characterization of LNA and mixer
4. Design of impedance matching network

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5 Design of low-pass and band-pass filter at RF

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Lee T, "Design of CMOS RF Integrated Circuits", Cambridge, 2nd Edition, 2004

2 Razavi B, "RF Microelectronics", Pearson Education, 2nd Edition, 2012

REFERENCES:

1 Ludwig R, Bretchko P, "RF Circuit Design Theory and Applications", Prentice Hall, 2000.

2 Razavi B, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2nd Edition, 2017

3 Kyung-Whan Yeom, "Microwave Circuit Design - A Practical Approach using ADS", Pearson Education, 2015

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc24_ee75/preview

2 https://nptel.ac.in/courses/108107379

3 https://www.classcentral.com/course/swayam-rf-transceiver-of-design-269763

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the nonlinear effects in RF circuits

CO2 Design of RF circuits

CO3 Analyze the performance of RF circuits

CO4 Apply knowledge to identify a suitable architecture and systematically design an RF System

CO5 Analyze interpreting the experimentally measured data and produce the conclusions

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	-	1	-	2	2	2
CO2	3	3	3	3	2	-	-	1	-	1	-	2	1	2
CO3	3	3	2	2	1	-	-	1	-	1	-	2	1	2
CO4	3	2	1	2	2	-	-	-	-	1	-	2	2	2
CO5	3	3	2	2	1	-	-	-	-	1	-	2	2	2

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U23PEEC14	MICROWAVE ENGINEERUNG	L	T	P	C
Prerequisites:	**Transmission Lines and RF Systems**	2	0	2	3

COURSE OBJECTIVES:

- To understand the importance of various microwave components in several communication applications.
- To study the performance of microwave components using certain performance estimation parameters.
- To understand the fundamental concepts about microwave semiconductor devices.

UNIT I **HIGH FREQUENCY NETWORK CHARACTERIZATION** **6**

Scattering Parameters: Definition, Chain Scattering Matrix, Conversion of S-parameters, Generalized S-parameters and Practical Measurements; S parameter representation of N port networks, properties – S Matrix of a Directional Coupler – waveguide tees and rat race coupler – Qualitative discussion on: Waveguide Corners – Bends – Twists – Matched loads and movable shorts.

UNIT II **MICROWAVE SIGNAL GENERATOR** **6**

Two cavity Klystron amplifier – Transit time effect – Velocity modulation – current modulation-bunching – Reflex Klystron – Slow – Wave structures - Helix Travelling - Wave Tubes – Convection Current – Axial Electric Field – Wave Modes – Bandwidth, Power and Gain Considerations – cross field device, Magnetron – power and frequency considerations.

UNIT III **HIGH FREQUENCY SEMICONDUCTOR DEVICES** **6**

Gunn-Effect – Gunn Diode- Differential Negative Resistance- Modes of Operation-Amplification Microwave Generation Read Diode – Physical Description – Avalanche Multiplication IMPATT Diodes – TRAPATT Diode – BARITT Diode – Principles of Operation – Physical Structures; RF Bipolar Junction Transistor.

UNIT IV **MICROWAVE MEASUREMENTS** **6**

Slotted line VSWR measurement – impedance measurement – insertion loss and attenuation measurements – measurement of scattering parameters – Return loss measurement using directional coupler – Introduction to vector network analyzer and its uses – return loss and insertion loss Measurement of return loss and Insertion loss using Spectrum analyzer.

UNIT V **PLANAR TRANSMISSION LINES** **6**

Introduction – Microstrip Lines- Derivation of Characteristic Impedance of Microstrip Lines using QuasiStatic analysis – Losses in Microstrip Lines – Quality Factor Q of Microstrip Lines – Parallel Strip Lines-Characteristic Impedance-Attenuation losses – Coplanar Strip Lines- Shielded Strip Line-Problems

30 PERIODS

PRACTICAL EXERCISES:

1 Gunn diode and reflex klystron characteristics.

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2 Frequency and wavelength determination in a rectangular wave guide working in TE10 mode.
3 Radiation Characteristics of Horn Antenna.
4 Circulator and Isolator characteristic
5 Design of Microstrip circular patch antenna.

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Samuel Liao, "Microwave Devices and Circuits", 3rd Edition, Prentice Hall India, 2000.
2 David M Pozar, "Microwave Engineering", 4th Edition, Wiley & Sons, 2011.

REFERENCES:

1 Reinhold Ludwig, Gene Bogdanow, "RF Circuit Design Theory and Applications", Pearson Education, 2011.
2 Annapurna Das and Sisir K Das, "Microwave Engineering", 4th Edition, Tata McGraw Hill, 2020.
3 R E Collin, "Foundations for Microwave Engineering", 2nd Edition, Wiley & Sons, 2007.

ONLINE RESOURCES:

1 https://empossible.net/academics/emp4301_5302/
2 https://archive.nptel.ac.in/courses/108/101/108101112/
3 https://www.coursera.org/learn/microwave-antenna

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the working and performance of RF and its network characterization of waveguide.
CO2 Analyze the working and performance of Microwave signal generators.
CO3 Analyze the working of high frequency semiconductor devices.
CO4 Analyze the measurement techniques using microwave test bench, Vector Network Analyzer and Spectrum Analyze
CO5 Analyze the performance of planar transmission lines.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	-	1	2	2	2	-	1	2	1
CO2	3	3	2	2	1	-	1	2	2	2	-	1	2	1
CO3	3	3	2	2	1	-	1	2	2	2	-	1	2	1
CO4	3	3	2	2	1	-	1	2	2	2	-	1	2	1
CO5	3	3	2	2	1	-	1	2	2	2	-	1	2	1

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U23PEEC15	MICS AND RF SYSTEM DESIGN	L	T	P	C
Prerequisites:	**Transmission Lines and RF Systems**	2	0	2	3

COURSE OBJECTIVES:

- To study the characteristics of Active components and applications.
- To design the RF filter and analyze the circuits operated at millimeter wavelength.
- To design the antenna and analyze its performance using measurement techniques.

UNIT I **ACTIVE RF COMPONENTS AND APPLICATIONS** **6**

RF diodes, BJT, RF FET'S, High electron mobility transistors, matching and biasing networks-impedance matching using discrete components, microstrip line matching networks, amplifier classes of operation and biasing networks.

UNIT II **RF FILTER DESIGN** **6**

Overview, Basic resonator and filter configuration, special filter realizations, smith chart based filter design, coupled filter.

UNIT III **INTRODUCTION TO MICROWAVE INTEGRATED CIRCUITS** **6**

Overview of ABCD and S parameters - Overview of Planar transmission lines (Strip line, Microstrip line, Slot line, CPW, Fin line)-Design Parameters for Strip Line And Microstrip line-Active Device Technologies- Design Approaches Multichip Module Technology- Substrates

UNIT IV **NON RECIPROCAL COMPONENTS FOR MICs** **6**

Microstrip on Ferrimagnetic substrates, Microstrip circulators. Isolators and phase shifters, Design of microstrip circuits – high power and low power circuits.

UNIT V **INTEGRATED ANTENNA DESIGN AND MEASUREMENTS** **6**

Integrated Antenna Design- Photonic Band Gap Antennas - Micro Machined Antenna – Micro Electro Mechanical System Antennas - Test Fixture Measurements - Probe Station Measurements Thermal and Cryogenic Measurements- Experimental Field Probing Techniques.

30 PERIODS

PRACTICAL EXERCISES:

1. Design a low pass and high pass filter at RF using any software tool.
2. Design a band pass and band stop filter at RF using any software tool.
3. Measurement of S parameters for Inductor and Capacitor any software tool.
4. Measurement of S parameters for impedance matching circuits and filters any software tool.
5. Design a microstrip circuit.

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30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Reinhold Ludwig, Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education, 1st Edition, 2001.
2 Bharathi Bhat, Shiban K. Koul, "Stripline-like Transmission Lines for Microwave Integrated Circuits", New Age International Pvt. Ltd Publishers, 2007.

REFERENCES:

1 Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education, 2nd Edition, 2002.
2 Ulrich L. Rohde and David P. NewKirk, "RF / Microwave Circuit Design", John Wiley & Sons, 2000.
3 David Pozar, "Microwave Engineering", Addison Wesley, 4th Edition, 2011.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/117102012
2 https://archive.nptel.ac.in/courses/117/102/117102012/
3 https://www.classcentral.com/course/youtube-electronics-rf-integrated-circuits-47580

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply knowledge of S parameter theory to any RF active component design circuit for obtaining performance measure.
CO2 Analyze microwave circuits for filters design.
CO3 Evaluate the performance of any practical Microwave integrated circuits
CO4 Evaluate communication circuits and subsystems with practical design parameters for nonreciprocal components in MICs.
CO5 Design microwave integrated antenna design circuit for the required Performance using professional software tools.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	1	-	-	-	-	-	-	-	1	2
CO3	3	3	2	3	1	-	-	1	-	-	-	-	2	2
CO4	3	3	2	3	1	-	-	1	-	-	-	-	2	2
CO5	3	3	3	3	1	-	-	1	-	-	-	-	1	1

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U23PEEC16 **EMI /EMC PRE COMPLIANCE TESTING** **L T P C**

Prerequisites: Electromagnetic Field and Waves **2 0 2 3**

COURSE OBJECTIVES:

- To understand the basic concepts of Electromagnetic Interference.
- To explain the EMI coupling and control principles.
- To understand receivers and analyser functionalities and design issues in EMI/EMC

UNIT I **NATURE AND ORIGINS OF ELECTROMAGNETIC COMPATIBILITY** **6**

Introduction-Visualizing the EMI problem-Source of EMI, EMI coupling to victim equipment, Intersystem and Intrasystem EMI, EMC standards and specifications.

UNIT II **TYPES of EMI COUPLING** **6**

Conducted, radiated and transient coupling; Common ground impedance coupling; Common mode and ground loop coupling; Differential mode coupling, Near field cable to cable coupling; Field to cable coupling, Power mains and Power supply coupling; Transient EMI

UNIT III **MEASUREMENT DEVICES FOR EMI** **6**

Introduction – Measurement by direct connection, Inductively coupled devices, EMC antennas – Basic antenna parameters, Antennas for radiated emission testing, Wideband antennas – Magnetic field antennas, Type of antennas used in susceptibility testing.

UNIT IV **RECEIVERS, ANALYSERS AND MEASUREMENT EQUIPMENT** **6**

EMI receiver, Spectrum Analyzers, RF power meter Frequency meters. Standards requiring immunity tests, Automatic EMC tests, Electromagnetic transient testing, Transient types, Continuous and transient signal, ESD-electrostatic discharge.

UNIT V **PRE-COMPLIANCE TESTING TO AVOID EMC PROBLEMS** **6**

Need for Pre-Compliance Testing; Intersystem and Intrasystem EMC - Developing an approach to EMC design - Process flow chart, - EMC strategy – Self certification; Solutions to avoid EMC: ESD, Shielding, EMI Filters; Grounding; Bonding, Isolation transformer, Transient suppressors; EMI Suppression Cables.

30 PERIODS

PRACTICAL EXERCISES:

1. Basic spectrum measurement and power measurement with markers
2. Perform environment scan and detect various signals available
3. DPX, Spectrogram and transient capture with mask test and act on violation
4. EMI spurious detection and measurement against EMI limit lines

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5. Use of LISN and measurement concept of Conducted emission

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 David Morgan , "A Handbook for EMC Testing and Measurement", IET Electrical Measurement, 2012
2 Tim Williams, "EMC for Product Designers", 5th Edition, Elsevier, 2017.

REFERENCES:

1 V P Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, 1996
2 Paul, C R, "Introduction to Electromagnetic Compatibility", 2nd Edition, Wiley 2010.
3 David K Cheng, "Field and Wave Electromagnetics", 2nd Edition, Pearson Education, 2009

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/108/106/108106138/
2 https://onlinecourses.nptel.ac.in/noc24_ee67/preview
3 https://nptel.ac.in/courses/108106138

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the various types and mechanisms of Electromagnetic Interference.

CO2 Design a suitable EMI mitigation technique.

CO3 Evaluate EMI coupling & control principles.

CO4 Explain the importance receivers & analyser functionalities.

CO5 Analyze the design issues in EMI/EMC.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	-	-	1	-	-	-	-	1	1
CO2	3	3	3	3	1	-	-	1	-	-	-	-	2	1
CO3	3	3	2	3	1	-	-	1	-	-	-	-	1	1
CO4	2	2	1	1	1	-	-	1	-	-	-	-	1	1
CO5	3	3	2	2	1	-	-	1	-	-	-	-	2	2

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U23PEEC17	RFID SYSTEM DESIGN AND TESTING	L	T	P	C
Prerequisites:	**Transmission Lines and RF Systems**	2	0	2	3

COURSE OBJECTIVES:

- To understand fundamentals of near field and far field RFID communications.
- To describe the operating principles of RFID tag and reader.
- To introduce the security aspects and system architecture of RFID systems.

UNIT I **INTRODUCTION** **6**

RFID Principles: Near-field based RFID – Properties of Magnetic field – Far-field based RFID – Properties of Backscatter RF Systems – Modulation techniques – Frequency based property comparison of RFID Systems

UNIT II **RFID STANDARDS AND PROTOCOLS** **6**

RFID Industry standards: EPC global – ISO15693 Vicinity cards and RFID – ISO14443 Proximity cards and RFID – The NFC forum – Reading collocated RFID tags: Query Tree protocol – Query Slot protocol

UNIT III **OPERATING PRINCIPLES** **6**

RFID Tag components: RFID tag types – the 1-Bit Transponder and Chipless Tags – RFID readers and middleware component – Communication fundamentals: Coupling, Data encoding, multi-path effect – Tag, Reader and sensor communication.

UNIT IV **DATA INTEGRITY AND SECURITY** **6**

The checksum procedure – Multiaccess procedures – Attacks on RFID Systems – Protection by Cryptographic measures

UNIT V **RFID ENABLED SENSORS AND APPLICATIONS** **6**

RFID enabled Sensors: Antenna design challenges – IC design – Integration of sensors and RFID – Power consumption and Link budget. Applications: Contactless smart cards – Access control – Electronic passport – Industrial Automation – Medical applications – Challenges and opportunities.

30 PERIODS

PRACTICAL EXERCISES:

1. Design of a passive RFID Tag Antenna.
2. Design of an Active RFID Tag Antenna.
3. Design of an RFID reader antenna.
4. Determination of read range of the RFID tag at UHF and Microwave frequencies.
5. Determination of RFID tag performance for different standards.

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30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Roy Want, "RFID Explained: A Primer on Radio Frequency Identification Technologies", Morgan & Claypool Publishers, 2022.

2 Amin Rida, Li Yang, Manos M. Tentzeris, "RFID Enabled Sensor Design and Applications", Artech House, 2010

REFERENCES:

1 Klaus Finkenzeller, "RFID Handbook", 3rd Edition, Wiley, 2010

2 Syed Ahson, Mohammad Ilyas, "RFID Handbook", CRC Press, 2008

3 Paris Kitsos, "Security in RFID and Sensor Networks", CRC Press, 2016.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/102/117102012/

2 https://nptel.ac.in/courses/117102012

3 https://onlinecourses.nptel.ac.in/noc24_ee75/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the RFID systems based on frequency, architecture and performance

CO2 Explain the standards for RFID technology

CO3 Evaluate the operation of various components of RFID systems

CO4 Describe the privacy and security issues in RFID Systems

CO5 Analyze the construction and applications of RFID enabled sensor

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	-	1	2	2	2	-	-	3	1
CO2	2	2	1	1	1	-	1	2	2	2	-	-	3	1
CO3	3	3	2	3	2	-	1	2	2	2	-	-	3	1
CO4	2	2	1	1	1	-	1	2	2	2	-	-	3	1
CO5	3	3	2	2	2	-	1	2	2	2	-	-	3	1

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U23PEEC18	SIGNAL INTEGRITY	L	T	P	C
Prerequisites:	**Signals and Systems**	2	0	2	3

COURSE OBJECTIVES:

- To understand characteristic impedance of transmission line and impedance matching techniques.
- To understand plain signal reflection and cross talk noise in the transmission line, and also explain the mathematical analysis method.
- Understand Eye diagram and related measurement to test quality of Signal and Jitter analysis and jitter decomposition.

UNIT I SIGNAL REFLECTION AND IMPEDANCE MATCHING TECHNIQUE **6**

Phenomenon of signal reflection. Signal reflection at transmitting end. Signal reflection at branch point. Multiple reflection in transmission line. Prevention of signal reflection by using impedance matching technique.

UNIT II CROSSTALK NOISE **6**

Crosstalk definition and classification. Crosstalk mechanism. Analysis of crosstalk noise in transmission line. Main factor of causing crosstalk noise.

UNIT III DIFFERENTIAL SIGNAL TRANSMISSION CIRCUIT **6**

Pros and cons of using differential signaling compared with that of single-ended signaling. High-speed differential interfaces. Theory of differential signaling. Differential signal termination techniques.

UNIT IV FREQUENCY RESPONSE OF A CIRCUIT **6**

Frequency response of transmission line and circuit. Inter-symbol interference (ISI) and eye-pattern. Deterioration of a signal waveform due to ISI. Circuit techniques to prevent the deterioration. Linear time-invariant systems. Frequency response of pulse.

UNIT V EYE DIAGRAM AND JITTER **6**

Jitter Definition and Types of Jitter; Jitter decomposition; Eye diagram analysis and related measurement

30 PERIODS

PRACTICAL EXERCISES:

2Ch 1 GHz Arbitrary waveform generator , 2GHz 4 flex channel scope with automated jitter and eye diagram measurement , LVDS measurement suite

1. Generating 1GHz Differential signal from AWG.
2. Accurate jitter analysis using the spectral and Q-scale methods for detailed decomposition of jitter components, including the extraction of industry standard dual-dirac model parameters
3. Generate LVDS signal and conduct signal integrity measurement
4. Fixed point implementation of IIR filter.

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5 Signal integrity measurement, by generating LVDS signal

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Eric Bogatin, "Signal and Power integrity Simplified", Pearson, 3rd Edition, 2018.
2 Howard Johnson, Martin Graham, "High Speed Digital Design", Prentice Hall, 1st Edition, 2017.

REFERENCES:

1 Howard Johnson, "High Speed Signal Propagation", Prentice Hall, 1st Edition, 2015.
2 Stephan C Thierauf "Understanding Signal Integrity", Artech House, 2011.
3 Peter J Pupalaikis, "S-parameters for signal integrity", Cambridge University Press, 2020

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc24_ee67/preview
2 https://nptel.ac.in/courses/108105187
3 https://www.udemy.com/course/vlsi-academy-crosstalk/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze familiarity with High speed design and related issues
CO2 Understand the critical design aspect
CO3 Understand the Jitter and related measurements which is critical for design
CO4 Design the Practical application of high speed differential signals
CO5 Apply Measurement expertise up to industry expectations

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	2	-	-	-	1	-	2	2	2
CO2	3	3	3	3	2	2	-	-	-	1	-	2	1	2
CO3	3	3	2	3	2	2	-	-	-	1	-	2	1	2
CO4	3	3	3	3	2	2	-	-	-	1	-	2	2	2
CO5	3	2	3	3	2	2	-	-	-	1	-	2	2	2

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U23PEEC19	WEARABLE DEVICES	L	T	P	C
Prerequisites:	**Principles of Discrete Time Signal Processing**	3	0	0	3

COURSE OBJECTIVES:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9

Wearable Systems – Introduction, Need for Wearable Systems, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems – Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor.

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9

Wearability issues – physical shape and placement of sensor, Technical challenges – sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements – Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges – System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

UNIT IV SMART TEXTILE 9

Introduction to smart textile – Passive smart textile, active smart textile. Fabrication Techniques Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study smart fabric for monitoring biological parameters – ECG, respiration.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Edward Sazonov, Micheal R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Elsevier, 2014.

2 Annalisa Bonfiglo, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

REFERENCES:

1 Sandeep K S, Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability", Cambridge University Press, 2013.

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2 Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013.

3 Mehmet R Yuce, Jamil Y Khan, "Wireless Body Area Networks Technology, Implementation applications", Pan Stanford Publishing Pvt., Ltd, Singapore, 2012.

4 Guang-Zhong Yang, "Body Sensor Networks", Springer, 2006.

ONLINE RESOURCES:

1 https://www.coursera.org/learn/wearable-technologies

2 https://www.engineeringonline.ncsu.edu/course/ece-518-wearable-biosensors-and-microsystems/

3 https://www.tonex.com/training-courses/wireless-body-area-network-training-wban/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the concepts of wearable system.

CO2 Explain the signal processing and energy harvestings in wearable device.

CO3 Understand the concept of Body area network in health care.

CO4 Describe the concept of smart textile.

CO5 Explain the application of wearable system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO2	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO3	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO4	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	2	3	1

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U23PEEC20	BIO MEDICAL SIGNAL PROCESSING	L	T	P	C
Prerequisites:	**Principles of Discrete Time Signal Processing**	3	0	0	3

COURSE OBJECTIVES:

- To study the characteristics of different biosignals
- To learn linear and non-linear filtering techniques to extract desired information
- To understand various techniques for automated classification and decision making to aid diagnosis

UNIT I **BIOSIGNAL AND SPECTRAL CHARACTERISTICS** **9**

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II **TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION** **9**

Time series analysis – linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation –Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

UNIT III **ADAPTIVE FILTERING AND WAVELET DETECTION** **9**

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV **BIOSIGNAL CLASSIFICATION AND RECOGNITION** **9**

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

UNIT V **TIME FREQUENCY AND MULTIVARIATE ANALYSIS** **9**

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis- PCA,ICA.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.

2 Annalisa Bonfiglo and Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

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REFERENCES:

1 Kayvan Najarian, Robert Splerstor, "Biomedical signals and Image processing", CRC Press, 2nd Edition, 2012.

2 K P Soman, K Ramachandran, "Insight into wavelet from theory to practice", PHI, 3rd Edition, 2010.

3 D C Reddy, "Biomedical Signal Processing – Principles and Techniques", Tata McGraw Hill Publishing Co. Ltd., 2005.

4 John L Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications", Taylor& Francis Inc., 2004.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc20_ee41/preview

2 https://www.coursera.org/courses?query=signal%20processing

3 https://www.classcentral.com/course/swayam-biomedical-signal-processing-10069

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the characteristics of different biosignals.

CO2 Analyze biosignals in time domain & to estimate the spectrum.

CO3 Apply wavelet detection techniques for biosignal processing.

CO4 Describe Biosignals using neural networks and statistical classifiers.

CO5 Analyze the features using multivariate component analysis.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO2	3	3	2	2	-	-	-	1	-	-	-	2	3	1
CO3	3	2	1	2	-	-	-	1	-	-	-	2	3	1
CO4	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO5	3	3	2	2	-	-	-	1	-	-	-	2	3	1

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U23PEEEC21	THERAPEUTIC EQUIPMENT	L	T	P	C
Prerequisites:	**Electronic Circuits**	3	0	0	3

COURSE OBJECTIVES

- To learn the principles of cardiac assist devices
- To understand the need and use of extracorporeal devices, and the use of lasers in medicine
- To enable the students to gain knowledge on the working of therapeutic clinical equipment.

UNIT I CARDIAC AND RESPIRATORY THERAPY EQUIPMENT 9

Cardiac Pacemaker: Internal and External Pacemaker– Programmable pacemakers, Cardiac Defibrillators: AC and DC Defibrillator – Internal and External Defibrillators - Protection Circuit, Defibrillator analyzers. Cardiac ablation catheter. Types of Ventilators –Basic principles of electromechanical, pneumatic and electronic ventilators, Patient Cycle Ventilators, Ventilator testing. Humidifiers, Nebulizers, Inhalators.

UNIT II BIOMECHANICAL THERAPEUTIC EQUIPMENT 9

Electro diagnosis, Therapeutic radiation, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Functional Electrical Stimulation. Peripheral nerve stimulator, ultrasonic stimulators, Stimulators for pain and relief - Inferential Therapy Unit, TENS. GAIT Assessment and Therapy. Continuous Passive Motion unit, Cervical / Lumber Traction Machine -Traction Table.

UNIT III BODY CARE EQUIPMENT 9

Skin Treatment: Ultrasonic spot remover, vacuum therapy unit, Skin tightening, Wrinkle Reduction, Facial and Rejuvenation. Laser hair therapy machine. Body Slimmer/Shaper – Deep Heat Therapy, Massager, Fitness – Treadmill, Bike.

UNIT IV DENTAL CARE EQUIPMENT 9

Dental Chair - Dental Hand pieces and Accessories: Evolution of rotary equipment, Low-speed handpiece, High-speed handpiece, Hand piece maintenance. Vacuum and Pneumatic techniques: Vacuum techniques, Oral evacuation systems, Vacuum pump, Pneumatic techniques, Dental Radiography: Dental X-ray Machine.

UNIT V HEAT & PHOTON THERAPY EQUIPMENT 9

High frequency heat therapy, Principle, Short wave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy. Therapeutic UV and IR Lamps. Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO2 laser, He-Ne laser, Nd-YAG and Ruby laser.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 John G Webster, "Medical Instrumentation, Application and Design", 4th Edition, Wiley & Sons, 2009

2 Khandpur R S, "Handbook of Biomedical Instrumentation". 2nd Edition, Tata McGraw Hill, 2003

REFERENCES:

1 Joseph J Carr, John Michael Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall and Technology, 2008.

2 Leslie Cromwell, Fred. J. Weibell & Erich. A.Pfeiffer. "Biomedical Instrumentation and

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Measurements", 2nd Edition, Prentice Hall Inc., 2000.
3 John Low & Ann Reed. "Electrotherapy Explained Principles and Practice", 2nd Edition, Butterworth Heinemann Ltd., 2000.
4 Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc., 2004.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=medical%20device

2 https://www.edx.org/certificates/professional-certificate/delftx-biomedical-equipment-repair-maintenance-and-healthcare-technology-management

3 https://asapkerala.gov.in/course/3d-character-animation/certificate-programme-in-advanced-biomedical-equipment/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Evaluate suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc.

CO2 Explain the principles of body care equipment.

CO3 Explain the operation of dental care equipment.

CO4 Analyze the different types of therapies for suitable applications.

CO5 Explain the application of lasers in biomedical applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	1	-	-	-	2	3	1
CO2	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO3	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO4	3	3	2	2	-	-	-	1	-	-	-	2	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	2	3	1

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U23PEEC22	MEDICAL IMAGING SYSTEMS	L	T	P	C
Prerequisites: Physics for Electrical and Electronics Engineers		3	0	0	3

COURSE OBJECTIVES:

- To understand the generation of X-ray and its uses in Medical imaging.
- To describe the principle of Computed Tomography and different radio diagnostic equipment in Imaging.
- To discuss the radiation therapy techniques and radiation safety.

UNIT I **X RAYS** 9

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. Cine Angiography. Digital subtraction Angiography, Mammography.

UNIT II **COMPUTED TOMOGRAPHY** 9

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 III **MAGNETIC RESONANCE IMAGING** 9

Fundamentals of magnetic resonance- properties of electromagnetic waves, 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 IV **NUCLEAR IMAGING** 9

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 analyzer. Principles of SPECT and PET

UNIT V **RADIATION THERAPY AND RADIATION SAFETY** 9

Radiation therapy – linear accelerator, Telegamma Machine, 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:

1 Isaac Bankman, I N Bankman, "Handbook of Medical Imaging: Processing and Analysis(Biomedical Engineering)", Academic Press, 2000

2 Jacob Beutel, M Sonka, "Handbook of Medical Imaging", Volume 2, Medical Image Processing and Analysis, SPIE Press, 2000

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REFERENCES:

1 Khandpur R S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

2 Khin Wee Lai, Dyah Ekashanti Octorina Dewi "Medical Imaging Technology", Springer, 2015.

3 John Low, Ann Reed. "Electrotherapy Explained Principles and Practice". 2nd Edition, Butterworth Heinemann Ltd., 2000.

4 Geoff Dougherty, "Medical Image Processing - Techniques and Applications", Springer, 2011.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=medical%20device

2 https://www.edx.org/certificates/professional-certificate/delftx-biomedical-equipment-repair-maintenance-and-healthcare-technology-management

3 https://asapkerala.gov.in/course/3d-character-animation/certificate-programme-in-advanced-biomedical-equipment/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Evaluate suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc.

CO2 Explain the principles of body care equipment.

CO3 Explain the operation of dental care equipment.

CO4 Analyze the different types of therapies for suitable applications.

CO5 Explain the application of lasers in biomedical applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	1	-	-	-	2	3	1
CO2	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO3	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO4	3	3	2	2	-	-	-	1	-	-	-	2	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	2	3	1

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U23PEEC23	BRAIN COMPUTER INTERFACE AND APPLICATIONS	L	T	P	C
Prerequisites:	**Machine Learning and Artificial Neural Networks**	3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of brain computer interface.
- To Understand the various machine learning methods of BCI
- To discuss the various applications of BCI

UNIT I **INTRODUCTION TO BCI** **9**

Introduction - Brain structure and function, Brain Computer Interface Types – Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI

UNIT II **BRAIN ACTIVATION** **9**

Brain activation patterns - Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials -Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT III **FEATURE EXTRACTION METHODS** **9**

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artifacts reduction, Feature Extraction - Phase synchronization and coherence.

UNIT IV **MACHINE LEARNING METHODS FOR BCI** **9**

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis .

UNIT V **APPLICATIONS OF BCI** **9**

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection, Ethics of Brain Computer Interfacing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Rajesh P N Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, 1st Edition, 2013.

2 Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, 1st Edition 2012.

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REFERENCES:

1 Ella Hassianien, A, Azar A T, "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.

2 Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

3 Andrew Webb, "Statistical Pattern Recognition", Wiley International, 2nd Edition, 2002.

ONLINE RESOURCES:

1 https://www.udemy.com/course/brain-computer-interface/

2 https://nptel.ac.in/courses/108108167

3 https://ep.jhu.edu/courses/585783-introduction-to-brain-computer-interfaces/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the significance and role of this course in the present contemporary world.

CO2 Analyze various concept of BCI.

CO3 Explain about signal processing methods used in BCI

CO4 Explain the various machine learning methods of BCI

CO5 Design a system using machine learning algorithms for translation

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO2	3	3	2	2	-	-	-	1	-	-	-	2	3	1
CO3	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO4	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO5	3	3	2	3	-	-	-	1	-	-	-	2	3	1

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U23PEEC24	ROBOTICS IN MEDICINE	L	T	P	C
		3	0	0	3

Prerequisites: Electronic Circuits

COURSE OBJECTIVES:

- To learn about the fundamental of robotics and position analysis.
- To Study about the basics of trajectory planning, Motion control systems and actuators.
- To know the Fuzzy control and Applications of Robotics in Medicine.

UNIT I FUNDAMENTALS AND POSITION ANALYSIS 9

Fundamentals – Classification, Advantages and disadvantages, Components, Degrees of freedom, Joints, Coordinates, Reference frames, Programming modes, Characteristics, Workspace, Languages, Collaborative robots, Position analysis – Robots as mechanisms, Conventions, Transformations, Forward and inverse kinematics, Denavit Hartenberg Representation, Degeneracy and Dextrerity, Screw based robots, Position analysis of Articulated robot, Case studies

UNIT II PARALLEL ROBOTS, DIFFERENTIAL MOTIONS AND FORCE ANALYSIS 9

Parallel robots – Physical characteristics, Forward and Inverse Kinematic approaches, Planar and Spatial parallel robots, Differential relationships, The Jacobian, Large scale motions, Frame vs Robot, Differential motions and change, Hand frame, Operator, Jacobian and Inverse for Screw based and Parallel Robots, Differential operator, Lagarangian mechanics, Moments of Inertia, Dynamic Equations of Multiple DOF Robots, Static force analysis, Transformation of forces and moments between coordinate frames, Case studies

UNIT III TRAJECTORY PLANNING, MOTION CONTROL SYSTEMS AND ACTUATORS 9

Path and Trajectory, Joint Space and Cartesian Space Descriptions and Trajectory Planning, Cartesian, Trajectory Recording, Basics, Block diagrams, Laplace Transform, Block diagram Algebra, Transfer Functions, Characteristic equation, Steady state error, Root locus, Proportional, Integral and Derivative controllers, Compensators, Bode, Loops, Multiple IO systems, Control – State space and Digital, Nonlinear systems, Characteristics of Hydraulic, Pneumatic, Electric motors, Other actuators, Speed reduction, Case studies

UNIT IV SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS 9

Sensor Characteristics, Position, Velocity, Acceleration, Force, Pressure and Torque, Microswitches, Visible and IR, Touch, Proximity, Range finders, Sniff, Vision, Transforms – Fourier, Hough, Resolution, Quantization, Sampling, Image processing, Segmentation, Region growing and splitting, Operations, Object recognition, Depth, Specialized lighting, Compression, Colour images, Heuristics, Case studies

UNIT V FUZZY CONTROL AND APPLICATIONS IN MEDICINE 9

Fuzzy control - Crisp vs Fuzzy, Sets, Inference rules, Defuzzification, Simulation, Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery – Cardiac and abdominal procedures with tele operated robots, Orthopedic surgery with cooperative robots, Case studies

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TOTAL: 45 PERIODS

TEXT BOOKS:

1 S B Niku, "Introduction to Robotics, Analysis, Control, Applications", Pearson Education, 2020.

2 Robert Schilling, "Fundamentals of Robotics-Analysis and control", Prentice Hall of India, 2003.

REFERENCES:

1 Mittal, Nagrath, "Robotics and Control", Tata McGraw Hill, 2003.

2 Grover, Wiess, Nagel, Oderey, "Industrial Robotics", Tata McGraw Hill, 2012.

3 Bijay K Ghosh, Ning Xi T J Tarn, "Control in Robotics and Automation Sensor – Based Integration", Academic Press, 1999.

ONLINE RESOURCES:

1 https://www.coursera.org/learn/wearable-technologies

2 https://www.engineeringonline.ncsu.edu/course/ece-518-wearable-biosensors-and-microsystems/

3 https://www.tonex.com/training-courses/wireless-body-area-network-training-wban/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the fundamental of robotics and position analysis.

CO2 Explain the functioning of parallel robots, different types of motions and force analysis.

CO3 Explain the basics of trajectory planning, Motion control systems and actuators.

CO4 Explain the use of various sensors and vision systems in robotics.

CO5 Explain the fuzzy control in robotics and application in robotics in medicine

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO2	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO3	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO4	2	2	1	1	-	-	-	1	-	-	-	2	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	2	3	1

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U23PEEC25	CLOUD INFRASTRUCTURE AND SERVICES	L	T	P	C
Prerequisites:	**Computer Communication Networks**	2	0	2	3

COURSE OBJECTIVES:

- To articulate the main concepts, key technologies, strengths, and limitations of cloud computing.
- To understand the basic concepts of cloud computing and cloud enables.
- To manage the cloud computing infrastructure with security.

UNIT I **INTRODUCTION** 6

The vision of cloud computing – The cloud computing reference model – Characteristics and benefits – Challenges ahead – Historical developments - Distributed systems – Virtualization – Building cloud computing environments – Application development - Infrastructure and system development – Computing platforms and technologies. Parallel vs. distributed computing – Elements of parallel computing – Hardware architectures for parallel processing Approaches to parallel programming – Laws of caution.

UNIT II **CLOUD ENABLING TECHNOLOGIES** 6

Introduction – The cloud reference model – Types of clouds – Economics of the cloud Virtualization: Introduction – Characteristics of virtualized environments – Taxonomy of virtualization techniques – Virtualization and cloud computing – Pros and cons of virtualization – Technology example: VMware: full virtualization.

UNIT III **CLOUD ARCHITECTURE AND STORAGE** 6

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Multi-entity support – Multi-schema approach - Multi-tenancy using cloud data stores – Data access control for enterprise applications. Data in the cloud: Relational databases - Cloud file systems: GFS and HDFS – Big Table, HBase - Cloud data stores: Datastore and Simple DB.

UNIT IV **RESOURCE MANAGEMENT AND SECURITY IN CLOUD** 6

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Virtual Machine Security – IAM –Security Standards.

UNIT V **CLOUD TECHNOLOGIES AND ADVANCEMENTS** 6

Amazon web services: Compute services – Storage services – Communication services – Additional services, Google App Engine: Architecture and core concepts – Application life cycle – Cost model – Observations.

30 PERIODS

PRACTICAL EXERCISES:

1. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
2. Install Google App Engine. Create hello world app and other simple web applications using python/java and ue GAE launcher to launch the web applications.
3. Simulate a cloud scenario using Cloud Sim and run a scheduling algorithm that is not present in Cloud Sim and find a procedure to transfer the files from one virtual machine to another virtual machine
4. Install Hadoop single node cluster and run simple applications like word count.
5. Create and execute your first container using Docker and run it from Docker hub.

30 PERIODS

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TOTAL: 60 PERIODS

TEXT BOOKS:

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 Rittinghouse, John W., James F Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press, 2017.

REFERENCES:

1 Rajkumar Buyya, Christian Vecchiola, S ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013.

2 Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", Tata McGraw Hill, 2009.

3 George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", O'Reilly, 2009.

ONLINE RESOURCES

1 https://onlinecourses.nptel.ac.in/noc21_cs14/preview

2 https://onlinecourses.nptel.ac.in/noc20_cs20/preview

3 https://archive.nptel.ac.in/courses/106/105/106105167/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the principles of Parallel and Distributed Computing and evolution of cloud computing from existing technologies.

CO2 Analyze different types of Virtualization technologies and Service Oriented Architecture systems.

CO3 Explain the concepts of NIST Cloud Computing architecture and its design challenges.

CO4 Analyse the issues in Resource provisioning and the cloud computing infrastructure with security.

CO5 Apply various service delivery models of a cloud computing architecture.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO2	3	3	2	2	-	-	-	2	2	2	-	1	2	2
CO3	2	2	1	1	-	-	-	2	2	2	-	-	2	2
CO4	3	3	2	2	-	-	-	2	2	2	-	1	2	2
CO5	3	2	1	2	-	-	-	2	2	2	-	1	2	2

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U23PEEC26	CRYPTOGRAPHY AND CYBER SECURITY	L	T	P	C
Prerequisites:	**Vector Calculus & Complex Functions**	2	0	2	3

COURSE OBJECTIVES:

- Learn to analyze the security of in-built cryptosystems.
- Develop cryptographic algorithms for information security.
- Understand cybercrimes and cyber security

UNIT I **MATRICES** **6**

Symmetric and orthogonal matrices – Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton theorem (Without proof) Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II **SYMMETRIC CRYPTOGRAPHY** **6**

MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures - Modular arithmetic Euclid's algorithm- Congruence and matrices - Groups, Rings, Fields- Finite fields- SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis - Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard - RC4 – Key distribution.

UNIT III **PUBLIC KEY CRYPTOGRAPHY** **6**

MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing – Factorization – 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 - ElGamal cryptosystem – Elliptic curve arithmetic- Elliptic curve cryptography.

UNIT IV **INTEGRITY AND AUTHENTICATION ALGORITHMS** **6**

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function: HMAC, CMAC – SHA – Digital signature and authentication protocols – DSS – Schnorr Digital Signature Scheme – ElGamal cryptosystem – Entity Authentication: Biometrics, Passwords, Challenge Response protocols – Authentication applications – Kerberos- MUTUAL TRUST: Key management and distribution – Symmetric key distribution using symmetric and asymmetric encryption – Distribution of public keys – X.509 Certificates.

UNIT V **CYBER CRIMES AND CYBER SECURITY** **6**

Cyber Crime and Information Security – classifications of Cyber Crimes – Tools and Methods – Password Cracking, Keyloggers, Spywares, SQL Injection – Network Access Control – Cloud Security – Web Security – Wireless Security.

PRACTICAL EXERCISES:

1. Write a C program that contains a string (char pointer) with a value\Hello World'. The programs should XOR each character in this string with 0 and should AND or and XOR each character in this string with 127 and display the result. Display the result.
2. Write a Java program to perform encryption and decryption using Ceaser Cipher, Substitution Cipher and Hill Cipher and write a Java program to implement RSA Algorithm.
3. Write the RC4 logic in Java using Java Cryptography, encrypt text "Hello world" using Blowfish. create your own key using Java key tool
4. Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript.
5. Calculate the message digest of a text using the SHA-1 and MD5 algorithm.

30 PERIODS
TOTAL: 60 PERIODS

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TEXT BOOKS:

1 William Stallings, "Cryptography and Network Security - Principles and Practice", Seventh Edition, Pearson Education, 2017

2 Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cybercrimes, Computer Forensics and Legal Perspectives", 1st Edition, Wiley India, 2011.

REFERENCES:

1 Behrouz A Ferouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3rd Edition, Tata Mc Graw Hill, 2015.
Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, "Security in Computing", 5th Edition, Prentice Hall, 2015.

3 C K Shyamala, N Harini, T R Padmanabhan, "Cryptography and Network Security", Wiley India Pvt. Ltd., 2013.

4 Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security Private Communication in a Public World", Prentice Hall, 2002.

ONLINE RESOURCES

1 https://onlinecourses.nptel.ac.in/noc22_cs03/preview

2 https://onlinecourses.nptel.ac.in/noc20_cs21/preview

3 https://onlinecourses.nptel.ac.in/noc23_cs127/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the fundamentals of networks security, security architecture, threats and vulnerabilities.

CO2 Apply the different cryptographic operations of symmetric cryptographic algorithms.

CO3 Apply the different cryptographic operations of public key cryptography.

CO4 Apply the various Authentication schemes to simulate different applications.

CO5 Explain various cybercrimes and cyber security.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	-	-	-	-	1	2	2
CO2	3	2	1	2	2	-	-	2	2	2	-	1	2	2
CO3	3	2	1	2	2	-	-	2	2	2	-	1	2	2
CO4	3	2	1	2	2	-	-	2	2	2	-	1	2	2
CO5	2	2	1	2	2	-	-	-	-	-	-	1	2	2

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U23PEEC27	DEEP LEARNING TECHNIQUES	L	T	P	C
Prerequisites:	**Machine Learning and Artificial Neural Networks**	2	0	2	3

COURSE OBJECTIVES:

- To learn various hacking techniques and attacks
- To understand about different modes of hacking tools and phases of penetration tests and Methodologies.
- To gain the knowledge of interpreting the results of a controlled attack.

UNIT I **MACHINE LEARNING BASICS** 6

Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient decent, Curse of Dimensionality.

UNIT II **INTRODUCTION OF DEEP NEURAL NETWORKS** 6

Multilayer perceptron – Gradient Descent (GD) – Backpropagation - Vanishing and Exploding GD problem – Optimization Methods: Stochastic GD: Momentum based GD & Nesterov Accelerated GD, AdaGrad, RMSProp, Adam – Bias Variance tradeoff – Regularization – Dropout.

UNIT III **CONVOLUTIONAL NEURAL NETWORKS** 6

Motivation – Architectural Overview – Pooling – Parameter sharing – Regularization – Popular CNN Architectures: ResNet, AlexNet, VGGNet – Transfer learning – Image classification using Transfer learning.

UNIT IV **RECURRENT NEURAL NETWORKS** 6

Sequence Modelling – Recurrent Neural Networks, Bidirectional RNNs – Encoder – decoder sequence to sequence architectures – Deep Recurrent Networks, Recursive Neural Networks – Long Short-Term Memory Networks – Other Gated RNNs

UNIT V **AUTOENCODERS AND GENERATIVE MODELS** 6

Autoencoders – Regularized Autoencoders – stochastic Encoders and Decoders – Contractive Encoders – Deep Belief networks – Boltzmann Machines – Deep Boltzmann Machine – Directed Generative Nets – Generative Adversarial Networks

TOTAL: 30 PERIODS

PRACTICAL EXCERCISES

1 Train a Deep learning model to classify a given image using pre trained model
2 Object detection using Convolution Neural Network
3 Recommendation system from sales data using Deep Learning
4 Perform Sentiment Analysis in network graph using RNN
5 Image generation using GAN

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TEXT BOOKS:

1 Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.

2 Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

REFERENCES:

1 Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.

2 Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 3rd Edition 2014.

3 Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.

ONLINE RESOURCES:

1 https://www.coursera.org/specializations/deep-learning

2 https://in.mathworks.com/solutions/deep-learning/tutorials-examples.html

3 https://onlinecourses.nptel.ac.in/noc20_cs62/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the fundamental machine learning concepts.

CO2 Explain the different optimizers in deep neural networks.

CO3 Design and implement deep learning architectures, such as CNNs, RNNs, autoencoders and Generative models

CO4 Apply deep learning models.

CO5 Apply deep learning techniques to real-world problems, with awareness of ethical considerations.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	-	-	2	2	2	-	2	2	1
CO2	2	2	1	1	2	-	-	2	2	2	-	2	2	1
CO3	3	3	3	3	2	-	-	2	2	2	-	2	2	1
CO4	3	2	1	2	2	-	-	2	2	2	-	2	2	1
CO5	3	2	1	2	2	-	-	2	2	2	-	2	2	1

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U23PEEC28	COMPUTER VISION	L	T	P	C
Prerequisites:	**Principles of Discrete Time Signal Processing**	2	0	2	3

COURSE OBJECTIVES:

- To understand the fundamental concepts related to Image formation and processing.
- To learn feature detection, matching and detection with feature based alignment and motion estimation.
- To develop skills on 3D reconstruction and image based rendering and recognition.

UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING 6

Computer Vision – Geometric primitives and transformations – Photometric image formation – The digital camera – Point operators – Linear filtering – More neighborhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization.

UNIT II FEATURE DETECTION, MATCHING AND SEGMENTATION 6

Points and patches – Edges – Lines - Segmentation – Active contours – Split and merge – Mean shift and mode finding – Normalized cuts – Graph cuts and energy-based methods.

UNIT III FEATURE-BASED ALIGNMENT & MOTION ESTIMATION 6

2D and 3D feature-based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation – Two frame structure from motion – Factorization – Bundle adjustment – Constrained structure and motion – Translational alignment – Parametric motion – Spline – based motion – Optical flow – Layered motion.

UNIT IV 3D RECONSTRUCTION 6

Shape from X – Active range finding - Surface representations – Point-based representations – Volumetric representations – Model-based reconstruction – Recovering texture maps and albedosos.

UNIT V IMAGE-BASED RENDERING AND RECOGNITION 6

View interpolation Layered depth images - Light fields and Lumigraphs – Environment mattes – Video-based rendering – Object detection – Face recognition – Instance recognition – Category recognition – Context and scene understanding – Recognition databases and test sets.

TOTAL: 30 PERIODS

PRACTICAL EXCERCISES

1 Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Bolb detection, Image Annotation – Drawing lines, text circle, rectangle, ellipse on images.

2 Image Enhancement - Understanding Color spaces, color space conversion, Histogram equialization, Convolution, Image smoothing, Gradients, Edge Detection.

3 Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Feature matching based image alignment.

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4 Image segmentation using Graphcut / Grabcut.

5 3D Reconstruction – Creating Depth map from stereo images and Object Detection and Tracking using Kalman Filter, Camshift.

TEXT BOOKS:

1 Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer - Texts in Computer Science, 2nd Edition, 2022.

2 D A Forsyth, J Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2nd Edition, 2015.

REFERENCES:

1 Richard Hartley, Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004.

2 Christopher M Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

3 E R Davies, "Computer and Machine Vision", 4th Edition, Academic Press, 2012.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=computer%20vision

2 https://www.edx.org/learn/computer-vision

3 https://online.stanford.edu/courses/cs231n-deep-learning-computer-vision

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the fundamental theories and methods in image processing and computer vision.

CO2 Apply basic and some advanced image processing techniques in OpenCV.

CO3 Apply 2D a feature-based based image alignment, segmentation and motion estimations.

CO4 Apply 3D image reconstruction techniques.

CO5 Apply image rendering and recognition techniques.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	-	-	2	2	2	-	2	2	1
CO2	3	2	1	2	2	-	-	2	2	2	-	2	2	1
CO3	3	2	1	2	2	-	-	2	2	2	-	2	2	1
CO4	3	2	1	2	2	-	-	2	2	2	-	2	2	1
CO5	3	2	1	2	2	-	-	2	2	2	-	2	2	1

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U23PEEC29	SECURITY IN IoT	L	T	P	C
Prerequisites: Computer Communication Networks		3	0	0	3

COURSE OBJECTIVES:

- To learn about the security issues in IoT and cloud computing.
- To learn about the cryptography solutions and issues in IoT.
- To learn about the security measures taken in IoT and Cloud systems to improve security.

UNIT I FUNDAMENTALS OF IoT ECOSYSTEM 9

IoT security issues, how to design an IoT system, Hardware, software and network security related to IoT systems - Basics of cryptographic solutions to IoT systems.

UNIT II OVERVIEW OF CLOUD COMPUTING AND ITS SERVICES 9

Cloud Computing Fundamental: Cloud computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS.

UNIT III CHALLENGES IN CLOUD COMPUTING 9

Benefits and challenges of cloud computing - Public vs. Private clouds, Role of virtualization in enabling the cloud.

UNIT IV SECURITY CONCEPTS IN CONTEXT TO IoT DEVICES 9

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, Virtualization

UNIT V IoT SECURITY THREATS AND COUNTERMEASURES 9

System-Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyper jacking.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 David Etter, "IoT Security: Practical guide book "Create Space, 1st Edition, 2016.

2 Brian Russell, Drew Van Duren, "Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem", 2nd Edition, 2018.

REFERENCES:

1 Drew Van Duren, Brian Russell, "Practical Internet of Things Security", Packt, 1st Edition, 2016.

2 Sean Smith, "The Internet of Risky Things", O'Reilly Media, 1st Edition, 2017.

ONLINE RESOURCES:

1 https://ciet.nic.in/itms.php

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2 https://www.udemy.com/course/security-in-iot-pna/

3 https://www.cybrary.it/course/iot-security

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain security issues and Hardware Architecture of IoT Device

CO2 Comprehend different IoT Protocols and Layer Functioning.

CO3 Describe how to protect and secure the network connecting IoT devices to back-end systems on the internet.

CO4 Describe different authentication mechanism such as digital certificates, biometrics, etc.

CO5 Explain collecting, aggregating, monitoring, and normalizing data from IoT devices and providing actionable reporting and alerting on specific activities or when activities fall outside established policies.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	2	2	1
CO2	2	2	1	1	1	-	-	1	-	-	-	2	2	1
CO3	2	2	1	1	1	-	-	1	-	-	-	2	2	1
CO4	2	2	1	1	1	1	-	1	-	-	-	2	2	1
CO5	2	2	1	1	1	1	-	1	-	-	-	2	2	1

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U23PEEC30 **BLOCKCHAIN TECHNOLOGIES** **L T P C**

Prerequisites: Machine Learning and Artificial Neural Networks **2 0 2 3**

COURSE OBJECTIVES:

- To study the basics of Blockchain technology.
- To understand various aspects of Blockchain technology like application in various domains.
- To gain the knowledge about private and public Blockchain, and smart contract.

UNIT I **INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN** **6**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II **BITCOIN AND CRYPTOCURRENCY** **6**

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III **INTRODUCTION TO ETHEREUM** **6**

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT IV **INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING** **6**

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V **BLOCKCHAIN APPLICATIONS** **6**

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

30 PERIODS

PRACTICAL EXCERCISES

1 Create a Simple Blockchain in any suitable programming language.

2 Use Geth to Implement Private Ethereum Block Chain.

3 Design Hyperledger Fabric Client Application.

4 Design Hyperledger Fabric with Smart Contract.

5 Using Python Libraries to develop Block Chain Application.

30 PERIODS

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TOTAL: 60 PERIODS

TEXT BOOKS:

1 Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", 2nd Edition, Packt Publishing, 2018.
2 Antonopoulos, G Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.

REFERENCES:

1 Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016.
2 Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014..
3 D. Drescher, Blockchain Basics. Apress, 2017.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/106/104/106104220/
2 https://www.udemy.com/course/build-your-blockchain-az/
3 https://eduxlabs.com/courses/blockchain-technologytraining/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the working of Blockchain technology.
CO2 Analyze the working of Smart Contracts.
CO3 Analyze the working of Hyperledger.
CO4 Apply the learning of solidity to build de-centralized apps on Ethereum.
CO5 Design applications on Blockchain.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	-	-	2	2	2	-	2	2	1
CO2	3	3	2	2	2	-	-	2	2	2	-	2	2	1
CO3	3	3	2	2	2	-	-	2	2	2	-	2	2	1
CO4	3	2	1	2	2	-	-	2	2	2	-	2	2	1
CO5	3	3	3	3	2	-	-	2	2	2	-	2	2	1

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U23PEEC31	IOT BASED SYSTEM DESIGN	L	T	P	C
Prerequisites	Embedded Systems and IOT Design	2	0	2	3

COURSE OBJECTIVES:

- To understand the basics and the various services provided by of IoT.
- To familiarize themselves with various communication techniques and networking.
- To know the implementation of IoT with different tools and its applications.

UNIT I INTRODUCTION TO INTERNET OF THINGS 6

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – IoT Enabling Technologies – IoT Architecture – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects – IoT levels and deployment templates – A panaromic view of IoT applications.

UNIT II MIDDLEWARE AND PROTOCOLS OF IOT 6

Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture Approach for IoT Systems – SOA based IoT Middleware) Middleware architecture of RFID, WSN, SCADA, M2M – Interoperability challenges of IoT-Protocols for RFID, WSN, SCADA, M2M – Zigbee, KNX, BACNet, MODBUS - Challenges Introduced by 5G in IoT Middleware (Technological Requirements of 5G Systems – Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) – Resource management in IoT.

UNIT III COMMUNICATION AND NETWORKING 6

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition –Application Layer Protocols: CoAP and MQTT-Data aggregation & dissemination.

UNIT IV IOT IMPLEMENTATION TOOLS 6

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python, Implementation of IoT with Raspberry Pi.

UNIT V APPLICATIONS AND CASE STUDIES 6

Home automations - Smart cities – Environment – Energy – Retail – Logistics - Agriculture – Industry - Health and life style – Case study.

30 PERIODS

PRACTICAL EXERCISES:

1. Write a Program for arithmetic operation in Python.
2. Write a Program for looping statement in Python.
3. Write program using Arduino IDE for Blink LED.
4. IoT Application Development Using sensors and actuators (temperature sensor, light sensor, infrared sensor)

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5 To develop an application for measuring the distance using ultrasonic sensor and post distance value on Google Cloud IoT platform.

30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Honbo Zhou, "Internet of Things in the Cloud: A middleware perspective", CRC press, 2012.

2 Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-on Approach", Arshdeep Bahga & Vijay Madisetti, 1st Edition, 2014.

REFERENCES:

1 Pethuru Raj, Anupama C Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.

2 Constandinos X, Mavromoustakis, George Mastorakis, Jordi Mongay Batalla, Internet of Things (IoT) in 5G Mobile Technologies", Springer International Publishing Switzerland, 2016.

3 Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things" Springer-Verlag Berlin Heidelberg, 2011

ONLINE RESOURCES:

1 https://www.edx.org/learn/iot-internet-of-things/waseda-university-iot-system-design-software-and-hardware-integration

2 https://archive.nptel.ac.in/courses/108/104/108104100/

3 https://www.coursera.org/learn/iot-based-system-design-foundations-and-applications

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1 Summarize the main concepts, key technologies, strength and limitations of IoT.

CO2 Describe the architecture, infrastructure models of IoT.

CO3 Analyze how the sensors are communicated in IoT and write a program using Arduino.

CO4 Design different models for IoT implementation.

CO5 Design the new models for market strategic interaction.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	2	3	2
CO2	2	2	1	1	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	3	2	2	3	2	2	-	3	3	3
CO4	3	3	3	3	3	2	2	3	2	2	-	3	3	3
CO5	3	3	3	3	3	2	2	3	2	2	1	3	3	3

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U23PEEC32	IOT PROCESSORS	L	T	P	C
Prerequisites	**Embedded Systems and IOT Design**	2	0	2	3

COURSE OBJECTIVES:

- Learn the architecture and features of ARM.
- Study the exception handling and interrupts in CORTEX M3.
- Learn the architecture of STM 32L15XXX ARM CORTEX M3/M4 microcontroller.

UNIT I **OVERVIEW OF ARM AND CORTEX-M3** **6**

ARM Architecture – Versions, Instruction Set Development, Thumb 2 and Instruction Set Architecture, Cortex M3 Basics: Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Block Diagram. CORTEX M3 Instruction Sets: Assembly Basics, Instruction List, and Instruction Descriptions.

UNIT II **CORTEX EXCEPTION HANDLING AND INTERRUPTS** **6**

Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor Call and Pendable Service Call, NVIC: Nested Vector Interrupt Controller, Overview, Basic Interrupts, SYSTICK Time, Interrupt Behaviour Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail – Chaining Interrupts, Late Arrivals and Interrupt Latency.

UNIT III **CORTEX M3/M4 PROGRAMMING** **6**

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS Using Assembly, Exception Programming Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation, Memory Protection Unit and other CORTEX M3 Features, MPU Registers, Setting up the MPU, Power Management, Multiprocessor Configuration

UNIT IV **STM32L15XXX ARMCORTEX M3/M4 MICROCONTROLLER AND DEBUGGING TOOLS** **6**

STM32L15XXX ARM CORTEX M3/M4 Microcontroller: Memory and Bus Architecture, STM32L15XXX Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In – Circuit Emulator (ICE), Logic Analyser.

UNIT V **INTRODUCTION TO SYSTEM – ON – CHIP S** **6**

System Architecture: An Overview, Components of the System Processors, Memories and Interconnects, Processor Architectures, Memory and Addressing, System Level Interconnection – An Approach for SOC Design – Chip basics – Cycle Time – Die Area – Power and Cost – Area, Power and Time Trade – Offs in Processor Design – Reliability and Configurability – SOC Design Approach – Application Studies – AES, 3D Graphics Processor. Image Compression and Video Compression.

30 PERIODS

PRACTICAL EXERCISES:

ARM Assembly Programming

1. Write a program to add two 32-bit numbers stored in r0 and r1 registers and write the result to r2. The result is stored to a memory location.
   a) Run the program with breakpoint and verify the result
   b) Run the program with stepping and verify the content of registers at each stage.

Embedded C Programming on ARM Cortex M3/M4 Microcontroller

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2. Write a program to turn on green LED (Port B.6) and Blue LED (Port B.7) on STM32LDiscovery by configuring GPIO.
3. Transmit a string "Programming with ARM Cortex" to PC by configuring the registers of USART2. Use polling method.

ARM Cortex M3/M4 Programming with CMSIS

4. Write a program to toggle the LEDs at the rate of 1 sec using standard peripheral library. Use Timer3 for Delay.
5. Transmit a string "Programming with ARM Cortex" to PC by using standard peripheral library with the help of USART3. Use polling method.

30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Joseph Yiu, "The Definitive Guide to the ARM CORTEX M3/M4", 3rd Edition, Elsevier 2014.

2 Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimizing System Software", Elsevier, 2006.

REFERENCES:

1 Michael J Flynn and Wayne Luk, Computer System Design, System On Chip, Wiley India 2011.

2 Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education, India, 2015.

3 STM32L152xx ARM Cortex M3 Microcontroller Reference Manual 5/

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/106/117106111/

2 https://www.nitttrc.edu.in/nptel/courses/video/106105193/L11

3 https://freevideolectures.com/course/2341/embedded-systems/10

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1 Explain the architecture, features of ARM and Write a program using ARM Assembly.

CO2 Summarize the concepts of exception handling.

CO3 Write a program using ARM CORTEX M3/M4.

CO4 Explain the architecture of STM32L15XXX ARM CORTEX M3/M4.

CO5 Describe the concept and application of SoC.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	-	-	3	2	2	-	3	3	2
CO2	2	2	1	1	-	-	-	-	-	-	-	3	3	2
CO3	3	3	3	3	2	-	-	3	2	2	-	3	3	2
CO4	2	2	1	1	-	-	-	-	-	-	-	3	3	2
CO5	2	2	1	1	-	2	-	3	-	-	-	3	3	2

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U23PEEC33	WIRELESS SENSOR NETWORK DESIGN	L	T	P	C
Prerequisites	Computer Communication Networks	2	0	2	3

COURSE OBJECTIVES:

- To understand the fundamentals of wireless sensor network.
- To gain knowledge on the MAC and Routing Protocols of WSN.
- To acquire knowledge on the protocols required for developing real time applications using WSN and 6LOWPAN.

UNIT I **INTRODUCTION** **6**

Principle of Wireless Sensor Network -Introduction to wireless sensor networks- Challenges, Comparison with ad hoc network, Node architecture and Network architecture, design principles, Service interfaces, Gateway, Short range radio communication standards-IEEE 802.15.4, Zigbee and Bluetooth. Physical layer and transceiver design considerations.

UNIT II **MAC AND ROUTING PROTOCOLS** **6**

MAC protocols – fundamentals, low duty cycle protocols and wakeup concepts, contention and Schedule-based protocols - SMAC, BMAC,TRAMA, Routing protocols – Requirements, Classification -SPIN, Directed Diffusion, COUGAR, ACQUIRE, LEACH, PEGASIS.

UNIT III **6LOWPAN** **6**

6LoWPAN Architecture - protocol stack, Adaptation Layer, Link layers – Addressing, Routing – Mesh Under - Route-Over, Header Compression - Stateless header compression - Context-based header compression, Fragmentation and Reassembly , Mobility – types, Mobile IPv6, Proxy Home Agent, Proxy MIPv6, NEMO –Routing – MANET, ROLL, Border routing.

UNIT IV **APPLICATION** **6**

Design Issues, Protocol Paradigms -End-to-end, Real-time streaming and sessions, Publish/subscribe, Web service paradigms, Common Protocols -Web service protocols, MQ telemetry transport for sensor networks (MQTT-S), ZigBee compact application protocol (CAP),Service discovery, Simple network management protocol (SNMP), Real-time transport and sessions, Industry- Specific protocols.

UNIT V **TOOLS** **6**

TinyOS – Introduction, NesC, Interfaces, modules, configuration, Programming in TinyOS using NesC, TOSSIM, Contiki – Structure, Communication Stack, Simulation environment – Cooja simulator, Programming

30 PERIODS

PRACTICAL EXERCISES:

1. Implement a Power Efficient and Delay Aware MAC protocol using Simulation Tool.
2. Implement a Predictive Wake-up MAC protocol using Simulation Tool.
3. Implement a Low Energy Adaptive Hierarchy protocol (LEACH) & Low Energy Adaptive Hierarchy protocol (PEGASIS) using Simulation Tool.
4. Implement a Scheduling based protocol for WSNs using Simulation Tool.

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5 Write a program to configure various sensors with end-to-end devices and routers.

30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Holger Karl, Andreas willig, "Protocol and Architecture for Wireless Sensor Networks", John Wiley & Sons, 2006.

2 Zach Shelby Sensinode and Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet" John Wiley & Sons, 2009.

REFERENCES:

1 Anna Forster, "Introduction to Wireless Sensor Networks", Wiley, 2017.

2 C Siva Ram Murthy, B S Manoj, "Ad Hoc Wireless Networks Architectures and Protocols", Prentice Hall, 2004.

3 Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks: an information processing approach", Elsevier publication, 2004.

4 I F Akyildiz, W Su, Y Sankarasubramaniam, E Cayirci, "Wireless sensor networks: a Survey", In the Journal of Computer Networks, Elsevier, 38, 394 – 422, 2002.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/106/105/106105160/

2 https://nptel.ac.in/courses/106105160

3 https://www.mooc-list.com/tags/contiki-os

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the Network architecture and design solutions for WSNs applications.

CO2 Design an efficient MAC and Routing Protocols.

CO3 Design solutions for 6LOWPAN applications.

CO4 Summarize how to develop efficient layered Web service protocols.

CO5 Explain the use of Tiny OS and Contiki OS in WSNs and 6LOWPAN applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	2	3	2
CO2	3	3	3	3	3	1	-	3	2	2	-	3	3	2
CO3	3	3	3	3	3	1	-	3	2	2	-	3	3	2
CO4	2	2	1	1	-	-	-	-	-	-	-	3	3	2
CO5	2	2	1	1	3	-	-	-	-	-	-	3	3	2

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U23PEEC34	MEMS DESIGN	L	T	P	C
Prerequisites	**Basic Electrical and Instrumentation Engineering**	2	0	2	3

COURSE OBJECTIVES:

- To understand the basic electrical and mechanical concepts of MEMS design.
- To understand the design aspects of electrostatic sensors, thermal sensors and actuators.
- To understand the design aspects of piezoelectric sensors, magnetic sensors and actuators.

UNIT I **ESSENTIAL ELECTRIC AND MECHANICAL CONCEPTS** **6**

Conductivity of semiconductors, Crystal planes and orientations, stress and strain, flexural beam bending analysis under simple loading conditions, Dynamic system, resonant frequency and quality factor.

UNIT II **ELECTRO STATIC SENSING AND ACTUATION** **6**

Parallel plate capacitor, Applications of parallel plate capacitors- inertial sensor, pressure sensor, flow sensor, tactile sensor, parallel plate actuators, inter digitated finger capacitors, applications of comb drive devices.

UNIT III **THERMAL SENSING AND ACTUATION** **6**

Fundamentals of thermal transfer, Sensors and actuators based on thermal expansion, Thermal couples, Thermal resistors, Applications- Infrared sensors, flow sensors, Inertial sensors, other sensors.

UNIT IV **PIEZOELECTRIC SENSING AND ACTUATION** **6**

Mathematical description of piezoelectric effects, Cantilever piezoelectric actuator model, properties of piezoelectric materials –Quartz, PZT, PVDF, ZnO , Applications – Acoustic sensors, Tactile sensors.

UNIT V **MAGNETIC SENSING AND ACTUATION** **6**

Concepts and principles- magnetization and nomenclatures, principles of micromagnetic actuators, fabrication of micro magnetic components- deposition, design and fabrication of magnetic coil, MEMS magnetic actuators.

30 PERIODS

PRACTICAL EXERCISES:

1 Design and simulation of piezoelectric cantilever.

2 Design and simulation of thermo couples.

3 Design and simulation of comb drive actuators.

4 Simulation of accelerometers.

5 Simulation of micro mirror.

30 PERIODS

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TOTAL: 60 PERIODS

TEXT BOOKS:

1 Chang Liu, "Foundations of MEMS", 2nd Edition, Pearson Education India Limited, 2012.

2 Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2002.

REFERENCES:

1 B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday, "Textbook of Nanoscience and Nanotechnology", Springer, 2013.
2 Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata Mcgraw Hill, 2002.
3 Vinod Kumar Khanna, "Nanosensors: Physical, Chemical, and Biological", CRC Press, 2012.
4 Julian W Gardner, Vijay K Varadhan, "Micro sensors, MEMS and Smart devices", John Wiley & sons, 2001.

ONLINE RESOURCES:

1 http://www.cense.iisc.ac.in/course/mems-modeling-design-and-implementation

2 https://www.edx.org/learn/engineering/ecole-polytechnique-federale-de-lausanne-micro-and-nanofabrication-mems

3 https://nptel.ac.in/courses/117105082

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the basics of MEMS design aspects.

CO2 Apply the knowledge in the development of electro static sensors and actuators.

CO3 Design and describe the development of thermal sensors and actuators.

CO4 Design and describe the development of piezoelectric sensors and actuators.

CO5 Apply the knowledge in the development of magnetic sensors and actuators.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	2	3	2
CO2	3	2	1	2	3	1	1	3	2	2	-	2	3	2
CO3	3	3	3	3	3	1	1	3	2	2	-	3	3	2
CO4	3	3	3	3	-	-	-	2	-	-	-	3	3	2
CO5	3	2	1	2	-	-	-	-	-	-	-	2	3	2

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U23PEEC35	INDUSTRIAL IOT AND INDUSTRY 4.0	L	T	P	C
Prerequisites:	**Embedded Systems and IOT Design**	2	0	2	3

COURSE OBJECTIVES:

- To provide students with good depth of knowledge of IoT sensors, Actuators and communication protocol used in IoT development platform.
- To understand IoT connectivity of smart devices to cloud having multiple communication medium, protocols, device management and monitoring.
- To gain knowledge in design and analysis of Industrial IOT Systems for various application.

UNIT I UNDERSTANDING IOT CONCEPT AND DEVELOPMENT PLATFORM 6

IOT Definition, Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics.

UNIT II COMMUNICATION PROTOCOL USED IN IOT DEVELOPMENT PLATFORM 6

UART Communication Protocol, I2C Protocol device interfacing and decoding of signal, SPI Protocol device interfacing and decoding of signal, WIFI and Router interfacing, Ethernet Configuration, Bluetooth study and analysis of data flow, Zigbee Interfacing and study of signal flow.

UNIT III CONTROLLING HARDWARE AND SENSORS USING IOT 6

IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on Interfacing external gadgets, Controlling Hardware- Connecting LED, Buzzer, Controlling servo motor, speed control of DC Motor, Stepper motors; Sensors- Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor.

UNIT IV CLOUD SERVICES USED IN IOT DEVELOPMENT PLATFORM 6

Configuration of the cloud platform, Sending data from the IOT nodes to the gateways using different communication options; Transferring data from gateway to the cloud; Exploring the web services like mail, Messaging (SMS) and Twitter etc.; Tracking of cloud data as per the requirement; Google Cloud service architect; AWS clod Services architect; Microsoft Azure cloud services Architect; OPEN source Cloud Services; Initial State Iot Dashboard & Cloud Services.

UNIT V CHALLENGES IN IOT SYSTEM DESIGN – HARDWARE & SOFTWARE 6

Antenna design and placement, Chip-package system development, Power electronics, electromagnetic interference/compatibility (EMI/EMC), Electronics reliability; Battery simulation.

30 PERIODS

PRACTICAL EXERCISES:

1. Write a program using Temperature sensor for detecting heat / fire.
2. Write a program using sensors for car parking assist.
3. Write a program using sensors for water level indicator and overflow detection.

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4. Write a program to control Buzzer/ LED using Alexa Echo Dot.
5. Write a program to control DC motor / Stepper motor using Google Assistance.

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A Hands-on Approach", Universities Press, 2015,
2 Matt Richardson & Shawn Wallace, "Getting Started with Raspberry Pi", O'Reilly, 4th Edition, 2021,

REFERENCES:

1 Sudip Misra,Chandana Roy, Anadarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press,2021.
2 Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895.
3 N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.
4 Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc20_cs24/preview
2 https://www.coursera.org/learn/industrial-internet-of-things
3 https://professionalprograms.mit.edu/online-program-internet-of-things/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the building blocks of IoT technology and explore the vast spectrum of IoT applications
CO2 Summarize the processors & peripherals to design & build IoT hardware.
CO3 Analyze how to assess and select various IOT physical devices and endpoints for IoT applications.
CO4 Design by Connecting numerous IOT applications with the physical world of humans and real life problem solving.
CO5 Design and implement IOT applications that manage big data.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	3	3	3
CO2	2	2	1	1	-	-	-	-	-	-	-	3	3	3
CO3	3	3	2	2	-	2	-	2	-	-	-	3	3	3
CO4	3	3	3	3	3	2	-	2	2	2	-	3	3	3
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	3

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U23PEEC36	FUNDAMENTALS OF NANO ELECTRONICS	L	T	P	C
Prerequisites: Electronic Circuits		3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of nano electronics and quantum electronics.
- To understand the concepts of nano electronic devices, transistors, tunnelling devices and superconducting devices.
- To understand the basics of nanotube devices.

UNIT I **INTRODUCTION TO NANO ELECTRONICS** **9**

Scaling to nano - Light as a wave and particle- Electrons as waves and particles- origin of quantum mechanics - General postulates of quantum mechanics - Time independent Schrodinger wave equation- Electron confinement - Quantum dots, wires and well-Spin and angular momentum.

UNIT II **QUANTUM ELECTRONICS** **9**

Quantum electronic devices - Short channel MOS transistor - Split gate transistor - Electron wave transistor - Electron wave transistor - Electron spin transistor - Quantum cellular automata - Quantum dot array, Quantum memory.

UNIT III **NANO ELECTRONIC TRANSISTORS** **9**

Coulomb blockade - Coulomb blockade in Nano capacitors - Coulomb blockade in tunnel junctions - Single electron transistors, Semiconductor nanowire FETs and SETs, Molecular SETs and molecular electronics - Memory cell.

UNIT IV **NANO ELECTRONIC TUNNELING AND SUPER CONDUCTING DEVICES** **9**

Tunnel effect -Tunneling element -Tunneling diode - Resonant tunneling diode - Three terminal resonant tunneling devices- Superconducting switching devices- Cryotron- Josephson tunneling device.

UNIT V **NANOTUBES AND NANOSTRUCTURE DEVICES** **9**

Carbon Nanotube - Fullerenes - Types of nanotubes – Formation of nanotubes –Assemblies – Purification of carbon nanotubes – Electronic properties – Synthesis of carbon nanotubes – Carbon nanotube interconnects – Carbon nanotube FETs and SETs –Nanotube for memory applications - Nano structures and nano structured devices.

TOTAL: 45 PERIODS

TEXTBOOKS:

1 Hanson, "Fundamentals of Nano Electronics", Pearson Education, 2009.
2 Goser, Karl, Peter Glosekotter, Jan Dienstuhl, "Nano Electronics and Nano Systems: from Transistors to Molecular and Quantum Devices", Springer Science & Business Media, 2004.

REFERENCES:

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1 Brajesh Kumar Kaushik, "Nano Electronics: Devices, Circuits and Systems", Elsevier Science, 2018.
2 Robert Puers, Livio Baldi, Marcel Van de Voorde and Sebastiaan E. Van Nooten, "Nano Electronics: Materials, Devices, Applications", Wiley, 2017.
3 Mircea Dragoman, Daniela Dragoman, "Nano Electronics: Principles and Devices", Artech House, 2009.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_ee47/preview

2 https://nptel.ac.in/courses/117108047

3 https://onlinecourses.nptel.ac.in/noc19_bt29/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the basics of nano electronics including quantum wires, dots and wells.

CO2 Explain the mechanism behind quantum electronic devices.

CO3 Explain the operation of Nano Electronic transistors.

CO4 Summarize the performance aspects of tunneling and superconducting Nano Electronic devices.

CO5 Describe the development of nanotubes and nanostructure devices.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	2	3	1

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U23PEEC37	AVIONICS SYSTEMS	L	T	P	C
Prerequisites:	**Wireless Communication**	3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the needs for avionics for both Civil and military aircraft.
- To impart knowledge on avionics architecture and avionics data bus and the various cockpit displays and human interfaces.
- To impart knowledge on the concepts of flight control systems, FMS and their importance and different navigation aids and need for certification.

UNIT I **INTRODUCTION TO AVIONICS** 9

Basics of Avionics-Basics of Cockpits – Need for Avionics in civil and military aircraft and space systems – Integrated Avionics Architecture – Military and Civil system – Typical avionics System and Sub systems – Design and Technologies – Requirements and Importance of ilities of Avionic Systems.

UNIT II **DIGITAL AVIONICS BUS ARCHITECTURE** 9

Evolution of Avionics architecture – Avionics Data buses MIL-STD-1553, MIL-STD-1773, ARINC 429, ARINC-629, AFDX/ARINC-664, ARINC-818 – Aircraft system Interface

UNIT III **COCKPIT DISPLAYS AND MAN-MACHINE INTERACTION** 9

Trends in display technology- CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) – Civil cockpit and military cockpit: MFD, MFK, HUD, HDD, HMD, HOTAS – Glass cockpit.

UNIT IV **FLIGHT CONTROL SYSTEMS** 9

Introduction to Flight control systems and FMS – Longitudinal control – Lateral Control – Autopilot – Flight planning – Radar Electronic Warfare - Certification-Military and civil aircrafts.

UNIT V **NAVIGATION SYSTEMS** 9

Overview of navigation systems – Communication Systems – Radio navigation – Types & Principles – Fundamentals of Inertial Sensors – INS – GNSS -- GPS – Approach and Landing Aids – ILS & MLS – Hybrid Navigation

TOTAL: 45 PERIODS

TEXT BOOKS:

1 R P G Collinson, "Introduction to Avionics", Springer Publications, 3rd Edition, 2011.
2 Myron Kayton, Walter R Fried, "Avionics Navigation Systems" 2nd Edition, Wiley Publication, 2008.

REFERENCES:

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1 R P G Collinson, "Introduction to Avionics Systems", Springer Publications, 2nd Edition, 2013.

2 Albert Helfrick, "Principles of Avionics", Avionics Communications, 7th Edition, 2010.

3 Cary R Spitzer, "The Avionics Handbook", CRC Press, 2000.

ONLINE RESOURCES:

1 https://www.coursera.org/lecture/aeronautics/basics-X8Mvf

2 https://www.shiksha.com/online-courses/aerospace-engineering-aircraft-systems-and-avionics-course-udeml3734

3 https://onlinecourses.nptel.ac.in/noc22_ae14/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the different of Avionics Systems and its need for civil and military aircrafts considering the reliability and safety aspects

CO2 Analyse a suitable architecture and data bus based on the requirements

CO3 Summarize the different display technologies used in cockpit

CO4 Explain the principles of flight control systems and the importance of FMS

CO5 Explain the communication and navigation techniques used in aircrafts.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO4	2	2	1	1	-	-	-	-	-	-	-	1	3	-
CO5	2	2	1	1	-	-	-	-	-	-	-	1	3	-

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U23PEEC38	POSITIONING AND NAVIGATION SYSTEMS	L	T	P	C
Prerequisites:	**Physics for Electrical and Electronics Engineers**	3	0	0	3

COURSE OBJECTIVES:

- To explain the fundamentals of navigation systems.
- To acquire knowledge on inertial and radio navigation.
- To have an overview of global positioning systems and to learn the hybrid navigation systems.

UNIT I **NAVIGATION CONCEPTS** **9**

Fundamentals of navigation systems and Position Fixing – Categories of navigation – Geometric concepts of Navigation – The Earth in inertial space - Different Coordinate Systems – Coordinate Transformation - Euler angle formulations - Direction cosine matrices formulation – Quaternion formulation.

UNIT II **INERTIAL NAVIGATION SYSTEMS** **9**

Inertial sensors - Gyroscopes -Types - Mechanical - Electromechanical-Optical Gyro – Ring Laser gyro – Fiber optic gyro - Accelerometers – Pendulous type – Force Balance type – MEMs – Basic Principles of Inertial Navigation – Types – Platform and Strap down – Mechanization INS system – Rate Corrections – Acceleration errors – Schuler Tuning.

UNIT III **RADIO NAVIGATION & AIR TRAFFIC MANAGEMENT** **9**

Different types of radio navigation- ADF, VOR, DME, TACAN,VORTAC - Doppler – Hyperbolic Navigations – Air Traffic Management – RADAR Surveillance – Airborne Collision Avoidance Systems.

UNIT IV **GLOBAL POSITIONING SYSTEM** **9**

Overview of GPS: Basic concept, system architecture, GPS Signals Signal structure, anti-spoofing (AS), selective availability, GPS for position and velocity determination, GPS aided Geo-augmented navigation (GAGAN) architecture – GPS error sources – clock error, ionospheric error, tropospheric error, multipath, ionospheric error estimation using dual frequency GPS receiver.

UNIT V **HYBRID NAVIGATION & RELATIVE NAVIGATION SYSTEMS** **9**

Hybrid Navigation – Introduction to Kalman filtering – Case Studies – Integration of GPS and INS using Kalman Filter – Relative Navigation – fundamentals – Equations of Relative Motion for circular orbits (Clohessy_Wiltshire Equations) – Sensors for Rendezvous Navigation – Relative positioning – Point positioning and differential positioning – Differential GPS (DGPS) and Space based Augmentation system (SBAS) – Concepts – Relative GPS – Formation Flying – Figure of Merit (FOM).

TOTAL: 45 PERIODS

TEXT BOOKS:

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1 Christopher Jekeli, "Inertial Navigation Systems with Geodetic Applications", De Gruyter, 2nd Edition, 2023.
2 Paul David Groves, "Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems", Artech House, 2nd Edition, 2013.

REFERENCES:

1 Alexander V Nebylov, Joseph Watson, "Aerospace Navigation Systems", John Wiley & Sons, 1st Edition, 2016.
2 Anthony Lawrence, "Modern Inertial Technology Navigation, Guidance, and Control", Springer New York, 2nd Edition, 2012.
3 Paul D Groves. "Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems", Artech House, 2nd Edition, 2013.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc23_ce94/preview
2 https://www.coursera.org/courses?query=gps
3 https://ep.jhu.edu/courses/525645-modern-navigation-systems/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the advanced concepts of positioning and navigation systems.

CO2 Describe about Gyroscopes and accelerometers and inertial navigation systems and its types and Mechanisation

CO3 Explain the different radio navigation aids and its usage for civil and military aircrafts and satellites.

CO4 Explain the Satellite Navigation – GPS and its usage in aircraft and spacecraft applications

CO5 Apply hybrid navigation systems and relative navigation in a spacecraft.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	1	3	1

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U23PEEC39	SATELLITE COMMUNICATION	L	T	P	C
Prerequisites: Digital Communication		3	0	0	3

COURSE OBJECTIVES:

- Understand the basics of satellite orbits, satellite segment and earth segment.
- Understand Link Power budget calculation and the various satellite access and coding technology.
- Understand the applications of satellites.

UNIT I **SATELLITE ORBITS** **9**

Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo-stationary orbits – Look Angle Determination – Limits of visibility – eclipse Sub satellite point –Sun transit outage-Launching Procedures – launch vehicles and propulsion.

UNIT II **SPACE SEGMENT** **9**

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command-Transponders Antenna Subsystem.

UNIT III **SATELLITE LINK DESIGN** **9**

Basic link analysis, Uplink and Downlink Design equation, Free space loss – Atmospheric effects, Ionospheric scintillation, Rain induced attenuation and interference, system noise temperature, Link Design with and without frequency reuse.

UNIT IV **SATELLITE ACCESS AND CODING TECHNIQUES** **9**

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, PAMA and DAMA Assignment Methods, compression – encryption, Coding Schemes.

UNIT V **SATELLITE APPLICATIONS** **9**

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, LEO, MEO, Satellite Navigational System. GPS-Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH).

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Dennis Roddy, "Satellite Communication", 4th Edition, Tata McGraw Hill International, 2017.

2 Timothy Pratt, Charles, W Bostain, Jeremy E Allnutt, "Satellite Communication", 3rd Edition, Wiley Publications, 2021.

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REFERENCES:

1 Tri T Ha, "Digital Satellite Communications", 2nd Edition, Tata McGraw Hill Education, 2017.

2 Wilbur L Pritchard, Hendri G Suyderhoud, Robert A Nelson, "Satellite Communications Systems Engineering", 2nd Edition, Prentice Hall/Pearson, 2013.

3 Bruce R Elbert, "The Satellite Communication Applications Hand Book", 2nd Edition, Artech House, 2004.

ONLINE RESOURCES:

1 https://plus.nasa.gov/video/space-flight-the-application-of-orbital-mechanics/

2 https://nescacademy.nasa.gov

3 https://www.nasa.gov/smallsat-institute/sst-soa/soa-communications/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the satellite orbits.

CO2 Analyze the satellite subsystems.

CO3 Evaluate the satellite link power budget.

CO4 Explain the access technology and coding techniques for satellite.

CO5 Design various satellite applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO4	2	2	1	1	-	-	-	-	-	-	-	1	3	-
CO5	2	2	1	1	-	-	-	-	-	-	-	1	3	-

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U23PEEC40	REMOTE SENSING	L	T	P	C
Prerequisites:	**Physics for Electrical and Electronics Engineers**	3	0	0	3

COURSE OBJECTIVES:

- To learn about the fundamentals of remote sensing.
- To acquire knowledge on orbits and platforms.
- To have an overview of data products and interpretation.

UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9

Definition – components of RS – History of Remote Sensing – Merits and demerits of Data Collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchhoff's law – Radiation sources: active & passive – Radiation Quantities.

UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows – Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

UNIT III ORBITS AND PLATFORMS 9

Motions of planets and satellites – Newton 's law of gravitation – Gravitational field and potential – Escape velocity – Kepler's law of planetary motion – Orbit elements and types – Orbital perturbations and manoeuvres – Types of remote sensing platforms – Ground based, Air borne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit

UNIT IV SENSING TECHNIQUES 9

Classification of remote sensors – Resolution concept: spatial, spectral, radiometric and temporal resolutions - Scanners – Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors – High Resolution Sensors – LIDAR, UAV – Orbital and sensor characteristics of live Indian earth observation satellites.

UNIT V DATA PRODUCTS AND INTERPRETATION 9

Photographic and digital products – Types, levels and open-source satellite data products – selection and procurement of data – Visual interpretation: basic elements and interpretation keys – Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Basudeb Bhatta, "Remote Sensing and GIS", Oxford University Press, 3rd Edition, 2020.

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2 Charles Elachi and Jacob Van Zyl, "Introduction to Physics and Techniques of Remote Sensing", 3rd Edition, John Wiley & Sons Publication, 2021.

REFERENCES:

1 Verbyla, David, "Satellite Remote Sensing of Natural Resources", CRC Press, 1st Edition, 2022.
2 Floyd F Sabins, Jr., James M Ellis, "Remote Sensing Principles, Interpretation, and Applications", 4th Edition, Waveland Press, 2020.
3 George Joseph, C Jeganathan, "Fundamentals of Remote Sensing", 3rd Edition, Universities Press (India) Private limited, 2018.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=remote%20sensing
2 https://www.classcentral.com/course/swayam-remote-sensing-and-gis-14272
3 https://elearning.iirs.gov.in/courses/IIRS_NCERT_Remote_Sensing/story_html5.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the principles of electromagnetic radiation.
CO2 Describe about atmospheric radiation interactions.
CO3 Summarize the laws of planetary motion.
CO4 Analyse the different types of resolution.
CO5 Explain the concepts of digital interpretation.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1	3	1
CO5	2	2	1	1	-	-	-	1	-	-	-	1	3	1

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U23PEEC41	ROCKETRY AND SPACE MECHANICS	L	T	P	C
Prerequisites:	**Physics for Electrical and Electronics Engineers**	3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on fundamental aspects of rocket motion along with detailed estimation of rocket trajectories.
- To learn about optimization of multistage rockets and the basics of space mechanics.
- To gain knowledge on the basics of orbit transfer of satellites and various control methods of rockets.

UNIT I **ORBITAL MECHANICS** **9**

Description of solar system – Kepler's Laws of planetary motion – Newton's Law of Universal gravitation – Two body and Three-body problems – Jacobi's Integral, Librations points – Estimation of orbital and escape velocities.

UNIT II **SATELLITE DYNAMICS** **9**

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – orbit transfer and examples – Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements.

UNIT III **ROCKET MOTION** **9**

Principle of operation of rocket motor – thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories – determinations of range and altitude – simple approximations to burnout velocity.

UNIT IV **ROCKET AERODYNAMICS** **9**

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – rocket stability – rocket dispersion – launching problems.

UNIT V **STAGING AND CONTROL OF ROCKET VEHICLES** **9**

Need for multi staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques – aerodynamic and jet control methods of rocket vehicles – SITVC.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 R P G Collinson, "Introduction to Avionics", Springer Publications, 3rd Edition, 2011.

2 Howard D Curtis, "Orbital Mechanics for Engineering Students", Elsevier Science, 2015.

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REFERENCES:

1 Suresh. B N & Sivan K, "Integrated Design for Space Transportation System", Springer India, 2015.

2 Sutton G P, "Rocket Propulsion Elements", John Wiley & Sons, 8th Edition, 2010.

3 Richard Tinder", Relativistic Flight Mechanics and Space Travel A Primer for Students, Engineers, and Scientists", Morgan & Claypool Publishers, 2007.

ONLINE RESOURCES:

1 https://plus.nasa.gov/video/space-flight-the-application-of-orbital-mechanics/

2 https://www.nasa.gov/stem-content/high-powered-rocketry-video-series/

3 https://www.youtube.com/watch?v=GnzwO37I13I /

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamental laws of orbital mechanics.

CO2 Design orbital parameters and trajectory for geocentric or interplanetary missions.

CO3 Describe the calculations for planar motion of rockets.

CO4 Explain the forces and moments acting on airframe of a missile.

CO5 Explain the need for staging and stage separation dynamics of rocket vehicles.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2	1	-	-	-	-	-	1	3	-
CO2	2	2	2	2	2	1	-	-	-	-	-	1	3	-
CO3	2	2	2	2	2	1	-	-	-	-	-	1	3	-
CO4	2	2	2	2	2	1	-	-	-	-	-	1	3	-
CO5	2	2	2	2	2	1	-	-	-	-	-	1	3	-

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U23PEEC42	RADAR TECHNOLOGIES	L	T	P	C
Prerequisites:	**Electromagnetic Field and Waves, Communication Systems**	3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the basics of Radar, its types and Radar equation.
- To impart knowledge on tracking Radar and various signal processing in Radar.
- To impart knowledge on the concepts Subsystems in Radar.

UNIT I **INTRODUCTION TO RADAR EQUATION** **9**

The Origins of Radar ,Radar principles, Basic Block Diagram, Radar classifications based on Frequencies, Wave form and application, Radar Fundamentals: Detection, Range, velocity, The simple form of the Radar Equation, Pulsed Radar equation, Detection of Signals in Noise-Receiver Noise, Signal-to-Noise Ratio, Probabilities of Detection and False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets, Transmitter Power, Pulse Repetition Frequency, Antenna Parameters, System losses.

UNIT II **CW, MTI AND PULSE DOPPLER RADAR** **9**

CW and Frequency Modulated Radar, Doppler and MTI Radar- Delay Line Cancellers, Staggered Pulse Repetition Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance, MTI from a Moving Platform (AMIT), Pulse Doppler Radar.

UNIT III **TRACKING RADAR** **9**

Tracking with Radar, Monopulse Tracking, Conical Scan, Sequential Lobing, Limitations to Tracking Accuracy, Low-Angle Tracking - Comparison of Trackers, Track while Scan (TWS) Radar- Target prediction, state estimation, Measurement models, alpha – beta tracker, Kalman Filtering, Extended Kalman filtering.

UNIT IV **RADAR SIGNAL PROCESSING** **9**

Radar Signal Processing Fundamentals, Detection strategies, Optimal detection, Threshold detection, Constant False alarm rate detectors, Adaptive CFAR, pulse compression waveforms, compression gain, LFM waveforms matched filtering, radar ambiguity functions, radar resolution, Detection of radar signals in Noise and clutter, detection of non-fluctuating target in noise, Doppler spectrum of fluctuating targets, Range Doppler spectrum of stationary and moving radar.

UNIT V **RADAR TRANSMITTERS AND RECEIVERS** **9**

Radar Transmitter, Linear Beam Power Tubes, Solid State RF Power Sources, Magnetron, Crossed Field Amplifiers, Other RF Power Sources, The Radar Receiver, Receiver noise power, Super heterodyne Receiver, Duplexers and Receiver Protectors- Radar Displays. Radar

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Antenna - Reflector Antennas - Electronically Steered Phased Array Antennas – Phase Shifters

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Habibur Rahman, "Fundamental Principles of Radar", CRC press, Taylor and Francis, 2019.
2 M R Richards, J A Scheer, W A Holm, "Principles of Modern Radar, Basic Principles", SciTech Publishing, 2012.

REFERENCES:

1 Nathansan, "Radar design principles-Signal processing and environment", PHI, 2nd Edition, 2007.
2 M I Skolnik, "Introduction to Radar Systems", Tata McGraw Hill, 2006.
3 Mark A Richards, "Fundamentals of Radar Signal Processing", Tata McGraw Hill, 2005.

ONLINE RESOURCES:

1 https://www.youtube.com/watch?v=Xemo2ZpduHA
2 https://appliedsciences.nasa.gov/get-involved/training/english/arset-radar-remote-sensing-land-water-disaster-applications
3 https://nisar.jpl.nasa.gov/resources/sar-education-resources/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the different Radar parameters.
CO2 Analyse a various Radar types.
CO3 Evaluate different tracking and filtering schemes.
CO4 Apply signal processing in target detection.
CO5 Design Radar transmitter and receiver blocks.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-	3	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-	3	-

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U23PEEC43	MILLIMETER WAVE COMMUNICATION	L	T	P	C
Prerequisites: Wireless Communication		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave Communications system.
- To know the antenna design at Millimeter wave frequencies.

UNIT I **INTRODUCTION** **9**

Millimeter wave characteristics- millimeter wave wireless, Implementation Challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.

UNIT II **MM WAVE DEVICES AND CIRCUITS** **9**

Models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, and PLL. Metrics for analog mm wave devices, Trends and architectures for mm wave wireless, ADC"s and DAC"s.

UNIT III **MM WAVE COMMUNICATION SYSTEMS** **9**

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations

UNIT IV **MM WAVE MIMO SYSTEMS** **9**

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT V **ANTENNAS FOR MM WAVE SYSTEMS** **9**

Antenna beamwidth, polarization, advanced beam steering and beam forming, On-chip and in package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays.

TOTAL: 45 PERIODS

REFERENCES:

1 K C Huang, Z Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.

2 Robert W Heath, Robert C Daniel, James N Theodore S Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

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ONLINE RESOURCES:

1 https://digimat.in/nptel/courses/video/117105139/L01.html

2 https://www.coursera.org/learn/rf-mmwave-circuit-design

3 https://onlinecourses.nptel.ac.in/noc23_ee69/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamentals of Millimeter wave

CO2 Describe about the millimeter devices and circuits

CO3 Comprehend the various components of Millimeter wave communication systems

CO4 Explain the millimeter wave MIMO system

CO5 Explain the concepts of antenna design for millimeter wave system

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	1	2	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1	2	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1	2	1
CO4	2	2	1	1	1	-	-	-	-	-	-	1	2	1
CO5	2	2	1	1	1	-	-	-	-	-	-	1	2	1

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U23PEEC44	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

Prerequisites: Communication Systems

COURSE OBJECTIVES:

- To understand the evolving paradigm of cooperative communication
- To understand concepts related to green wireless communication
- To expose the student to the energy saving techniques adopted in existing wireless components

UNIT I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9

Network architectures and research issues in cooperative cellular wireless networks; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes, Cooperative techniques for energy efficiency.

UNIT II COOPERATIVE BASE STATION TECHNIQUES 9

Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE – Advanced.

UNIT III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9

Distributed space-time block codes ; Collaborative relaying in downlink cellular systems; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

UNIT IV GREEN RADIO NETWORKS 9

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy saving techniques in cellular wireless base stations, Power – management for base stations in smart grid environment, Cooperative multicell processing techniques for energy-efficient cellular wireless communications, green communications in cellular networks with fixed relay nodes.

UNIT V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks; Energy performance in TDD-CDMA multihop cellular networks; Resource allocation for green communication in relay-based cellular networks; Green Radio Test-Beds and Standardization Activities.

45 PERIODS

TEXT BOOKS:

1 Ekram Hossain, Dong In Kim, Vijay K Bhargava, "Cooperative Cellular Wireless Networks", Cambridge University Press, 2011.

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2 Ekram Hossain, Vijay K Bhargava, Gerhard P Fettweis, "Green Radio Communication Networks", Cambridge University Press, 2012.

REFERENCES:

1 Jinsong Wu, Sundeep Rangan, Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

2 Yan Zhang, Hsiao-Hwa Chen; Mohsen Guizani, "Cooperative Wireless Communications", CRC Press, 10 Mar 2009

ONLINE RESOURCES:

1 https://www.coursera.org/learn/foundations-of-advanced-wireless-communication

2 https://www.researchgate.net/publication/320293847_Green_Communications_Techniques_and_Challenges

3 https://www.classcentral.com/course/wireless-communications-7503

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the need and design of cooperative and green wireless communication

CO2 Describe cooperative base station techniques for cellular wireless networks.

CO3 Explain the concepts of relay-based cooperative cellular networks.

CO4 Apply the energy saving techniques to develop green technology.

CO5 Describe the access techniques for green radio networks.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	1	3	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1	3	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1	3	1
CO4	3	2	1	2	-	-	-	-	-	-	-	1	3	1
CO5	2	2	1	1	-	-	-	-	-	-	-	1	3	1

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U23PEEC45	4G/5G COMMUNICATION NETWORKS	L	T	P	C
Prerequisites: Communication Systems		2	0	2	3

COURSE OBJECTIVES:

- To learn the evolution and fundamentals of 5G networks.
- To understand the process associated with 5G architecture.
- To understand about spectrum sharing, spectrum trading and security features in 5G networks.

UNIT I **EVOLUTION OF WIRELESS NETWORKS** **6**

Networks evolution: 2G, 3G, 4G, evolution of radio access networks, need for 5G. 4G versus 5G, Next Generation core (NG-core), visualized Evolved Packet core (vEPC).

UNIT II **5G CONCEPTS AND CHALLENGES** **6**

Fundamentals of 5G technologies, overview of 5G core network architecture,5G new radio and cloud technologies, Radio Access Technologies (RATs), EPC for 5G.

UNIT III **NETWORK ARCHITECTURE AND THE PROCESSES** **6**

Probability – Discrete and continuous random variables – Moments – Moment generating functions: Binomial, Poisson, Geometric and Uniform distributions.

UNIT IV **COMPUTER FUNDAMENTALS** **6**

Functional Units of a Digital Computer: Von Neumann Architecture and Harvard Architecture – Operation and Operands of Computer Hardware Instruction – Instruction Set Architecture (ISA): Memory Location, Address and Operation – Instruction and Instruction Sequencing – Addressing Modes.

UNIT V **SECURITY IN 5G NETWORKS** **6**

Instruction Execution – Building a Data Path- Pipelining- basic memory, static ROM, PROM, EPROM, EEPROM, Cache Memories: Mapping and Replacement Techniques – Virtual Memory – DMA.

30 PERIODS

PRACTICAL EXERCISES:

1. 5G-Compliant waveform generation and testing.
2. Modelling of 5G Synchronization signal blocks and bursts.
3. Channel modelling in 5G networks.
4. Multiband OFDM demodulation.
5. Perfect channel estimation and development of 5G new radio polar coding.

30 PERIODS

TOTAL: 60 PERIODS

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TEXT BOOKS:

1 Stephen Rommer, "1.5G Core networks: Powering Digitalization", Academic Press, 2019.

2 Saro Velrajan, "An Introduction to 5G Wireless Networks: Technology, Concepts and Use-Cases", 1st Edition, 2020.

REFERENCES:

1 Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", 6th Edition, Tata McGraw Hill, 2012.

2 William Stallings, "Computer Organization and Architecture–Designing for Performance", 10th Edition, Pearson Education, 2016.

3 M Morris Mano, "Digital Logic and Computer Design", 10th Edition, Pearson Education, 2016.

ONLINE RESOURCES

1 https://archive.nptel.ac.in/courses/117/105/117105078

2 https://www.coursera.org/courses?query=computer%20architecture

3 https://onlinecourses.nptel.ac.in/noc21_ee39/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply Boolean Algebra and Simplification procedures relevant to digital logic.

CO2 Design various combinational digital circuits using logic gates.

CO3 Design synchronous and asynchronous sequential digital circuits using logic gates.

CO4 Summarize the basic structure and operation of a digital computer.

CO5 Analyze the data path unit of processor and concept of various memories.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	2	2	2	-	1	2	2
CO2	3	3	3	3	1	-	-	2	2	2	-	1	2	2
CO3	3	3	3	3	1	-	-	2	2	2	-	1	2	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	-	2	2

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U23PEEC46 **SOFTWARE DEFINED NETWORKS** L T P C
2 0 2 3

Prerequisites: Communication Systems

COURSE OBJECTIVES:

- To understand the need for SDN and its data plane operations
- To comprehend the migration of networking functions to SDN environment
- To comprehend the concepts behind network virtualization

UNIT I **SDN: BACKGROUND AND DATA PLANE** 6

Evolving Network Requirements – The SDN Approach – SDN and NFV-Related Standards – SDN Data Plane – OpenFlow Logical Network Device – OpenFlow Protocol

UNIT II **SDN CONTROL PLANE** 6

SDN Control Plane Architecture: Southbound Interface, Northbound Interface – Control Plane Functions – ITU-T Model – Open Daylight – REST – Cooperation and Coordination among Controllers.

UNIT III **SDN APPLICATION PLANE** 6

SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Measurement and Monitoring – Security – Data Center Networking – Mobility and Wireless – Information-centric Networking

UNIT IV **NETWORK FUNCTION VIRTUALIZATION** 6

NFV Concepts – Benefits and Requirements – Reference Architecture – NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV

UNIT V **NETWORK VIRTUALIZATION** 6

Virtual LANs – OpenFlow VLAN Support – Virtual Private Networks – Network Virtualization – Open Daylight's Virtual Tenant Network – Co Software-Defined Infrastructure

30 PERIODS

PRACTICAL EXERCISES:

1. Installing Mininet simulator
2. Creating a 1 controller, 3 node topology, POX controller
3. Ability to view, read/write Flow table rules (for different applications - say firewall, Learning switch etc.), POX, Open vSwitch
4. Building a SDN based application
5. Renaissance of self-stabilizing control plane.

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30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud", Pearson Education, 1st Edition, 2015
2 Thomas D Nadeau, Ken Gray, "SDN: Software Defined Networks", O'Reilly Media, 2013.

REFERENCES:

1 Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", 1st Edition, CRC Press, 2014
2 Paul Goransson, Chuck Black Timothy Culver, "Software Defined Networks: A Comprehensive Approach", 2nd Edition, Morgan Kaufmann Press, 2016.
3 Oswald Coker, Siamak Azodolmolky, "Software-Defined Networking with OpenFlow", 2nd Edition, O'Reilly Media, 2017.

ONLINE RESOURCES

1 http://digimat.in/nptel/courses/video/108107107
2 https://www.coursera.org/learn/sdnetworking
3 https://dokumen.pub/an-introduction-to-5g-wireless-networks-technology-concepts-and-use-cases-9798643303107.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the motivation behind SDN and its data plane
CO2 Describe functions of control plane
CO3 Apply SDN to networking applications
CO4 Apply various operations of network function virtualization
CO5 Explain various use cases of SD

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	3	2	-	2	2	2	-	3	2	1
CO2	2	2	1	1	2	2	-	2	2	2	-	3	2	1
CO3	3	2	1	2	1	2	-	2	2	2	-	3	2	1
CO4	3	2	1	2	2	1	-	2	2	2	-	2	2	1
CO5	2	2	1	1	2	1	-	2	2	2	-	2	2	1

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U23PEEC47 **MASSIVE MIMO NETWORKS** L T P C

2 0 2 3

Prerequisites: **Communication Systems**

COURSE OBJECTIVES:

- To gain knowledge about massive MIMO networks.
- To understand the massive MIMO propagation channels
- To comprehend the concepts of massive MIMO deployment in the context of single cell and multi cell deployment.

UNIT I **MASSIVE MIMO NETWORKS** 6

Definition of Massive MIMO, Correlated Rayleigh Fading, System Model for Uplink and Downlink, Basic Impact of Spatial Channel Correlation, Channel Hardening and Favorable Propagation, Local Scattering Spatial Correlation Model.

UNIT II **THE MASSIVE MIMO PROPAGATION CHANNEL** 6

Favourable Propagation and Deterministic Channels-Capacity Upper Bound-Distance from Favourable Propagation-Favourable Propagation and Linear Processing-Singular Values and Favorable Propagation, Favourable Propagation and Random Channels-Independent Rayleigh Fading-Uniformly Random Line-of-Sight (UR-LoS)-Independent Rayleigh Fading versus UR-LoS - Finite-Dimensional Channels.

UNIT III **SINGLE-CELL SYSTEMS** 6

Uplink Pilots and Channel Estimation - Orthogonal Pilots- De-Spreading of the Received Pilot Signal-MMSE Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission-Linear Precoding-Zero-Forcing-Maximum-Ratio, Discussion- Interpretation of the Effective SINR Expressions-Implications for Power Control-Scaling Laws and Upper Bounds on the SINR - Near-Optimality of Linear Processing when M >> K - Net Spectral Efficiency - Limiting Factors: Number of Antennas and Mobility.

UNIT IV **MULTI-CELL SYSTEMS** 6

Uplink Pilots and Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission -Zero-Forcing - Maximum-Ratio, Discussion -Asymptotic Limits with Infinite Numbers of Base Station Antennas - The Effects of Pilot Contamination - Non-Synchronous Pilot Interference.

UNIT V **CASE STUDIES** 6

Single-Cell Deployment Example: Fixed Broadband Access in Rural Area, Multi-Cell Deployment: Preliminaries and Algorithms, Multi-Cell Deployment Examples: Mobile Access - Dense Urban Scenario - Suburban Scenario - Minimum Per-Terminal Throughput Performance – Additional Observations - Comparison of Power Control Policies.

30 PERIODS

PRACTICAL EXERCISES:

Implement the following using MATLAB

1 Massive MIMO hybrid beamforming
2 Single cell massive MIMO downlink communications

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3 Multicell massive MIMO downlink communications.
4 Precoding in massive MIMO single cell and multicell downlink communications
5 Channel estimation in massive MIMO system

30 PERIODS
TOTAL: 60 PERIODS

TEXT BOOKS:

1 Thomas L Marzetta, Erik G Larsson, Hong Yang, Hien Quoc Ngo, "Fundamentals of Massive MIMO", Cambridge University Press, 2016.
2 Emil Björnson, Jakob Hoydis, Luca Sanguinetti, "Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency", Foundations and Trends, 2017.

REFERENCES:

1 Long Zhao, Hui Zhao, Kan Zheng, "Wei Xiang Massive MIMO in 5G Networks: Selected Applications", Springer 2018.
2 Leibo Liu, Guiqiang Peng, Shaojun Wei, "Massive MIMO Detection Algorithm and VLSI Architecture", Springer 2019.
3 Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai, "mmWave Massive MIMO A Paradigm for 5G", Elsevier, 2017

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_ee65/preview
2 https://www.coursera.org/learn/5g-network-fundamentals
3 https://www.shiksha.com/online-courses/foundations-of-advanced-wireless-communication-course-courl5442

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain massive MIMO networks
CO2 Analyze massive MIMO propagation channels and their capacity bounds
CO3 Analyze channel estimation techniques for single cell system.
CO4 Analyze channel estimation techniques for multi cell system.
CO5 Explain the concepts underlining the deployment of single and multi-cell massive MIMO system

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	-	-	2	2	2	-	1	2	1
CO2	3	3	1	2	2	-	-	2	2	2	-	1	2	1
CO3	3	3	1	2	2	-	-	2	2	2	-	1	2	1
CO4	3	3	1	2	2	-	-	2	2	2	-	1	2	1
CO5	2	2	1	1	2	-	-	2	2	2	-	1	2	1

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U23PEEC48	HIGH PERFORMANCE COMPUTER NETWORKS	L	T	P	C
		3	0	0	3

Prerequisites: Communication Systems

COURSE OBJECTIVES:

- To ensure a comprehensive understanding of high speed computer network architectures.
- To study mathematical models related to network performance analysis.
- To focus on current and emerging networking Technologies.

UNIT I **SWITCHING NETWORKS** **9**

Switching – Packet switching - Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched – SONET, DWDM, DSL, Intelligent Networks – CATV, ATM – Features, Addressing Signalling & Routing, Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM.

UNIT II **MULTIMEDIA NETWORKING APPLICATIONS** **9**

Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP – differentiated services.

UNIT III **ADVANCED NETWORKS CONCEPTS** **9**

VPN-Remote – Access VPN, site-to-site VPN, Tunnelling to PPP, Security in VPN, MPLS – operation, Routing, Tunnelling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networks – P2P connections, IPv4 vs. v6.

UNIT IV **PACKET QUEUES AND DELAY ANALYSIS** **9**

Littles theorem, Birth and Death process, queueing discipline – Control & stability, Markovian FIFO queueing system, Non-markovian – Pollaczek-Khinchin formula and M/G/1, M/D/1, self-similar models and Batch-arrival model, Networks of Queues – Burke's theorem and Jackson Theorem.

UNIT V **NETWORK SECURITY AND MANAGEMENT** **9**

Principles of cryptography – Elliptic-AES- Authentication – integrity – key distribution and certification – Access control and: fire walls – DoS-attacks and counter measures – security in many layers, Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Aunurag Kumar, D Manjunath, Joy Kuri, "Communication Networking", Morgan Kaufmann Publishers, 2011.

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2 Fred Halsall, Lingana Gouda Kulkarni, "Computer Networking and the Internet", 5th Edition, Pearson Education, 2012.

REFERENCES:

1 Jean Walrand, Pravin Varia, "High Performance Communication Networks", 2nd Edition, Morgan Kaufmann Publishers, 2009.

2 William Stallings, "ISDN and Broad band ISDN with Frame Relay and ATM", 4th Edition, Pearson Education, 2009.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=high%20performance%20computing

2 https://onlinecourses.nptel.ac.in/noc23_cs35/preview

3 https://www.classcentral.com/course/swayam-advanced-computer-networks-119393

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the types of switching networks.

CO2 Describe the multimedia applications in networks.

CO3 Comprehend advanced network with reference to MPLS, VPN.

CO4 Analyze performance of network related issues using mathematical models.

CO5 Explain the concepts of network security and management

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	1	2	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1	2	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1	2	1
CO4	3	3	2	2	-	-	-	-	-	-	-	1	2	1
CO5	2	2	1	1	-	-	-	-	-	-	-	1	2]	1

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U23OE101	ALGEBRA AND NUMBER THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the student acquire sound knowledge of groups, rings, fields and polynomials which will be then used to solve the real life problems.
- To make the students to understand the basic concepts in number theory.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and studying in the subject

UNIT I **GROUPS AND RINGS** 9

Groups - Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem. Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

UNIT II **FINITE FIELDS AND POLYNOMIALS** 9

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

UNIT III **DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS** 9

Division algorithm – Base - b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

UNIT IV **DIOPHANTINE EQUATIONS AND CONGRUENCES** 9

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications: Divisibility tests - Modular exponentiation-Chinese remainder theorem – 2 x 2 linear systems.

UNIT V **CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS** 9

Wilson's theorem – Fermat's little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Jordi Guardia, Nicusor Minculete, Diana Savin, Montserrat, "New Frontiers in Number Theory and Applications", 1st Edition, Birkhauser Verlag AG, 2024.
2. Richard Michael Hill, "Introduction to Number Theory", World Scientific Europe Ltd., 2018.

REFERENCES:

1. Steven Howard Weintraub, "An Introduction to Abstract Algebra", World Scientific Publishing Company, 1st Edition, 2022.
2. John Stillwell, "Algebraic Number Theory for Beginners: Following a Path from Euclid to Noether" Cambridge University Press, 2022.

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3. Ian Stewart, David Tall, "Algebraic Number Theory and Fermat's Last Theorem", Taylor and Francis, 4th Edition, CRC Press, 2020.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/111106131
2. https://nptel.ac.in/courses/111101137
3. https://nptel.ac.in/courses/111103020

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the notations and properties of algebraic structures such as groups, rings and fields.
CO2 Analyze the polynomial rings and irreducible polynomials over finite fields.
CO3 Apply the division algorithm and fundamental theorems on prime numbers.
CO4 Apply the congruence relation in number theory to solve the real life problems.
CO5 Analyze the concepts of multiplicative functions and classical theorems.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	3	2	1	2	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	1	-	-	-	1

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U23OE102 **PROBABILITY AND QUEUEING THEORY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts of probability, one and two dimensional random variables, and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in IT fields.
- To understand the concepts and significance of advanced queueing models and apply in engineering.

UNIT I **PROBABILITY AND RANDOM VARIABLES** **9**

Probability – 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.

UNIT II **TWO DIMENSIONAL RANDOM VARIABLES** **9**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables.

UNIT III **RANDOM PROCESSES** **9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

UNIT IV **QUEUEING MODELS** **9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms – Queues with impatient customers: Balking and reneging.

UNIT V **ADVANCED QUEUEING MODELS** **9**

Finite source models - M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/EK/1 as special cases – Series queues – Open Jackson networks.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. S. Venkatarama Krishnan, "Probability and Random Processes", 1st Edition, John Wiley & Sons, 2022.
2. Padma Prithivirajan, "Probability and Queueing Theory", 1st Edition, LAP Lambert Academic Publishing, 2022.

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REFERENCES:

1. Athanasios Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", 5th Edition, Tata McGraw Hill, 2021.
2. Geoffrey Grimmett, David Stirzaker, "Probability and Random Processes", 4th Edition, OUP Oxford, 2020.
3. H A Taha, "Operations Research", 10th Edition, Pearson Education, 2019.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/111103159
2. https://nptel.ac.in/courses/111106150
3. https://nptel.ac.in/courses/111103022

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply the concepts of probability and some standard distributions in real life problems.
CO2 Analyze the concepts of two dimensional random variables.
CO3 Apply the concept of random processes in Engineering disciplines.
CO4 Analyze the various queue models.
CO5 Apply the concepts of series queues and open Jackson networks in real life problems.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	1	-	-	-	1
CO5	3	2	1	2	-	-	-	-	-	-	-	-

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U23OE103	PROBABILITY AND RANDOM PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide necessary basics in probability that are relevant in applications such as random signals and linear systems in communication engineering.
- To understand the concepts of random processes which are widely used in communication networks.
- To understand the concept of correlation, spectral densities and significance of linear systems with random inputs.

UNIT I PROBABILITY AND RANDOM VARIABLES 9

Probability–Discrete and continuous random variables–Moments – Moment generating functions–Joint Distribution–Covariance and Correlation – Transformation of a random variable.

UNIT II RANDOM PROCESSES 9

Classification–Characterization – Cross correlation and Cross covariance functions – Stationary Random Processes – Markov process - Markov chain.

UNIT III SPECIAL RANDOM PROCESSES 9

Bernoulli Process – Gaussian Process – Poisson process – Random telegraph process.

UNIT IV CORRELATION AND SPECTRAL DENSITIES 9

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. S. Venkatarama Krishnan, "Probability and Random Processes", 1st Edition, John Wiley & Sons, 2022.
2. Athanasios Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", 5th Edition, Tata Mc Graw Hill, 2021.

REFERENCES:

1. Geoffrey Grimmett, David Stirzaker, "Probability and Random Processes", 4th Edition, Oxford University Press, 2020.
2. Hossein Pishro-Nik, "Introduction to Probability, Statistics, and Random Processes", Online Edition, Kappa Research, 2023.
3. Sheldon M. Ross, "Introduction to Probability Models", 13th Edition, Academic Press, 2021.

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ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/117/105/117105085/
2. https://ocw.mit.edu/courses/18-440-probability-and-random-variables-spring-2014/
3. https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/pages/part-iii-random-processes/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply one- and two-dimensional random variables in engineering applications.
CO2 Apply the concept random processes in engineering disciplines.
CO3 Apply special random process to model the occurrences of events and the time points.
CO4 Analyze the concept of autocorrelation, cross correlation, power spectral density and its importance in communication Engineering.
CO5 Analyze the response of random inputs to linear time invariant systems.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	1	-	-	-	1
CO2	3	2	1	2	-	-	-	1	-	-	-	1
CO3	3	2	1	2	-	-	-	1	-	-	-	1
CO4	3	3	2	2	-	-	-	1	-	-	-	1
CO5	3	3	2	2	-	-	-	1	-	-	-	1

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U23OE104	LINEAR ALGEBRA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the basic notions of vector spaces which will then be used to solve related problems.
- To understand the concepts of linear transformation, inner product spaces and orthogonalization.
- To utilize numerical methods to determine the eigenvalues of a matrix and execute matrix decomposition.

UNIT I **VECTOR SPACES** **9**

Vector spaces over Real and Complex fields – Subspace – Linear space – Linear independence and dependence – Basis and dimension.

UNIT II **LINEAR TRANSFORMATION** **9**

Linear transformation – Rank space and null space – Rank and nullity – Dimension theorem.

UNIT III **MATRIX REPRESENTATION OF LINEAR TRANSFORMATION** **9**

Matrix representation of linear transformation – Eigenvalues and eigenvectors of linear transformation –Diagonalization.

UNIT IV **INNER PRODUCT SPACES** **9**

Inner product and norms – Properties – Orthogonal, Orthonormal vectors – Gram Schmidt orthonormalization process – Least square approximation.

UNIT V **EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION** **9**

Eigen value Problems: Power method, Jacobi rotation method – Singular value decomposition – QR decomposition.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. David C Lay, Steven R Lay, Judi J McDonald, "Linear Algebra and Its Applications", 6th Edition, Pearson Education, 2021.
2. Kenneth Hoffman, Ray Kunze, "Linear Algebra", 2nd Edition Reprint, Pearson Education, 2023.

REFERENCES:

1. Gilbert Strang, "Linear Algebra and Its Applications", 5th Edition, Cengage Learning, 2020.
2. Stephen H Friedberg, Arnold J Insel, Lawrence E Spence, "Linear Algebra", 4th Edition, Pearson Education, 2020.
3. Serge Lang, "Introduction to Linear Algebra", Revised Edition 2nd, Springer, 2021.

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ONLINE RESOURCES:

1. https://www.coursera.org/learn/introduction-to-linear-algebra
2. https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/
3. https://onlinecourses.nptel.ac.in/noc22_ma45/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Solve system of linear equations and test the consistency.
CO2 Analyze the basis and dimension of vector space.
CO3 Solve linear transformation and its matrix representation.
CO4 Solve orthonormal basis of inner product space and find least square approximation.
CO5 Evaluate the eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	1	-	-	-	1
CO2	3	3	2	2	-	-	-	-	-	-	-	1
CO3	3	2	1	1	-	-	-	1	-	-	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1
CO5	3	3	2	3	-	-	-	1	-	-	-	1

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U23OE105	EVERYDAY PHYSICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop knowledge in the basic concepts of physics.
- To understand the application of Physics in everyday life.
- To know how the applications show impact in everyday life.

UNIT I **MECHANICS AND HEAT** **9**

Force – weight – work – energy – power – horsepower – centrifuge – washing machine – variation of boiling point with pressure – pressure cooker – cooling by expansion – refrigerator - air conditioner – Bernoulli principle – Bunsen burner, aero plane.

UNIT II **SOUND AND OPTICS** **9**

Sound waves – Doppler Effect - power of lens – long sight and short sight – microscope – telescope – binocular – camera.

UNIT III **ELECTRICAL AND ELECTRONIC APPLIANCES** **9**

Working of the tube light and fan – kilowatt hour – fuse and heating elements – microwave oven – electric heater – photoelectric effect – video camera.

UNIT IV **GEOPHYSICS AND MEDICAL PHYSICS** **9**

Earthquake – Richter scale – rainfall unit – lightning arrestors – cosmic showers – Coolidge tube – X – rays – ultrasound scan – CAT.

UNIT V **ENERGY SOURCES** **9**

Fission – energy release – principle of nuclear reactor – radiation dosimeter – hazards and protection – solar energy – photovoltaic cell.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. D Halliday, R Rensick, J Walker, "Principles of Physics", 12th Edition , John Wiley & Sons, 2023.
2. P S Hemne, C L Arora, "Physics for B.Sc. students - Optics", S. Chand Publishing, 2022.

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REFERENCES:

1. N Ravi, "The Hindu Speaks on Scientific Facts" (Vol-1)", The Hindu Group, 2024.
2. John Christopher Draper, "A Text-book of Medical Physics", Legare Street Press, 2022.
3. Jahan Singh, "Fundamentals of Nuclear Physics", Pragati Prakashan, 2021.

ONLINE RESOURCES:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
2. http://onlinecourses.nptel.ac.in/
3. https://books.google.com/books/about/An_Introduction_to_Medical_Physics.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the mechanical concepts in various appliances.
CO2 Apply the elementary mechanical concepts in sound and optics.
CO3 Explain the working of electrical and electronic appliances.
CO4 Summarize the basic concepts in Geo Physics and nuclear physics.
CO5 Apply the concepts of nuclear physics and space sciences in our daily life.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	3	2	1	2	-	-	-	-	-	-	-	-

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U23OE106	CONSUMER AWARENESS ON APPLIANCES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquire knowledge of the multiple gadgets and devices.
- To understand difference between products from multiple brands.
- To learn the basics of marketing of gadgets used in daily life.

UNIT I **POWER GADGETS AT HOME AND WORK** 9

The electric power grid – single and three phase connection – UPS – Voltage stabilizers – lighting – energy saving devices and techniques (fluorescent, CFL, LED, solar panels – household equipment: power consumption of devices (electric fan, air conditioner, refrigerator, washing machine).

UNIT II **COMMUNICATION AND ENTERTAINMENT ELECTRONICS** 9

Telephone – Facsimile – Cell phone – Photocopier – Scanner – microphones – CD/DVD/Blu-ray players – portable media players – use of headphones.

UNIT III **PRODUCT INFORMATION** 9

Brand name and brand mark – selection of good brand – Corporate brand and product brand – product guarantee and warranty – standardization – product servicing – after sales services.

UNIT IV **ONLINE RESOURCES** 9

Apps, cloud based resources – e-commerce and productivity tools – access patterns – Comparing products online – choosing websites and online stores – awareness on terms and conditions.

UNIT V **NETWORKING SITES AND SAFETY** 9

Significance of social networking sites, browsers and cookies – email scams – knowledge on complaint procedure and disputes settlement – security issues on payment portals.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Pearson, "Principles of Marketing", 19th Edition, Dimensions, 2023.
2. Jobber and Elli, "Principles and Practices of Marketing", 9th Edition, Tata McGraw Hill, 2020.

REFERENCES:

1. Kleinert Eric, "Troubleshooting and Repairing Major Appliances", 3rd Edition, Atlantic Publishers, 2022.
2. K B Bhatia," Electrical appliances and devices", Khanna Publishers, 2024.
3. Charlie wing, "How Your House Works - A Visual Guide to understanding and Maintaining your Home", John Wiley & Sons, 2023.

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ONLINE RESOURCES:

1. https://www.springer.com/series/13812
2. https://cloud.google.com/learn/training/networking-security
3. https://onlinecourses.nptel.ac.in/noc24_ph17/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the power gadgets and their maintenance.
CO2 Explain the devices used for communication and entertainment.
CO3 Explain the information about multiple brand products to make intelligent purchase decisions.
CO4 Summarize the online resources and awareness about their making policies.
CO5 Describe the significance of social networking sites, knowledge on complaint procedure and security issues.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE107	BIOPHYSICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the knowledge about the physical forces in analysing the human body.
- To identify the necessity of diagnosis and therapy for various devices.
- To appreciate the effects of acoustics and ultrasonic in human body.

UNIT I **PHYSICAL FORCES EXEMPILIFIED IN MAN** 9

Introduction – mechanical forces – osmotic force – electric forces – bioelectric potentials – colloids – inter molecular forces – electromagnetic forces – generalized force.

UNIT II **HEAT ENERGY AND BIO - ENERGETICS** 9

Heat transfer – heat loss by the human body to the ambient air – radioactive heat transfer from the human body – Stefan – Boltzmann law – counter current heat exchange applications to vasculature of the human arm – concept of entropy in biological systems – fundamentals of energy cycle.

UNIT III **WAVES: SOUND AND ULTRASOUND** 9

Absorption – principle mechanism of absorption of matter waves – frictional resistance and elastic reactance of bulk tissue – Weber – Fechner law – physiological effects of intense matter waves and ultrasonic therapy - applications.

UNIT IV **FLUID FLOW** 9

Flow of frictionless fluids: Bernoulli's law – fluid flow in constricted tube – blood flow through a blood vessel with a partial blockage – angioplasty. Flow of viscous fluids: Analogy between fluid flow and electric current flow – fluid friction.

UNIT V **RADIATION** 9

Isotopes as tracers – labeling with isotopes – stable and radioactive isotopes – biological effects of radiation – internal radiation hazards – radiation units – Dosimetry.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. E J Casey, "Biophysics – concepts and mechanism", Alpha Edition, 2021.
2. William C Parke, "Biophysics - A Student Guide to the Physics of the Life Science and Medicine", Springer Nature Switzerland, 2021.

REFERENCES:

1. P Narayanan, " Essentials of Biophysics " 3rd Edition, New Age International Private Limited, 2023.
2. M A Subramanian, "Biophysics Principles and Techniques", MJP Publishers, 2021.
3. Paul Davidovits, "Physics in Biology and Medicine", 5th Edition, Elsevier Science Publishing Co Inc., 2024.

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ONLINE RESOURCES:

1. https://www.fuw.edu.pl/~jantosi/booksonbiophysics/Introduction_of_Biophysics.pdf
2. https://archive.org/details/volkenshtein-biophysics-mir
3. https://ia801307.us.archive.org/29/items/biophysicsconcep00case/biophysicsconcep00case.pdf

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the knowledge about the physical forces exemplified in the human body.
CO2 Explain the importance of heat transfer in human body.
CO3 Describe the principle mechanism of matter waves and applications of ultrasound.
CO4 Apply the various laws of fluid flow in the study of human body.
CO5 Summarize the concepts of acoustic and radiation therapy.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	3	2	1	2	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE108 **ASTROPHYSICS** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To elucidate the nature of the myriad objects and the universe as a whole.
- To understand the structure and the formation of myriad objects.
- To inculcate the ideas of discouraging our galaxies and their formation theories.

UNIT I **OPTICAL ASTRONOMY** 9

Electromagnetic spectrum and astronomical sources - emission and absorption spectra Doppler Effect - units of distances - distance measurements in astronomy stellar distances - Apparent - Absolute, Bolometric magnitudes - Luminosity.

UNIT II **STARS** 9

Spectral classification of stars - H-R diagram: binary and multiple stars visual, astrometry and eclipsing binaries - galactic and globular clusters - Stellar evolution - birth and death of a star - Sun - typical star - Structure of photosphere - sunspots.

UNIT III **MOON** 9

The moon's orbit relative to the earth - moon's distance - moon's phases - sidereal and synodic month - character of moon's surface - lunar eclipse - lunar tides - origin of moon.

UNIT IV **BETWEEN THE PLANETS** 9

Asteroids - meteoroids - meteors - comets - orbits of comets - spectrum of comets - formation of comet's tail.

UNIT V **DISCOVERING OUR GALAXIES** 9

The Milky Way Structural Feature Galaxies - Galaxies and universe: shape of galaxies - distance of galaxies big bang and steady state theory - galactic rotation - cluster of galaxies - cosmology.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. K S Krishna Swamy, "Astrophysics", New Age International Private Limited, 2022.
2. Wolfgang Demtroder, "Astrophysics", Springer, 2023.

REFERENCES:

1. Minn Carleton College, "Astronomy", Legare Street Press, 2023.
2. Camille Flammarion, "Astronomy", Legare Street Press, 2023.
3. Maggie Aderin-Pocock , "The sky at night: The art of stargazing", BBC books, 2023.

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Y6599yfrONLINE RESOURCES:

1. https://www.uu.edu/societies/inklings/books/scienceandfaith/Chapter4.pdf
2. https://www.britannica.com/science/stellar-classification
3. https://openstax.org/books/astronomy-2e/pages/5-6-the-doppler-effect

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply physics principles to the interpretation of a broad range of astrophysical Observations.

CO2 Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories.

CO3 Summarize the basic properties of the Sun.

CO4 Describe the features of objects in the Solar System, giving details of similarities and differences between these objects.

CO5 Describe the main features of formation theories of various types of observed galaxies.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE109	INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain about nanomaterials, their importance and their dimensions.
- To study about the synthetic methods of nanomaterials.
- To develop skills about the structure, function and application of nanomaterials.

UNIT I **INTRODUCTION** 9

Nanoscale Science and Technology- Introduction, Classifications of nanostructured materials - nano particles- quantum dots, nanowires ultra-thinfilms-multi layered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

UNIT II **GENERAL METHODS OF PREPARATION** 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, Sputtering, Evaporation, Molecular Beam Epitaxy, Electrochemical deposition.

UNIT III **NANOMATERIALS** 9

Nanometal oxides-ZnO, TiO2, MgO, ZrO2, NiO, nano alumina, CaO, AgTiO2, Ferrites, Quantum wires, Quantum dots. Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- Synthesis, structure-property Relationships and applications, Nanocomposites – FRP synthesis, property and its application.

UNIT IV **CHARACTERIZATION TECHNIQUES** 9

Xray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques, AFM, SPM, STM, SNOM, ESCA, SIMS.

UNIT V **APPLICATIONS** 9

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechnology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)-Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products - In Photostat, printing, solar cell, battery.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1. R L Snyder, R W Kelsall, D L Jones, "Nanotechnology: A Hands-On Approach", 2nd Edition , John Wiley & Sons, 2023.
2. M C Roco, W S Bainbridge, B E Tonn, G M Whitesides, "Nanotechnology Research Directions for Societal Needs in 2025", Springer, 2024.

REFERENCES:

1. C Binns, "Introduction to Nanoscience and Nanotechnology", 2nd Edition, Wiley- Blackwell, 2021.
2. T Pradeep, "Atomically Precise Metal Nanoclusters", Elsevier, 2022.
3. C Anandharamakrishnan, "3D Printing of Foods", John Wiley & Sons, 2024.

ONLINE RESOURCES:

1. https://www.classcentral.com/course/electronics-purdue-university-fundamentals-of-nan-40243
2. https://www.classcentral.com/course/swayam-chemistry-of-nanomaterials-269673.
3. https://www.classcentral.com/course/introduction-to-the-modern-nanotechnology-22238.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the basic concepts of Nanoscience and Nanotechnology and their impact in various fields, types of nanomaterials, dimensions and their properties.

CO2 Summarize the various techniques involved in synthesizing nanomaterials for engineering and technology applications.

CO3 Describe the various forms of nanomaterials with their structure- property relationship and applications.

CO4 Explain the structure of nanomaterials using various characterization techniques.

CO5 Analyse the application of nano materials in medical, electronic and engineering fields.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	1	-	-	-	-	1
CO2	2	2	1	1	-	-	1	-	-	-	-	1
CO3	2	2	1	1	-	-	1	-	-	-	-	1
CO4	2	2	1	1	-	-	1	-	-	-	-	1
CO5	3	3	2	2	-	-	1	-	-	-	-	1

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U23OE110	GREEN TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts of green technology through understanding the basics of eco-system and Biodiversity.
- To learn different types of environmental acts and analyse the green tax incentives, rebates, business redesign and its models.
- To extend knowledge of the importance of life cycle assessment.

UNIT I **INTRODUCTION** 9

The concept of green technology – its origin and historical evolution – nature, scope, significance, and multi-disciplinary approaches – classification of green technologies (e.g., clean energy, sustainable materials, carbon capture) – developing theoretical frameworks to understand green innovation – green technology initiatives and policies in India.

UNIT II **SUSTAINABILITY AND ENVIRONMENT** 9

Organizational environment - internal and external environment - Indian corporate structure and environment - how to go green - spread the concept in organization - environmental and sustainability issues.

UNIT III **ECOSYSTEM ECONOMICS** 9

Approaches - ecological economics - indicators of sustainability - ecosystem services and their sustainable use; bio-diversity - Indian perspective - alternate theories - Steady-state economics – circular economy.

UNIT IV **LAWS OF GREEN TECHNOLOGY** 9

Laws - Environmental reporting standards and compliance mechanisms – ISO 14001 - green finance - financial initiative by United Nations Environment Programme (UNEP). Environmental Management Systems – principles, certification process, and organizational impact – ISO 14064.

UNIT V **GREEN ECONOMICS** 9

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.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. WIPO, "Green Technology Book: Solutions for Climate Change Mitigation", 2nd Edition, World Intellectual Property Organization, 2023.
2. S J Arceivala, "Green Technologies", 1st Edition, Tata McGraw Hill, 2023.

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REFERENCES:

1. P Oksen, "Green Technology Book: Solutions for Climate Change Adaptation", 1st Edition, World Intellectual Property Organization, 2022.
2. A Kumar, S Singh, 'Renewable Energy and Green Technology: Principles and Practices", Routledge, 2023.
3. M N O Sadiku, "Emerging Green Technologies" CRC Press, 2022.

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/105/102/105102195/
2. https://onlinecourses.nptel.ac.in/noc20_ce57/preview
3. https://archive.nptel.ac.in/courses/105/107/105107176/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the concepts of green technologies in a project.

CO2 Explain the importance of environment and sustainability and their classes and issues.

CO3 Apply Eco-system concepts for sustainable.

CO4 Explain the Environmental laws and regulations for green technology.

CO5 Apply the green tax incentives and rebates and Eco-commerce models for greener economics.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	2	-	-	-	1	1
CO2	2	2	1	1	-	-	2	-	-	-	1	1
CO3	3	2	1	2	-	-	2	-	-	-	1	1
CO4	2	2	1	1	-	-	2	1	-	-	1	1
CO5	3	2	1	2	-	-	2	-	-	-	1	1

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U23OE111	THE ENVIRONMENT AND SOCIETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the complexity of environmental and social impacts of industry.
- To analyze about personal responsibilities and roles in environmental and social problems.
- To acquire new ideas for better integrating industry, environment, and equity.

UNIT I ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY 9

Introduction to Environment- Ecosystem and its types- Biodiversity- Types of biodiversity. Importance of biodiversity-Loss of Biodiversity- Conservation of Biodiversity.

UNIT II ENVIRONMENT AND THE HUMAN INTERACTION 9

Types of Anthropogenic Activities-Anthropogenic Activities and Their Impacts on the Environment-Ways to Mitigate the Negative Impacts of Anthropogenic Activities on the Environment-Mitigation Measures for Anthropogenic Impacts.

UNIT III ISSUES IN ENVIRONMENTALISM 9

Significant global environmental issues such as acid rain, climate change, and resource depletion; historical developments in cultural, social and economic issues related to land, forest, and water management in a global context; interface between environment and society.

UNIT IV THREATS TO ENVIRONMENT 9

Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs).

UNIT V ENVIRONMENT AND SUSTAINABLE DEVELOPMENT 9

Causes and effects of Depletion of Natural Resources - Impact of environmental degradation-Need for Sustainable development, Strategies for Achieving Sustainability, Sustainable Development in India, Role of Individuals and Communities.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1. A Sabban, "Advances in Green Electronics Technologies in 2023", 1st Edition, IntechOpen, 2023.
2. R Dogra, "Renewable Energy and Green Technology", 1st Edition; Brillion Publishing, 2023.

REFERENCES:

1. P Robbins, L Hintz, M Moore, "Environment and Society: A Critical Introduction", 3rd Edition, Wiley- Blackwell, 2022.
2. P Frankopan, "The Earth Transformed: An Untold History. Allen Lane", Bloomsbury publisher, 2023.
3. M A Ali, M Kamraju, "Natural Resources and Society: Understanding the Complex Relationship Between Humans and the Environment" Springer Cham, 2023.

ONLINE RESOURCES:

1. http://www.who.int/topics/environmental_pollution/en/
2. http://edugreen.teri.res.in/explore/explore.htm
3. https://onlinecourses.swayam2.ac.in/nou20_ag12/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the environment ecosystem, importance of biodiversity and its conservation.

CO2 Analyze the various anthropogenic activities, its impact on environment and mitigation measures.

CO3 Describe the various global environmental issues.

CO4 Analyse the ecological degradation, environmental pollution issues owing to developmental activities.

CO5 Apply the green tax incentives and rebates and Eco-commerce models for greener economics.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	2	3	-	2	-	-	2
CO2	3	3	2	2	-	2	3	-	2	-	-	2
CO3	2	2	1	1	-	2	3	-	2	-	-	2
CO4	3	3	2	2	-	2	3	-	2	-	-	2
CO5	3	2	1	2	-	2	3	-	2	-	-	2

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U23OE112	INDUSTRIAL CORROSION AND PREVENTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart Knowledge on fundamental concepts of corrosion.
- To know the various types of corrosion.
- To create corrosion prevention plans in various industries.

UNIT I INTRODUCTION TO CORROSION 9

Introduction and importance, Forms of corrosion - uniform corrosion, pitting, crevice corrosion, inter granular corrosion, stress corrosion cracking and prevention of corrosion.

UNIT II CORROSION CONTROL IN POWER INDUSTRIES 9

Introduction, Frequent forms of corrosion, environment, case studies and prevention methodology and corrosion resistance materials.

UNIT III CORROSION CONTROL IN PETROCHEMICAL INDUSTRIES 9

Introduction, regular forms of corrosion, environment, case studies, prevention strategies – inhibitors and surface engineering - corrosion resistance materials

UNIT IV CORROSION CONTROL IN MARINE INDUSTRIES 9

Introduction, Metallurgical properties influencing corrosion. Common forms of corrosion, environment, Passivity – design of corrosion resistant alloys, case studies, and corrosion resistance materials.

UNIT V CORROSION CONTROL IN FERTILIZER INDUSTRIES 9

Introduction, frequent forms of corrosion, environment, case studies and corrosion resistance materials.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mars G Fontana, "Corrosion Engineering", 3rd Edition, Tata McGraw Hill, 2019.
2. D B David, M Bastidas David, "Corrosion and protection of Metals", Metals, 2020.

REFERENCES:

1. Savas Kaya, Ime Bassey Obot, Demet Özkir, Goncagül Serdaroglu, Ambrish Singh, "Corrosion Science: Theoretical and Practical Applications", Apple Academic Press, 2024.

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2. E J David, Talbot D R James, Talbot, "Corrosion Science and Technology", CRC Press, 2020.
3. E I Younes, Kacimi, Savas Kaya, Rachid Touir, "New Challenges and Industrial Applications for Corrosion Prevention and Control", IGI Global, 2020.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/113108051
2. https://www.corrosionclinic.com/corrosion_courses/corrosion_control_prevention_5-day.htm
3. https://www.ampp.org/technical-research/what-is-corrosion/corrosion-reference-library

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the basic principles of corrosion and its types.

CO2 Explain about corrosion damage in the power, petroleum, marine, and fertilizer industries.

CO3 Analyze the corrosion prevention techniques in the industries.

CO4 Summarize theory behind the fabrication of a corrosion-resistant alloy.

CO5 Explain the causes and remedies for corrosion

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	1
CO2	2	2	1	1	-	-	1	-	-	-	-	1
CO3	3	3	2	2	-	-	1	-	-	-	-	1
CO4	2	2	1	1	-	-	1	-	-	-	-	1
CO5	2	2	1	1	-	-	1	-	-	-	-	1

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U23OE113 **ENGLISH THROUGH MEDIA** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enhance students' ability to read & write efficiently while developing information ethically.
- To cultivate students' proficiency in developing listening, thinking, advertising & persuasive writing.
- To equip their proficiency with phonetics, accents, group discussions in real life situations as well as visual and verbal media.

UNIT I **READING AND WRITING SKILLS** 9

Reading for information – Skimming & Scanning; Importance of Language: Subjective & Objective Language. Writing – Use of Language to manipulate information; writing feature stories – Presentation and Structure.

UNIT II **LISTENING AND INTERVIEWING SKILLS** 9

Listening to talks – conversational strategies. Interviewing Skills – Agreeing and Disagreeing – Asserting and Negotiating.

UNIT III **REPORTING SKILLS – ORAL AND WRITTEN** 9

Critical Thinking: Problem Solving Skills –conversation Etiquette – Politeness Strategies. Online Writing: Netiquette – Analytical report, Brevity in advertising, persuasive writing.

UNIT IV **PRESENTATION SKILLS** 9

Purpose and features of presentation – Narrating Consumer Oriented Marketing of products, Group Discussion on culture, tradition, values.

UNIT V **ANALYZING AND EVALUATING SKILLS** 9

Vocabulary – Collocations & Slangs – Referencing – welcoming, conducting Programmes. Reviewing & Commenting – Expressing through visual & verbal media – Authentic conversation based on real – life situations.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "English for Engineers & Technologists", 2020 Edition, Orient Blackswan Private Ltd., 2020.
2. Veena Selvam, Sujatha Priyadarshini, Deepa Mary Francis, K N Shoba , Lourdes Joevani, "English for Science & Technology", Cambridge University Press, 2021.

REFERENCES:

1. James Curran, Joanna Redden, "Understanding Media: Communication, Power and Social Chang", Pelican Publishing, 2024.
2. Soma Mahesh Kumar, "Soft Skills: Enhanching Personal and Professional Success", 1st Edition, Tata McGraw Hill, 2023.
3. Rodney H Jones, Sylvia Jaworska, "Erhan Aslan; Language and Media- A Resource Book for Students", e-book, Routledge, 2020.

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ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20hs32/preview
2. https://www.coursera.org/learn/working-with-the-media
3. https://www.udemy.com/course/political-candidate-media-and-public-speaking-training/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply reading and writing skills by exploring the language used in media.
CO2 Apply listening skills to communicate effectively in their area of specialization.
CO3 Apply soft skills in both oral and written communication.
CO4 Apply speaking skills in a variety of mediums including live communication.
CO5 Analyze different types of texts in different media like online, print, and social media.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	2	-	2	-	-
CO2	3	-	-	-	-	-	-	2	-	2	-	-
CO3	3	-	-	-	-	-	-	2	-	2	-	-
CO4	3	-	-	-	-	-	-	2	-	2	-	-
CO5	1	-	-	-	-	-	-	2	-	2	-	-

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U23OE114 **ENGLISH FOR EMPLOYABILITY SKILLS** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the students to skills necessary for getting, keeping and being successful in a profession.
- To understand the importance of communication and enhance self-confidence.
- To develop and nurture the Employability skills of the students through individual and group activities.

UNIT I **COMMUNICATION SKILLS** 9

Communication: An Introduction; Formal and Informal English; Description, Narration and Demonstration; Methods of Communication, Verbal Communication, Non-verbal Communication; Importance of feedbacks, Basics of Effective Communication; Writing Skills - Parts of Speech and Sentences; Soft Skills for Employers and Employees.

UNIT II **RESUME WRITING** 9

Resume, Curriculum vitae, how to develop an impressive resume, Different formats of resume – Chronological, Functional, Hybrid, Job application or cover letter.

UNIT III **PRESENTATION SKILLS** 9

Presentation Techniques – Time Management Techniques – Body language – Managerial Skills –Making Effective Presentation, Professional presentation- planning, preparing and delivering presentation.

UNIT IV **GROUP DISCUSSION AND PUBLIC SPEAKING** 9

Introduction to Group Discussion – Understanding Group Dynamics – Group Discussion Strategies–Activities to Improve GD Skills – Public Speaking Techniques – Public Speaking Activities.

UNIT V **INTERVIEW SKILLS** 9

Listening to Interviews; Types of Interviews; Preparation for the Interview – Interview Techniques and Etiquettes – Mock Interview – Online Interview Techniques.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Prashant Sharma, "Soft Skills: Personality Development for Life Success", 1st Edition, BPB Publications, 2022.

2 Rajendran, Jayanthi, Jeya Santhi V, Nagalakshmi B, "The Art of English Communication: A Practical Approach", Notionpress.com, 2025.

REFERENCES:

1. Grant, Adam. "Think Again: The Power of Knowing What You Don't Know", Penguin Random House, 2021.
2. Harrison, Ryan. "How To Talk To Anybody: 14 Speaking Techniques To Instantly Connect with Anyone", LearnWell Books, 2022.
3. Gloria J Galanes, Katherine Adams, Carrisa S Hoelscher, Stephen A Spates, "Effective Group Discussion: Theory and Practice", Tata McGraw Hill, 2023.

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ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_hs15/preview
2. https://www.coursera.org/learn/verbal-communications-and-presentation-skills
3. The Complete Guide to Resume Formats: Chronological, Functional, and Hybrid | UseResume.ai

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

- **CO1** Apply Employment Skills In Their Environment
- **CO2** Write Resume Writing & Job Application.
- **CO3** Apply The Fundamental Inputs Of Communication Skills In Making Speech Delivery.
- **CO4** Apply Various Group Discussion Skills To Take Part In Effective Discussions In A Professional Context.
- **CO5** Analyze Various Interview Formats For Job Interviews.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	3	3	3	-	1
CO2	3	-	-	-	-	-	-	3	3	3	-	1
CO3	3	-	-	-	-	-	-	3	3	3	-	1
CO4	3	-	-	-	-	-	-	3	3	3	-	1
CO5	3	-	-	-	-	-	-	3	3	3	-	1

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U23OE115 **INVENTIONS AND APPLICATIONS** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To analyse the engineering principles underlying major scientific inventions and their technological evolution.
- To apply scientific inventions in solving real-world engineering problems.
- To design innovative, sustainable, and ethical engineering solutions inspired by emerging technologies.

UNIT I FOUNDATIONS OF INVENTION AND INNOVATION 9

Definition and scope of invention vs. discovery – Drivers of scientific progress – Case studies of transformative inventions (printing press, steam engine, electricity, semiconductor devices) – Innovation models: TRIZ, disruptive innovation, and design thinking – Intellectual property rights and patents.

UNIT II COMMUNICATION AND INFORMATION TECHNOLOGY 9

Evolution of telecommunication systems – From telegraph to 5G networks – Internet architecture, cloud computing, IoT, AI, machine learning, and quantum computing – Applications in governance, smart cities, and cyber-physical systems – Limitations and challenges in scalability and security.

UNIT III ENERGY AND TRANSPORTATION SYSTEMS 9

Engineering design of combustion engines, power plants, and aerodynamics of flight – Advancements in electric vehicles, high-speed rail, and autonomous transport – Renewable energy technologies: photovoltaic cells, wind turbines, hydrogen fuel cells, bioenergy – Integration into smart grids – Case studies on sustainable energy transitions.

UNIT IV INVENTIONS IN MEDICINE AND BIOTECHNOLOGY 9

Medical imaging innovations (X-ray, MRI, PET, CT) – Engineering of biomedical devices, artificial organs, prosthetics, and implants – Nanomaterials in drug delivery and diagnostics – Genetic engineering, CRISPR, and synthetic biology – Role of AI and big data in precision healthcare.

UNIT V FRONTIER TECHNOLOGIES AND ETHICAL DIMENSIONS 9

3D printing and additive manufacturing – Robotics and autonomous systems – Space exploration technologies (rocketry, satellites, reusable launch systems) – Environmental engineering innovations (carbon capture, water purification, climate engineering) – Ethical, social, and sustainability considerations of emerging technologies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Vasant Gowariker, Science and Technology for Sustainable Development in India, 1st Edition, Sage Publications, 2020.
2. Rakesh Rathi, Nanotechnology and Smart Materials: Recent Advances and Applications, 1st Edition, CRC Press, 2021.

REFERENCES:

1. Cristiano Antonelli, Innovation and Technological Change: An Evolutionary Perspective, 2nd Edition, Routledge, 2020.
2. Pradeep Fulay and Mohammad Islam, Materials Science and Engineering: An Introduction to Concepts, 2nd Edition, CRC Press, 2021.
3. Debmalya Barh (Ed.), Genomic and Precision Medicine: Engineering and Applications, Academic Press, Elsevier, 2020.

ONLINE RESOURCES:

1. https://www.technologyreview.com
2. https://technology.nasa.gov
3. https://spectrum.ieee.org

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyse the principles and historical context of major inventions and innovations.

CO2 Evaluate the engineering design and technological basis of inventions across domains.

CO3 Apply scientific principles to assess the efficiency, scalability, and limitations of technologies.

CO4 Design innovative solutions by integrating interdisciplinary knowledge from engineering and science.

CO5 Critically assess ethical, environmental, and societal implications of emerging technologies.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	2	-		1	-	2	-
CO2	3	3	2	3	2	2	-		2	-	2	-
CO3	3	2	1	2	2	2	2		2	-	2	-
CO4	3	3	3	3	2	2	2		3	-	2	-
CO5	3	3	2	3	2	2	2		2	-	2	-

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U23OE116	PUBLIC POLICY AND GOVERNANCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart Knowledge on public policy-making processes and governance structures.
- To know the role of government institutions, stakeholders, and societal actors in shaping public policies.
- To explore the cchallenges and opportunities for global policy cooperation.

UNIT I INTRODUCTION TO PUBLIC POLICY AND GOVERNANCE 9

Public Policy - Definition and scope, Theories of policy-making (e.g., rational choice, incrementalism, advocacy coalition framework), Models of governance (e.g., hierarchical, network, collaborative)

UNIT II POLICY ANALYSIS AND EVALUATION 9

Policy analysis - Methods and tools for policy analysis (e.g., cost-benefit analysis, policy modeling, stakeholder analysis) Criteria for evaluating policy effectiveness, efficiency, and equity Case studies of policy success and failure.

UNIT III ACTORS AND INSTITUTIONS IN PUBLIC POLICY 9

Role of government agencies, legislatures, and courts in policy-making Influence of interest groups, advocacy coalitions, and the media on policy agendas Comparative analysis of governance structures and processes in different political systems.

UNIT IV POLICY IMPLEMENTATION AND MANAGEMENT 9

Challenges and strategies in policy implementation - the role of public administration, bureaucracies, and public-private partnerships tools for monitoring, evaluation, and adaptive management of policies.

UNIT V POLICY ISSUES AND CONTEMPORARY CHALLENGES 9

Current debates and controversies in public policy (e.g., healthcare reform, climate change, immigration) Emerging policy issues (e.g., digital governance, artificial intelligence, global pandemics)

TOTAL: 45 PERIODS

TEXT BOOKS:

1. James A. Stimson, Michael B. Macken, and Robert S. Erikson, Dynamic Representation: Policy, Public Opinion, and Democracy, 2nd Edition, Cambridge University Press, 2022.
2. Thomas R. Dye., "Understanding Public Policy", 15th Edition, Pearson Publishing Co., 2021.

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REFERENCES:

1. Christopher M. Weible and Paul A. Sabatier (Eds.), Theories of the Policy Process, 5th Edition, Routledge, 2022.
2. Michael E. Kraft and Scott R. Furlong., "Public Policy: Politics, Analysis, and Alternatives", 6th Edition, CQ Press, 2020.
3. B. Guy Peters, Advanced Introduction to Public Policy, 2nd Edition, Edward Elgar Publishing, 2021.

ONLINE RESOURCES:

1. https://www.brookings.edu
2. https://www.rand.org/topics/public-sector-governance.html
3. https://www.pewresearch.org/topic/politics-policy

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Understand the concepts and theories of public policy and governance.

CO2 Analyze the interplay between government, civil society, and the private sector in policymaking processes.

CO3 Evaluate the impact of public policies on different stakeholders and societal outcomes.

CO4 Develop skills in policy analysis, advocacy, and stakeholder engagement.

CO5 Apply theoretical frameworks to real-world policy issues and case studies. Understand the concepts and theories of public policy and governance.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	2	-	2	2	-	2	-
CO2	3	3	2	2	-	2	-	2	2	-	2	-
CO3	3	3	2	3	-	2	-	2	2	-	2	-
CO4	3	3	3	3	-	2	-	2	2	-	2	-
CO5	3	2	1	2	-	2	-	2	2	-	2	-

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U23OE122 FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand a comprehensive overview of Electric and Hybrid Electric Vehicles.
- To understand about different aspects of drive train topologies and components in HV & EV.
- To understand and advance in battery management and case studies.

UNIT I INTRODUCTION TO HYBRID ELECTRIC VEHICLES 9

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, the impact of modern drive-trains on energy supplies, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on the environment of EV and HV technology, disposal of battery cell and hazardous material and their impact on the environment.

UNIT II BASIC CONCEPT OF HYBRID TRACTION 9

Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, braking fundamentals and regenerative braking in EVs.

UNIT III ELECTRIC COMPONENTS USED IN HYBRID AND ELECTRIC VEHICLES 9

Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor Drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT IV POWER MANAGEMENT AND ENERGY SOURCES OF EV & HV 9

Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery based energy storage and simplified models of battery, Battery Management Systems (BMS), fuel cells, their characteristics and simplified models, Super capacitor based energy storage, its analysis and simplified models, flywheels and their modelling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology.

UNIT V APPLICATIONS OF EV & HV 9

Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV), Electric Vehicle Adoption in Urban Mobility, Electric Vehicle Integration with Renewable Energy

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 2nd Edition, CRC Press, 2011.
2. Chris Mi, M Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", 1st Edition, John Wiley &Sons, 2011.

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3. Lino Guzzella, Antonio Sciarretta, Modern Electric, "Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Edition, CRC Press, 2009.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Explain about the social and environmental significance, and impact of modern hybrid and electric vehicle

CO2 Describe Enhanced EV performance through diverse drives, efficiency analysis, and regenerative braking.

CO3 Explain the Improved efficiency and control in various motor drive configurations enhance performance.

CO4 Summarize on Efficient power management, battery technology understanding, and storage selection optimization

CO5 Explain about the Efficient vehicle designs, urban mobility, and renewable energy integration optimization.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	1	-	-	-	-	1
CO2	2	2	1	1	-	-	1	-	-	-	-	1
CO3	2	2	1	1	-	-	1	-	-	-	-	1
CO4	2	2	1	1	-	-	1	-	-	-	-	1
CO5	2	2	1	1	-	-	1	-	-	-	-	1

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U23OE123	INTRODUCTION TO PLC PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand basic PLC terminologies, digital principles, PLC architecture.
- Familiarize different programming languages of PLC.
- Develop PLC logic for simple applications using ladder logic

UNIT I **INTRODUCTION TO PLC** **9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC - PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

UNIT II **PLC INSTRUCTIONS** **9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays- Interlock examples- Timers, Counters, Examples.

UNIT III **PLC PROGRAMMING** **9**

Introduction to the Concept of IoT Devices – IoT Devices Versus Computers – IoT Configurations – Basic Components – Introduction to Arduino – Types of Arduino – Arduino Toolchain – Arduino Programming Structure – Sketches – Pins – Input/Output From Pins Using Sketches – Introduction to Arduino Shields – Integration of Sensors and Actuators with Arduino.

UNIT IV **COMMUNICATION OF PLC AND SCADA** **9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures.

UNIT V **APPLICATIONS OF PLC** **9**

Stepper Motor Control- Elevator Control - CNC Machine Control- conveyor control- Interlocking Problems.

TOTAL:45 PERIODS

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REFERENCES:

1 Madhuchhanda Mitra , Samerjit Sengupta, "Programmable Logic Controllers Industrial Automation", 1st Edition, Penram International Publishing, 2019.

2 J R Hackworth , F D Hackworth, "Programmable Logic Controllers Principles and Applications", 2nd Edition, Pearson Education, 2020.

3 Ojula, "PLC Programming & Implementation" 1st Edition, Publish Drive Publications, 2022.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Explain basics of PLC and PLC types.

CO2 Analyse PLC basic instructions and timers.

CO3 Analyse PLC module addressing, different types of functions.

CO4 Explain communication protocol and architecture.

CO5 Analyze PLC programming in different motors.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	1
CO2	3	3	1	2	-	-	-	-	-	-	-	1
CO3	3	3	1	2	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	1
CO5	3	3	1	2	-	-	-	-	-	-	-	1

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U23OE124	ENERGY MANAGEMENT AND AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to understand the concept of Energy Management
- To know the electrical load management techniques and power trading marketing
- To understand the basics of Energy audit and its economic analysis

UNIT I ENERGY SCENARIO AND BASICS OF ENERGY 9

Types of Energy Sources – Life of Energy Sources - Energy Scenario in India – Energy vs Economic Growth - Linkage between Energy Use and Environment - Need for Energy Conservation Work, Energy and Power – Electricity Basics – Energy Units.

UNIT II LIGHTING SYSTEMS 9

Energy management in lighting systems – Task and the working space - Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Power factor and effect of harmonics, lighting and energy standards

UNIT III METERING FOR ENERGY MANAGEMENT 9

Metering for energy management – Units of measure - Utility meters – Demand meters – Paralleling of current transformers – Instrument transformer burdens – Multi tasking solid state meters, metering location vs requirements, metering techniques.

UNIT IV SHORT-TERM POWER TRADE MARKET 9

Electricity Act 2003- Yearly Trends in Short-term Transactions of Electricity- Time of the Day Variation in Volume and Price of Electricity Transacted through Traders and Power Exchanges-Trading Margin Charged by Trading Licensees-Open Access Consumers on Power Exchanges-Effect of Congestion on the Volume of Electricity Transacted through Power Exchanges.

UNIT V ENERGY AUDIT 9

Energy Audit Definition – Need for Energy Audit – Types of Energy Audit and Approaches – Understanding Energy Costs - Energy Performance

TOTAL: 45 PERIODS

REFERENCES

1. Arry C White, Philip S Schmidt, David R Brown, "Industrial Energy Management Systems", 10th Edition, Hemisphere Publishing, 2023.
2. Albert Thumann, "Fundamentals of Energy Engineering", 3rd Edition, Prentice Hall of India, 2022.
3. A S Pabla, "Electrical Power distribution", 5th Edition, Tata McGraw Hill, 2018.

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COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1	Summarize the Energy Scenario and Basics of Electrical Energy
CO2	Explain the working and optimizing of Lightning System
CO3	Describe different meters and its necessity in Energy Management
CO4	Summarize the Short-Term Power Trade Market
CO5	Summarize the types of Energy Audit Approaches

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	1	-	-	-	-	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	1
CO5	2	2	1	1	-	-	-	-	-	-	-	1

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U23OE125	FUNDAMENTALS OF ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand and gain the knowledge of robotics.
- To understand and gain the knowledge of working principles of sensors and drives.
- To understand the social economical aspects and applications

UNIT I **INTRODUCTION** 9

Introduction to Principles & Strategies of Automation, Types & Levels of Automation, Need of Automation, Brief History, Basic Concepts of Robotics such as Definition, Three Laws, Elements of Robotic Systems i.e. Robot Anatomy, DoF, Misunderstood Devices etc., Classification of Robotic Systems on the Basis of Various Parameters such as Work Volume, etc., Associated Parameters i.e. Resolution, Accuracy, Repeatability, Dexterity, Compliance, RCC Device etc.

UNIT II **GRIPPERS AND TRANSMISSION SYSTEMS** 9

Grippers for Robotics - Types of Grippers, Guidelines for Design for Robotic Gripper, Force Analysis for Various Basic Gripper System, Degrees of Freedom - Determination of Degrees of Freedom for Four & Five Bar Mechanism, Slider Crank Mechanism, Stanford Robot and SCARA ROBOT using Grubler - Kutzbach Equation.

UNIT III **SENSORS AND DRIVES** 9

Sensors: - Classification and Applications of Sensors, Characteristics of Sensing Devices, Selections of Sensors. Need for Sensors and Vision Systems in the Working and Control of a Robot. Desirable Features and Working of Tactile, Proximity and Range Sensors, Position Sensors, Velocity Sensors, Acceleration Sensors. Drives: Type of Drive, Actuators- Pneumatic, Hydraulic, Electrical and its Selection while Designing a Robot System.

UNIT IV **ROBOT PROGRAMMING AND LANGUAGES** 9

Programming, WAIT, SIGNAL and DELAY Commands, Subroutines, Programming Languages: Generations of Robotic Languages, Introduction to Various Types such as VAL, RAIL, AML, python, ROS etc..

UNIT V **SOCIO-ECONOMIC ASPECTS AND APPLICATIONS** 9

Socio-Economic Aspect of Robotization. Economical Aspects for Robot Design, Safety for Robot and Standards, Introduction to Artificial Intelligence, AI Techniques, Need and Application of AI. Industrial Applications of Robot in Material Transfer, Manufacturing, Inspection and Assembly

TOTAL: 45 PERIODS

REFERENCES

1. Ashitava Ghosal, "Robotics: Fundamental Concepts and Analysis", 2nd Edition, Oxford Publishers, 2008.

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2. Guruprasad K R, "Robotics: Mechanics And Control", 1st Edition, Prentice Hall of India, 2019.
3. K S Fu, Ralph Gonzalez, C S G Lee, "Robotics: Control, Sensing, Vision and Intelligence", 1st Edition, Tata McGraw Hill, 2017.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Explain the robot anatomy and terminologies related to Robotics technology

CO2 Describe the gripper force and transmission systems used in robotics.

CO3 Explain the various types, selection and need of sensors

CO4 Explain robot programming techniques and common programming commands

CO5 Describe socio-economic aspects, AI techniques and robot applications in the area of robotics.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	1
CO5	2	2	1	1	-	-	-	-	-	-	-	1

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U23OE126	MEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand basic concepts of bio signals and bio potential electrodes
- To understand various electrode configurations.
- To understand concepts and types of bio amplifiers.

UNIT I **BIO POTENTIAL ELECTRODES** **9**

Origin of Bio potential and its propagation. Electrode-Electrolyte interface, electrode skin interface, half-cell potential, impedance, polarization effects of electrode-non polarizable electrodes. Types of electrodes-surface, needle and micro electrodes and their equivalent circuits. Recording problems-measurement with two electrodes.

UNIT II **ELECTRODE CONFIGURATIONS** **9**

Bio signal characteristics- frequency and amplitude ranges ECG – Einthoven's triangle, standard 12 lead system, EEG-10-20 electrode system, unipolar, bipolar and average mode. EMG, ERG and EOG –unipolar and bipolar mode.

UNIT III **BIO AMPLIFIER** **9**

Need for bio-amplifier- single ended bio amplifier, differential bio amplifier-right leg driven ECG amplifier. Band pass filtering, isolation amplifiers-transformer and optical isolation-isolated DC amplifier and AC carrier amplifier. Chopper amplifier-Power line interference.

UNIT IV **MEASUREMENT OF NON ELECTRICAL PARAMETER** **9**

Temperature, respiration rate and pulse rate measurements. Blood Pressure and indirect-methods-Auscultatory-method-Oscillometric-method,direct -methods, Electronic manometer. Pressure amplifiers-systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement. Indicator dilution, Thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT V **BIOCHEMICAL MEASUREMENT** **9**

Biochemical sensors-pH,pO2 and pCO2,Ion selective Field Effective Transistor(ISFET)Immunologically sensitive FET (IMFET),Blood Glucose sensors-Blood Gas Analyzers, Calorimeter, Flame Photometer, Spectrophotometer, Blood cell counter, Auto Analyzer(simplified schematic description).

TOTAL: 45 PERIODS

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REFERENCES:

1 R Khandpur, "Biomedical Instrumentation Technology and Applications", 4th Edition, Tata McGraw Hill, 2021.
2 Raghbir Singh Khandpur, "Compendium of Biomedical Instrumentation", 1st Edition, John Wiley & Sons, 2020.
3 John G Webster, "Medical Instrumentation: Application and Design", 5th Edition, John Wiley & Sons , 2020.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Explain the characteristics of bio-signals and their importance in medical diagnosis

CO2 Describe various electrode configurations and its working methods.

CO3 Comprehend concepts and types of bio amplifiers in medical instrumentation.

CO4 Explain different measurement methods of non- electrical parameters in medical instrumentation.

CO5 Summarize concepts about different biochemical measurements.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE127	PROGRAM LANGUAGE PRINCIPLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn syntax and semantics of programming language.
- To comprehend data, data types, basic statements, explore call-return architecture and ways of implanting them.
- To gain knowledge about object-orientation, concurrency, event handling in Programming language and a non-procedural programming paradigm.

UNIT I SYNTAX AND SEMANTICS 9

Evolution of programming languages – describing syntax – context-free grammars– attribute grammars – describing semantics – lexical analysis – parsing – recursive- bottom-up parsing.

UNIT II DATA, DATA TYPES AND BASIC STATEMENTS 9

Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection – primitive data types – strings – array types– Arithmetic expressions – overloaded operators –type conversions – Relational and Boolean expressions – assignment statements.

UNIT III SUBPROGRAMS AND IMPLEMENTATIONS 9

Subprograms – design issues – local referencing – parameter passing – overloaded methods – generic methods – design issues for functions – semantics of call and return– implementing simple subprograms.

UNIT IV OBJECT-ORIENTATION, CONCURRENCY AND EVENT HANDLING 9

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 V FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES 9

Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Introduction to logic and logic programming – Programming with Prolog.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Robert W Sebesta, "Concepts of Programming Languages", 10th Edition, Addison Wesley, 2014.
2. Michael L. Scott, "Programming Language Pragmatics", 3rd Edition, Morgan Kaufmann Publishers, 2015.

REFERENCES:

1. R Kent Dybvig, "The Scheme programming language", 4th Edition, MIT Press, 2009.

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2 Jeffrey D. Ullman, "Elements of ML programming", 2nd Edition, Prentice Hall, 1998.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/106/102/106102067/

2 https://www.geeksforgeeks.org/introduction-to-programming-languages/

3 https://bgibhopal.com/principles-of-programming-languages-and-their-significance-in-computer-science-engineering/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend the syntax and semantics of programming languages.

CO2 Describe data, data types, and basic statements of programming languages

CO3 Explain Subprogram Constructs and Methods.

CO4 Explain object-oriented, concurrency, and event handling programming constructs.

CO5 Summarize the Functional and logic Programming and Prolog.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	-
CO2	2	2	1	1	-	-	-	1	-	-	-	-
CO3	2	2	1	1	-	-	-	1	-	-	-	-
CO4	2	2	1	1	-	-	-	1	-	-	-	-
CO5	2	2	1	1	-	-	-	1	-	-	-	-

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U23OE128 **DATA WAREHOUSING AND DATA MINING** L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the concepts of data warehousing architecture, frequent pattern mining and regression
- To learn to use and implement various machine learning based classification techniques and evaluation metrics.
- To understand enhancing the classification algorithms, clustering and recent trends of Data mining.

UNIT I **DATAWAREHOUSING** 9

Data warehousing - Data warehousing Components — Data Warehouse Modeling — Design and implementation Mapping the Data Warehouse to Multiprocessor Architecture — Online Analytical Processing and Tools — Data Cube Technologies — Multidimensional Data Analysis — Introduction to KDD process — Knowledge discovery from databases — Data mining functionalities — Technologies used — Applications

UNIT II **FREQUENT PATTERN MINING TECHNIQUES AND REGRESSION** 9

Knowing Data: Data Sets, Data objects and attributes — Statistical description of data — Measuring similarity and dissimilarity —Mining frequent item sets: Apriority algorithm, FP Growth Tree — Frequent Pattern evaluation methods — Support, Confidence, Association Mining various kinds of association rules — Regression techniques: Linear Regression: Least Square Regression — Logistic — other regression types — Regression Performance: MSE, RMSE— Bias and Variance curve

UNIT III **CLASSIFICATION TECHNIQUES I AND EVALUAITON METRICS** 9

Lazy-Active Learners — k Nearest Neighbour — Decision tree induction: ID3, C4.5, CART — Bayesian classification: Naïve Bayes — Model Evaluation and Selection: Accuracy, AUC, Error rate, Sensitivity, Specificity, Precision, Recall — Cross validation — Confusion Matrix

UNIT IV **CLASSIFICATION II AND CLUSTERING TECHNIQUES** 9

Ensemble classifiers: Bagging, Adaboost — Cluster analysis — Clustering techniques: Partitioning methods — kMeans — kMeans++ — kMedoids — Hierarchical methods — Agglomerative Clustering - Dendrogram Evaluation of clustering algorithms — DBSCAN — Outlier detection: Outliers and Outlier analysis - Outlier detection methods

UNIT V **CASE STUDIES** 9

Mining Complex Data Types — Sequential pattern mining in symbolic sequences, Time Series — Mining graphs and networks — Visual and audio data mining - Data mining

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for intrusion detection and prevention - Data mining and Recommender systems.

TOTAL:45 PERIODS

TEXT BOOKS:

1 Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers, 2011.

2 G K Gupta, "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2014.

REFERENCES:

1 Alex Berson, Stephen J Smith, "Data Warehousing, Data Mining & OLAP", 21st Edition, Tata McGraw Hill, 2011.

2 Ian Witten, Eibe Frank, "Data Mining: Practical Machine Learning Tools and Techniques", 3rd Edition, Morgan Kaufmann, 2011.

3 George M Marakas, "Modern Data Warehousing, Mining and Visualization", 1st Edition, Prentice Hall of India, 2003.

ONLINE RESOURCES:

1 https://www.coursera.org/specializations/data-mining

2 https://nptel.ac.in/courses/106105174

3 https://www.geeksforgeeks.org/dbms/data-warehousing/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the components of data warehousing architecture.

CO2 Explain the frequent pattern mining and regression techniques.

CO3 Apply the various supervised classification models and measure the Model's Performance.

CO4 Apply and implement enhanced classification methods and other clustering techniques.

CO5 Explain the recent trends of Data mining in business applications.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	1	-	-	-	-
CO4	3	2	1	2	-	-	-	1	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE129	FOUNDATIONS OF SOFT COMPUTING TECHNIQUES	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To learn the basic concepts of Soft Computing
- To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems
- To apply soft computing techniques to solve problems.

UNIT I **INTRODUCTION TO SOFT COMPUTING** **9**

Introduction-Artificial Intelligence - Artificial Neural Networks - Fuzzy Systems - Genetic Algorithm and Evolutionary Programming - Swarm Intelligent Systems - Classification of ANNs - McCulloch and Pitts Neuron Model - Learning Rules - Hebbian and Delta - Perceptron Network - Adaline Network - Madaline Network

UNIT II **ARTIFICIAL NEURAL NETWORKS** **9**

Back propagation Neural Networks - Kohonen Neural Network - Learning Vector Quantization -Hamming Neural Network - Hopfield Neural Network - Bi-directional Associative Memory - Adaptive Resonance Theory Neural Networks - Support Vector Machines - Spike Neuron Models.

UNIT III **FUZZY SYSTEMS** **9**

Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets - Classical Relations and Fuzzy Relations -Membership Functions - Defuzzification - Fuzzy Arithmetic and Fuzzy Measures - Fuzzy Rule Base and Approximate Reasoning - Introduction to Fuzzy Decision Making.

UNIT IV **GENETIC ALGORITHMS** **9**

Basic Concepts - Working Principles – Encoding - Fitness Function - Reproduction - Inheritance Operators - Cross Over - Inversion and Deletion Mutation Operator - Bit-wise Operators - Convergence of Genetic Algorithm

UNIT V **HYBRID SYSTEMS** **9**

Hybrid Systems - Neural Networks, Fuzzy Logic and Genetic - GA Based Weight Determination - LR-Type Fuzzy Numbers - Fuzzy Neuron - Fuzzy BP Architecture - Learning in Fuzzy BP - Inference by Fuzzy BP - Fuzzy Art Map - A Brief Introduction - Soft Computing Tools - GA in Fuzzy Logic Controller Design - Fuzzy Logic Controller

TOTAL:45 PERIODS

TEXT BOOKS:

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1 N.P.Padhy, S P Simon, "Soft Computing with MATLAB Programming", 1st Edition, Oxford University Press, 2015.
2 S N Sivanandam , S N Deepa, "Principles of Soft Computing", 2nd Edition, Wiley & sons, 2011.

REFERENCES:

1 Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani," Neuro-Fuzzy and Soft Computing", 1st Edition, Prentice-Hall of India, 2021.
2 Kwang H Lee, First course on Fuzzy Theory and Applications, 1st Edition, Springer, 2021.
3 Sujatha Dash," Advanced Soft Computing Techniques in Data Science, IoT and Cloud Computing", 1st Edition, Springer, 2021

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc25_ma54/preview

2 https://www.geeksforgeeks.org/software-engineering/need-for-soft-computing/

3 https://onlinecourses.swayam2.ac.in/ntr25_ed107/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply suitable soft computing techniques for various applications

CO2 Integrate various soft computing techniques for complex problems.

CO3 Analyze various genetic and hybrid systems.

CO4 Analyze different Fuzzy and Neural algorithms

CO5 Analyze the various Neuron model systems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	-	-	1	1	1	-	-
CO2	3	3	2	2	-	-	-	1	1	1	-	2
CO3	3	2	2	2	-	-	-	1	1	1	-	-
CO4	3	2	1	2	-	-	-	1	1	1	-	-
CO5	3	2	1	2	-	-	-	1	1	1	-	-

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U23OE130	FUNDAMENTALS OF CLOUD COMPUTING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To introduce fundamental concepts and models of cloud computing, including its goals, benefits, and risks.
- To familiarize with key cloud enabling technologies and infrastructure mechanisms.
- To develop the ability to analyze and determine various cloud maintenance strategies

UNIT I **UNDERSTANDING CLOUD COMPUTING** **9**

Cloud Origins and Influences - Basic Concepts and Terminology - Goals and Benefits - Risks and Challenges - Fundamental Concepts and Models: Roles and Boundaries - Cloud Characteristics - Cloud Delivery Models - Cloud Deployment Models.

UNIT II **CLOUD ENABLING TECHNOLOGY** **9**

Data Center Technology - Virtualization Technology – Utility Computing - Automation - Web Technology - Multitenant Technology - Service Technology – Web 2.0.

UNIT III **CLOUD INFRASTRUCTURE MECHANISMS** **9**

Logical Network Perimeter - Virtual Server - Cloud Storage Device - Cloud Usage Monitor - Resource Replication – Ready-made Environment.

UNIT IV **SPECIALIZED CLOUD MECHANISMS** **9**

Automated Scaling Listener -Load Balancer - SLA Monitor - Pay-Per- Use Monitor - Audit Monitor - Fail Over System – Hypervisor - Resource Cluster - Multi-Device Broker - State Management Database.

UNIT V **FUNDAMENTAL CLOUD ARCHITECTURES** **9**

Workload Distribution Architecture - Resource Pooling Architecture - Dynamic Scalability Architecture - Elastic Resource Capacity Architecture - Service Load Balancing Architecture - Cloud Bursting Architecture - Elastic Disk Provisioning Architecture - Redundant Storage Architecture.

TOTAL:45 PERIODS

TEXT BOOKS:

1 Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Cloud Computing: Concepts, Technology& Architecture, 1st Edition, Prentice Hal of India, 2013.

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2 Kalani Kirk Hausman, Susan L Cook, Telmo Sampaio, Cloud Essentials, 1st Edition, Sybex, 2013.

REFERENCES:

1 John W Ritting house, James F.Ransome, Cloud Computing: Implementation, Management and Security, 1st Edition, CRC Press,2012.

2 Anthony T. Velte, Toby J Velte Robert Elsenpeter, Cloud Computing a practical approach, 1st Edition, Tata McGrawHill,2010.

3 Michael Miller, Cloud Computing: Web-based Applications That Change the Way You Work and Collaborate Online, 1st Edition, Que Publishing, 2008.

ONLINE WEB RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc25_cs11/preview

2 https://www.geeksforgeeks.org/cloud-computing/cloud-computing/

3 https://www.spiceworks.com/tech/cloud/articles/what-is-cloud-computing/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain fundamental concepts and models of cloud computing and cloud enabling technologies, infrastructure mechanisms

CO2 Explain Cloud Infrastructure Mechanisms

CO3 Explain different Cloud Maintenance strategies

CO4 Analyze Cloud Architectures and Delivery Model

CO5 Explain cloud architecture fundamentals

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-
CO4	3	2	1	2	-	-	-	1	1	1	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE131	HUMAN COMPUTER INTERACTION	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To understand human cognitive functions, interaction models, and usability principles in Human-Computer Interaction (HCI).
- To apply HCI techniques in designing and evaluating interactive, mobile, and web-based user interfaces.
- To explore ergonomics, software prototyping, and modern tools for improving user experience.

UNIT I **FOUNDATIONS OF HCI** **9**

The Human: I/O channels – Memory – Reasoning and problem solving; The Computer: Devices –Memory – processing and networks; Interaction: Models - frameworks – Ergonomics – styles –elements – interactivity- Paradigms. - Case Studies.

UNIT II **DESIGN SOFTWARE PROCESS** **9**

Interactive Design: Basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process: Software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules: principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

UNIT III **MODELS AND THEORIES** **9**

HCI Models: Cognitive models: Socio-Organizational issues and stakeholder requirements –Communication and collaboration models-Hypertext, Multimedia and WWW.

UNIT IV **MOBILE HCI** **9**

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets,Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. - Case Studies.

UNIT V **WEB INTERFACE DESIGN** **9**

Designing Web Interfaces – Drag Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow - Case Studies.

TOTAL:45 PERIODS

TEXT BOOKS:

1 Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human-Computer Interaction", 3rd Edition, Pearson Education, 2004.

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2 Ben Shneiderman, Catherine Plaisant, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", 6th Edition, Pearson, 2016.

REFERENCES:

1 Donald A. Norman, The Design of Everyday Things, 2nd Edition, Basic Books, Revised Edition, 2013.

2 Jeff Johnson, Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines, 2nd Edition, Morgan Kaufmann, 2013.

3 Rex Hartson, Pardha S. Pyla, The UX Book: Process and Guidelines for Ensuring a Quality User Experience, 2nd Edition, Morgan Kaufmann, 2018.

ONLINE RESOURCES:

1 https://www.interaction-design.org/

2 https://nptel.ac.in/courses/106103115

3 https://www.coursera.org/courses?query=human-computer-interaction

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamental principles of Human-Computer Interaction, including human cognitive functions and ergonomics.

CO2 Apply user-centered design principles to develop interactive software applications.

CO3 Analyze cognitive and socio-organizational models to improve user experience and interface usability.

CO4 Apply appropriate tools and techniques to design and evaluate mobile applications and web interfaces.

CO5 Analyze usability engineering methodologies and universal design principles to create inclusive and effective interfaces.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	1	-	-	-	-
CO4	3	2	1	2	-	-	-	1	-	-	-	-
CO5	3	2	1	2	-	-	-	1	-	-	-	-

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U23OE132 **WEB DEVELOPMENT FUNDAMENTALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals of internet
- To learn HTML, CSS, Java script for front end development
- To distinguish web security concepts and learn about vulnerabilities

UNIT I **INTRODUCTION TO INTERNET** **9**

Network Address Translation-Subnet Masking-Difference between Internet and Intranet-Working of Internet-Static and Dynamic Routing- Domain Name Server-Networking Tools-ipconfig, ping, netstat, traceroute.

UNIT II **INTERNET PROTOCOLS** **9**

HTTP-HTTPs-FTP-SMTP-IMAP-POP3-VoIP-ICMP-IGMP

UNIT III **WEB SERVERS AND PROXY SERVERS** **9**

Web Servers: Introduction, Working, Configuring, Hosting and Managing a Web Server, Proxy Servers: Introduction, Working, Types of Proxies, setting up and managing a Proxy server-Client- side Technologies-Server-side Technologies-Hybrid Technologies.

UNIT IV **JAVASCRIPT BASICS** **9**

Java script-jQuery-JSON-Node.js-Bootstrap-Introduction to forums-Blogging-Portfolio-Developing a responsive website-Combining web applications and mobile applications.

UNIT V **SEARCH ENGINES, COOKIES AND E-COMMERCE** **9**

Search Engines-Components, Working Optimization, Crawling, BOTS, Introduction to Cookies and Sessions-Introduction to E-Commerce Websites and E-Carts.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 M Ganesh Karthik, C Silpa, Dr B Lalitha, "Web Technologies", 1st Edition, Book Rivers, 2023.

2 P Meenakshi Devi, D Balakrishnan, S Nandhagopal, "Web Essentials", 1st Edition, ARS Publications, 2021.

REFERENCES:

1 Sammulal Porika, Peddi Kishor, "Web Technologies and Applications", 1st Edition, BS Publications, 2022.

2 Menal Dahiya, "Getting Started with Web Technologies", 1st Edition, Notion Press, 2022.

ONLINE RESOURCES:

1 https://www.tutorialspoint.com/internet_technologies/internet_quick_guide.ht
2 https://www.techtarget.com/whatis/definition/Web-server
3 https://archive.nptel.ac.in/courses/106/105/106105183/

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COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the notions of NAT, routing, DNS and networking tools

CO2 Explain the fundamental concepts of the Internet and networking protocols

CO3 Analyze interactive and responsive websites using HTML, CSS, and JavaScript

CO4 Describe dynamic web applications using server-side languages

CO5 Explain the basic concepts of crawling and BOTS

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	1
CO2	2	2	1	1	-	-	-	1	-	-	-	1
CO3	3	3	2	2	-	-	-	1	-	-	-	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1
CO5	2	2	1	1	-	-	-	1	-	-	-	1

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U23OE133	NETWORK MANAGEMENT SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To learn the interoperable network management as a typical distributed application
- To understand concepts and terminology associated with SNMP
- To understand the current trends in network management technologies.

UNIT I OSI NETWORK MANAGEMENT 8

OSI Network management model - Organizational model - Information model, Communication model. Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/CMIS.

UNIT II BROADBAND NETWORK MANAGEMENT 9

Broadband networks and services, ATM Technology - VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management - ATM Network reference model, Integrated local Management Interface. ATM Management Information base, Role of SNMP and ILMI in ATM Management, M1, M2, M3, M4 interface. ATM Digital Exchange Interface Management.

UNIT III SIMPLE NETWORK MANAGEMENT PROTOCOL 10

SNMPv1 Network Management: Communication and Functional Models. The SNMP Communication Model, Functional model, SNMP Management SNMPv2: SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base, SNMPv2 Protocol, Configuration management, Fault management, Performance management, Security management, Report Management, Policy Based Management, Services Level Management.

UNIT IV NETWORK MANAGEMENT SYSTEMS 9

Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Commercial Network management Systems, System Management and Enterprise Management Solutions.

UNIT V WEB-BASED MANAGEMENT 9

NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, WBEM: Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Mani Subramanian, "Network Management: Principles and Practices", 1st Edition, Pearson Education, 2020.

2 Alexander Clemm, "Network Management Fundamentals", 1st Edition, Cisco Press, 2021.

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REFERENCES:

1 Benoit Claise, Ralf Wolter, "Network Management: Accounting and Performance Strategies", 1st Edition, Pearson Education, 2022.

2 Vikas Kumar Jha, Bishwajeet Kumar Pandey, Ciro Rodriguez, "Network Evolution and Applications", 1st Edition, CRC Press, 2022.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc25_ee54/preview

2 https://www.youtube.com/watch?v=meFgK8z1pDc

3 https://nptel.ac.in/courses/117106116

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the various OSI Network management models.

CO2 Describe the Services provided by Broadband Network.

CO3 Summarize the concepts and terminology associated with SNMP.

CO4 Explain the current trends in network management technologies.

CO5 Explain the Various Web based management in Network.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	1
CO2	2	2	1	1	-	-	-	1	-	-	-	1
CO3	2	2	1	1	-	-	-	1	-	-	-	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1
CO5	2	2	1	1	-	-	-	1	-	-	-	1

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U23OE134	FUNDAMENTALS OF MOBILE COMPUTING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts of mobile computing and mobile telecommunication system
- To learn about the network layer protocols and Ad-Hoc networks and basis of transport and application layer protocols.
- To learn the knowledge about different mobile platforms and application development.

UNIT I **INTRODUCTION** 9

Introduction to Mobile Computing-Applications of Mobile Computing-Generations of Mobile Communication Technologies-MAC Protocols-SDMA- TDMA- FDMA- CDMA.

UNIT II **MOBILE TELECOMMUNICATION SYSTEM** 9

Introduction to Cellular Systems – GSM – Services & Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management –– GPRS- UMTS – Architecture – Handover – Security.

UNIT III **MOBILE NETWORK LAYER AND TRANSPORT LAYER** 9

Mobile IP – Dynamic Host Configuration Protocol - Routing – DSDV – DSR – WTLS-Traditional TCP, Mobile TCP.

UNIT IV **APPLICATION LAYER** 9

WAP – Architecture, Gateway, protocols, user agent profile – WDP –WTP –WSP – WAE – WTA Architecture – WML.

UNIT V **MOBILE PLATFORMS AND APPLICATIONS** 9

Mobile Device Operating Systems – Special Constraints & Requirements – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Manish Soni, "Mobile Computing: Concepts, Applications and Exercises", 1st Edition, Poorav Publications, 2025.

2 Subarna Shakya, "Mobile Computing and Sustainable Informatics", 1st Edition, Springer publications, 2023.

REFERENCES:

1 Mladen Bozanic, "Mobile Communication Networks: 5G and a Vision of 6G", 3rd Edition, Springer publications, 2021.

2 Prabhakar Sharma, "Mobile and Wireless Communication", 1st Edition, Notion Press, 2023.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/106/106/106106147/

2 https://www.geeksforgeeks.org/what-is-a-mobile-operating-system/

3 https://www.slideshare.net/slideshow/mobile-network-layer/28141434#2

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S.M

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the basic of mobile telecommunication system

CO2 Summarize the generations of telecommunication systems in wireless networks.

CO3 Describe the functionality of MAC, network layer and identify a routing protocol for a given Ad hoc network.

CO4 Explain the functionality of transport and application layers.

CO5 Describe the mobile application using android/blackberry/ios/Windows SDK.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	1
CO2	2	2	1	1	-	-	-	1	-	-	-	1
CO3	2	2	1	1	-	-	-	1	-	-	-	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1
CO5	2	2	1	1	-	-	-	1	-	-	-	1

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U230E135	ELECTRONIC COMMERCE	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To learn the E-Commerce Platform and its concepts
- To understand the Security and Challenges in E-Commerce
- To build an Own E-Commerce using Open-Source Frameworks

UNIT I **INTRODUCTION TO E-COMMERCE AND TECHNOLOGY INFRASTRUCTURE** **9**

Working of Web-HTML Markup for structure-Creating simple page-Marking up text-Adding Links-Adding Images-Table Markup-Forms-HTML5.

UNIT II **BUILDING AN E-COMMERCE WEBSITE, MOBILE SITE AND APPS** **9**

Systematic Approach to build an E-commerce: Planning- System Analysis- System Design- Building the System-Testing the system-Implementation and Maintenance-Optimize Web Performance-Choosing hardware and software-Other E-Commerce Site Tools-Develop a Mobile Website and Mobile App.

UNIT III **E-COMMERCE SECURITY AND PAYMENT SYSTEMS** **9**

E-Commerce Security Environment – Security threats in E-Commerce – Technology Solutions: Encryption, Securing Channels of Communication, Protecting Networks, Protecting Servers and Clients – Management Policies, Business Procedure and Public Laws - Payment Systems.

UNIT IV **BUSINESS CONCEPTS IN E-COMMERCE** **9**

Digital Commerce Marketing and Advertising strategies and tools – Internet Marketing Technologies – Social Marketing – Mobile Marketing – Location based Marketing – Ethical, Social, Political Issues in E-Commerce.

UNIT V **PROJECT CASE STUDY** **9**

Case Study: Identify Key components, strategy, B2B, B2C Models of E-commerce Business model of any e-commerce website - Mini Project: Develop E-Commerce project in any one of Platforms like Woo-Commerce, Magento or Open cart.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Kenneth C Laudon, "E-Commerce 2023: Business, Technology and Society", 1st Edition, Pearson Education, 2022.

2 V Rajaraman, "Essentials of E-Commerce Technology", 2nd Edition, Prentice Hall of India, 2022.

REFERENCES:

1 M Suyal, "Fundamentals of E-Commerce", 1st Edition, ABH Books, 2023.

2 Krishna Gupta, "E-Commerce Technologies", 2nd Edition, Neelkanth Publishers, 2023.

ONLINE RESOURCES:

1 http://docs.opencart.com/

2 http://devdocs.magento.com/

3 http://doc.prestashop.com/display/PS15/Developer+tutorials

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COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the concepts of HTML 5.0.

CO2 Analyze the mobile website and mobile app with respect to E-commerce tools.

CO3 Explain the strategies of E-commerce Security and Payment Systems.

CO4 Summarize the business concept in E-Commerce.

CO5 Describe the key components of B2B and B2C.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	1
CO2	3	3	2	2	-	-	-	1	-	-	-	1
CO3	2	2	1	1	-	-	-	1	-	-	-	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1
CO5	2	2	1	1	-	-	-	1	-	-	-	1

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U230E136 **MACHINE LEARNING USING PYTHON** L T P C
2 0 2 3

COURSE OBJECTIVES:

- To understand the basic concepts of machine learning
- To understand the fundamentals of supervised learning
- To understand the algorithms based on corresponding metrics identified

UNIT I INTRODUCTION TO MACHINE LEARNING 9

Machine Learning-Types of Machine Learning-Machine Learning Pipeline-Introduction to python packages used in Machine Learning- Examples of machine learning applications-Vapnik-Chervonenkis (VC) dimension-Probably Approximately Correct (PAC) learning- Hypothesis spaces- Inductive bias- Generalization-Bias variance trade-off.

UNIT II SUPERVISED LEARNING 9

Supervised Learning and its Applications-Preparing and Shaping the Data-Overfitting and Underfitting-Detecting and Preventing Overfitting and Underfitting-Regularization.

UNIT III REGRESSION AND APPLICATIONS 9

Regression and its types-Linear Regression-Logistic Regression-Data Exploration and Over Sampling-Polynomial Regression- Data Preparation Model Building and Performance Evaluation-Ridge Regression-LASSO Regression.

UNIT IV CLASSIFICATION AND APPLICATIONS 9

Classification Algorithms-Classification Types- Selection of Performance Parameters-Naïve Bayes Classifier-Stochastic Gradient Descent-K-Nearest Neighbor-Decision Tree-Random Forest-Support Vector Machine-Cohens Kappa Measure.

UNIT V UNSUPERVISED ALGORITHMS AND ENSEMBLE LEARNING 9

Unsupervised Algorithms- Visualizing Outputs-Performance Parameters-Clustering Types-Hierarchical Clustering-K-Means Clustering-Outlier Detection-Ensemble Learning-Sequential and Parallel Ensemble Techniques-Types of Ensemble Methods-Bagging-Boosting-Stacking-Reducing Errors with Ensembles.

TOTAL:45 PERIODS

PRACTICAL EXERCISES:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
3. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
4. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program.
5. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.

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30 PERIODS
TOTAL: 75 PERIODS

TEXT BOOKS:

1 Ethem Alpaydin, "Introduction to Machine Learning", 4th Edition, MIT Press, 2020.

2 Manaranjan Pradhan, "Machine Learning using Python", 2nd Edition, John Wiley & Sons, 2020.

REFERENCES:

1 Sebastain Raschka, Vahid Mirjalili, "Python Machine Learning", 3rd Edition, Packt publishing, 2019.

2 Mark E Fenner, "Machine Learning with Python for Everyone", 1st Edition, Pearson Education, 2020.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_cs24/preview

2 https://www.tutorialspoint.com/machine_learning/machine_learning_regression_analysis.htm

3 https://colab.research.google.com/github/deepmind/educational/blob/master/colabs/summer_schools/intro_to_unsupervised_learning.ipynb

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamental concepts of machine learning.
CO2 Apply supervised learning techniques.
CO3 Apply various kinds of regression to the following database
CO4 Analyze the concepts of Classification and its applications.
CO5 Analyze the algorithms in unsupervised learning and ensemble learning.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	-	-	1	-	1	-	1
CO2	3	2	1	2	1	-	-	1	-	1	-	1
CO3	3	2	1	2	1	-	-	1	-	1	-	1
CO4	3	3	2	2	1	-	-	1	-	1	-	1
CO5	3	3	2	2	1	-	-	1	-	1	-	1

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U23OE137	APPLIED DESIGN THINKING	L	T	P	C
		3	0	0	3

Course Objectives:

- Introduce tools & techniques of design thinking for innovative products.
- Development Illustrates customer-centric product innovation using simple.
- Describe system thinking principles as applied to complex systems.

UNIT I DESIGN THINKING PRINCIPLES 9

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies.

UNIT II END USER-CENTRIC INNOVATION 9

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit.

UNIT III APPLIED DESIGN THINKING TOOLS 9

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design.

UNIT IV CONCEPT GENERATION 9

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts.

UNIT V SYSTEM THINKING 9

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Maurício Vianna, Ysmar nVianna, Brenda Lucena, Beatriz Russo, "Design thinking: Business innovation", 1st Edition, MJV Technologies and innovation press, 2021.
2. George E Dieter, "Engineering design", 4th Revised edition, Tata McGraw Hill, 2019.

REFERENCES:

1. Len Bass, Ingo Weber, Liming Zhu G, DevOps, "A Software Architect's Perspective", 1st Edition, Addison-Wesley Professional, 2019.
2. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", 2nd Edition, Harper Business, 2019.
3. Stephen Fleming, Pravin, "Introduction of DevOps Resource Management", 1st Edition, Create space Independent Publication, 2021.

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ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/112/105/112105316/

2 https://www.shutterstock.com/video/search/design-thinking

3 https://onlinecourses.nptel.ac.in/noc22_mg32/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Design various hypotheses to mitigate the inherent risks in product innovations.

CO2 Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.

CO3 Apply the critical thinking, analysing, storytelling & pitching.

CO4 Apply system thinking in a real-world scenario.

CO5 Create the right prototype with Assess capability with solution concept.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	-	-	-	-	2	1
CO2	3	3	3	3	-	-	-	1	-	-	-	-	2	1
CO3	3	2	1	2	-	-	-	1	-	-	-	-	2	1
CO4	3	2	1	2	-	-	-	1	-	-	-	-	2	1
CO5	3	3	3	3	-	-	-	1	-	-	-	-	2	1

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U23OE138	FIRE SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- To enable the students to acquire knowledge of Fire and Safety Studies.
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance.
- To learn about fire areas, fire stopped areas and different types of fire-resistant doors

UNIT I **INHERENT SAFETY CONCEPTS** **9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within buildings and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behaviour of non-structural materials on fire- plastics, glass, textile fibres and other household materials.

UNIT II **PLANT LOCATIONS** **9**

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements standard heating condition, Indian standard test method, performance criteria.

UNIT III **WORKING CONDITIONS** **9**

Fire separation between building- principles of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors.

UNIT IV **FIRE SEVERITY AND REPAIR TECHNIQUES** **9**

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

UNIT V **WORKING AT HEIGHTS** **9**

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps- Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs -Work Permit Systems-Accident Case Studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Roytman M Y,"Principles of fire safety standards for building construction", 1st Edition, Amerind Publishing Co. Pvt. Ltd., 2018.
2. John A Purkiss,"Fire safety engineering design of structures", 2nd Edition, Butter worth Heinemann, 2019.

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REFERENCES:

1. Smith E E, and Harmathy T Z,"Design of buildings for fire safety", 1st Edition, ASTM Special Publication, 2018.
2. Jain V K,"Fire safety in buildings", 1st Edition, New Age International Pvt. Ltd., 2020.
3. Hazop & Hazan,"Identifying and Assessing Process Industry Hazards", 4th Edition, CRC Press, 2019.

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/105/102/105102176/
2. https://3danimation.in/projects/safety-animation-fire-safety-video/
3. https://onlinecourses.nptel.ac.in/noc20_ce09/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the effect of fire on materials used for construction.

CO2 Describe the method of test for non-combustibility and fire resistance.

CO3 Describe the design concept of fire walls, fire screens, local barriers and fire doors and able to select to prevent fire spread.

CO4 Apply the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

CO5 Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	-	1	-	1	-	-	2	1
CO2	2	2	1	1	1	1	-	1	-	1	-	-	2	1
CO3	2	2	1	1	1	1	-	1	-	1	-	-	2	1
CO4	3	2	1	2	1	1	-	1	-	1	-	-	2	1
CO5	2	2	1	1	1	1	-	1	-	1	-	-	2	1

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U23OE139	FUNCTIONAL MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart an insight in differentiating among various functional properties
- To describe the selection of appropriate material for certain functional applications.
- To study about the analysis of the nature and potential of functional materials.

UNIT I **INTRODUCTION** **9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modelling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

UNIT II **MOLECULAR SELF ASSEMBLY** **9**

Molecular Organization, Self-Assembly in Biology, Energetics of self-Organization, A few case studies, Synthetic Protocols and challenges, Solvent assisted self-assembly, Directed assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological applications of SAMs.

UNIT III **BIO-INSPIRED MATERIALS** **9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

UNIT IV **SMART OR INTELLIGENT MATERIALS** **9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electro ceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

UNIT V **MATERIALS FOR POLYMER ELECTRONICS** **9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Vijayamohanan K Pillai, Meera Parthasarathy, "Functional Materials: A chemist's perpective", 1st Edition, Universities Press, 2018.

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2 Deborah D L Chung, "Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications", 1st Edition, World Scientific Publishing, 2020.

REFERENCES:

1 Stephen Manne, "Biomimetic Materials Chemistry", 1st Edition, Wiley-VCH, 2018.
2 S Banerjee, A K Tyagi, "Functional Materials: Preparation, Processing and Applications," 1st Edition, Elsevier Science, 2018.
3 Dipti Ranjan Sahu, "Functional Materials," 1st Edition, Intech Open, 2019.
4 Mohsen Shahinpoor, "Fundamentals of Smart Materials," 1st Edition, Royal Society of Chemistry, 2020.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc23_ph34/preview
2 https://royalsociety.org/news-resources/projects/animate-materials/
3 https://nptel.ac.in/courses/112104173

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain Multi-scale Modelling and Computation and classify the functional materials.
CO2 Explain the molecular self-assembly and technological applications of SAMs.
CO3 Apply the various bio inspired materials, artificial sensory organs and nano technology in bio mineralization.
CO4 Describe the applications of smart materials, nano composites and nano-tube composites.
CO5 Apply the concept polymer electronics in Organic and Light Emitting Diodes, transistors and LEDs.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	1	1	-	-	-	-	-	2	-
CO2	2	2	1	1	-	1	1	-	-	-	-	-	2	-
CO3	3	2	1	2	-	1	1	-	-	-	-	-	2	-
CO4	2	2	1	1	-	1	1	-	-	-	-	-	2	-
CO5	3	2	1	2	-	1	1	-	-	-	-	-	2	-

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U23OE140	FUNDAMENTALS OF AERONAUTICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- To acquire the knowledge on the Historical evaluation of Airplanes.
- To learn the different component structures, construction, systems and functions.
- To study about the analysis of the nature and potential of functional materials.

UNIT I HISTORY OF FLIGHT 9

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS 9

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

UNIT III BASICS OF AERODYNAMICS 9

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

UNIT IV BASICS OF AIRCRAFT STRUCTURES 9

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.

UNIT V BASICS OF PROPULSION 9

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

TOTAL : 45 PERIODS

TEXT BOOKS:

1 Anderson J D, "Introduction to Flight", 8th Edition, Tata McGraw-Hill, 2018.

2 Rathakrishnan E, "Introduction to Aerospace Engineering: Basic Principles of Flight", 1st Edition, John Wiley & sons, 2021.

REFERENCES:

1 Stephen A Brandt, "Introduction to aeronautics: A design perspective", 2nd Edition, AIAA Education Series, 2019.

2 Sadhu Singh, "Internal Combustion Engines and Gas Turbine", 1st Edition, SS Kataraia & Sons, 2018.

3 Shevell, "Fundamentals of Flight", 2nd Edition, Pearson Education, 2018.

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ONLINE RESOURCES:

1 http://digimat.in/nptel/courses/video/101106033/L01.html

2 http://www.digimat.in/nptel/courses/video/101101083/L20.html

3 http://www.digimat.in/nptel/courses/video/101101001/A01.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the history of aircraft & developments over the years.

CO2 Describe the types & classifications of components and control systems.

CO3 Explain the basic concepts of flight & Physical properties of Atmosphere.

CO4 Explain the types of fuselage and constructions.

CO5 Describe the types of Engines and the Rocket.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO2	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO3	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO4	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO5	2	2	1	1	-	-	-	1	-	-	-	-	2	-

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U23OE141	INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

- Outline Fundamental concepts in UI & UX and Introduce the principles of Design and Building an mobile app.
- Illustrate the use of CAD in product design Outline the choice and use of prototyping tools.
- Understanding design of electronic circuits and fabrication of electronic devices.

UNIT I **UI/UX** **9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives.

UNIT II **APP DEVELOPMENT** **9**

SDLC - Introduction to App Development - Types of Apps - web Development understanding Stack -Frontend - backend - Working with Databases - Introduction to API Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

UNIT III **INDUSTRIAL DESIGN** **9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modelling - Basic 3D Modelling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing.

UNIT IV **MECHANICAL RAPID PROTOTYPING** **9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing.

UNIT V **ELECTRONIC RAPID PROTOTYPING** **9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Peter Fiell, "Charlotte Fiell, Industrial Design A-Z", 1st Edition, TASCHEN, 2018.
2. Madou M J, "Fundamentals of micro fabrication", 1st Edition, CRC Press, 2019.

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REFERENCES:

1. Jaeger R C, "Introduction to microelectronic Fabrication", 1st Edition, Addision Wesley Publishing Co., 2020.
2. Amstead B H, Ostwald Phylips, Bageman R, "Manufacturing Processes", 1st Edition, John Wiley & Sons, 2018.
3. Serope Kalpakjian, "Manufacturing Engineering and Technology", 3rd Edition, Addison Wesley Publishing Co., 2019.

ONLINE RESOURCES:

1. http://www.digimat.in/nptel/courses/video/112107217/L20.html
2. https://onlinecourses.nptel.ac.in/noc22_mm33/preview
3. https://archive.nptel.ac.in/courses/112/104/112104265/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Create quick UI/UX prototypes for customer needs.

CO2 Create web application to test product traction / product feature.

CO3 Design a 3D models for prototyping various product ideas.

CO4 Create prototypes using Tools and Techniques in a quick iterative methodology.

CO5 Describe the electronic rapid prototyping.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	-	-	-	-	2	-
CO2	3	3	3	3	-	-	-	1	-	-	-	-	2	-
CO3	3	3	3	3	-	-	-	1	-	-	-	-	2	-
CO4	3	3	3	3	-	-	-	1	-	-	-	-	2	-
CO5	2	2	1	1	-	-	-	1	-	-	-	-	2	-

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U23OE201	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquaint the knowledge of testing of hypothesis for small and large samples and design of experiments which plays an important role in real life applications.
- To introduce the basic concepts of solving algebraic and transcendental equations and introduce the numerical techniques of interpolation in various intervals and to solve differentiation and integration.
- To understand the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 9

Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 9

One way and two – way classifications – Completely randomized design –Randomized block design – Latin square design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton – Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigen values of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9

Single step methods: Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge – Kutta method for solving first order differential equations – Multi step methods: Milne's and Adams – Bash forth predictor corrector methods for solving first order differential equations.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 B S Grewal, J S Grewal, "Numerical Methods in Engineering and Science", 11th Edition, Khanna Publishers, 2021.

2 R A Johnson, I Miller, J Freund "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, 2017.

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REFERENCES:

1. Chaitanya Kumar, Harindejit Kaur Chawla, Indarpal Singh, "A text book on Numerical Methods and Analysis", Sultan Chand & Sons, 2024.
2. P Sivaramakrishna Das, C Vijayakumari, "Statistics and Numerical Methods", 9th Edition, Pearson Education, 2020.
3. S C Gupta , V K Kapoor, "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand & Sons, 2020.

ONLINE RESOURCES:

1. https://swayam.gov.in/nd2_cec20_ma01/preview
2. https://www.coursera.org/learn/intro-to-numerical-analysis
3. https://www.mooc-list.com/tags/numerical-methods

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Analyze the concepts of sampling, mean and variance using various statistical tests.
CO2 Analyze the concepts of design of experiments using ANOVA.
CO3 Solve the algebraic and numerical equations by numerical techniques.
CO4 Evaluate the numerical integration and differentiation using different methods.
CO5 Solve the first order differential equations by various methods.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	1	-	-	-	1
CO2	3	3	2	2	-	-	-	1	-	-	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	-
CO4	3	3	2	3	-	-	-	1	-	-	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	-

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U23OE202	RESOURCE MANAGEMENT TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Learn to formulate linear programming problems and solve LPP using simple algorithm.
- Learn to solve networking problems.
- Learn to formulate and solve integer programming problems.

UNIT I **LINEAR PROGRAMMING** **9**

Principal components of decision problem – Modeling phases – LP formulation and graphic solution – Resource allocation problems – simplex method – sensitivity analysis.

UNIT II **DUALITY AND NETWORKS** **9**

Definition of dual problems – primal – Dual relationships – Dual simplex method – post optimality analysis – Transportation and assignment model – Shortest route problem.

UNIT III **INTEGER PROGRAMMING** **9**

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

UNIT IV **CLASSICAL OPTIMISATION THEROY** **9**

Unconstrained external problems, Newton – Ralphson method – Equality constraints –Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

UNIT V **OBJECTS SCHEDULING** **9**

Network diagram representation – Critical path method – Time charts and resource leveling – PERT

TOTAL: 45 PERIODS

TEXT BOOKS:

1. H A Eiselt, Carl Louis Sandblom, "Operation Research", Springer, 2022.
2. Girish G.Pathak, "Operation Research", Tech Knowledge Publications, 2021.

REFERENCES:

1. Pundir S K, "Operation Research", CBS, 2020.
2. Bhupander Singh, S K Pundir, Amardeep, "Operation Research", A Pragati Edition, 2020.
3. S Hillier Frederick, J Lieberman Gerald, Nag Bodhibroto, Basu Preetam, "Introduction to Operation Research" Tata McGraw Hill, 2021.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112106134
2. https://nptel.ac.in/courses/112106134
3. https://archive.nptel.ac.in/courses/111/104/111104027/

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COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Solve LPP using simple algorithm
CO2 Solve networking problems.
CO3 Solve integer programming problems.
CO4 Solve Non Linear programming problems.
CO5 Solve project management problems.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	-	-	-
CO2	3	2	1	1	-	-	-	1	-	-	-	-
CO3	3	2	1	1	-	-	-	1	-	-	-	-
CO4	3	2	1	1	-	-	-	1	-	-	-	-
CO5	3	2	1	1	-	-	-	1	-	-	-	-

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U23OE203	GRAPH THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand and apply the fundamental concepts in graph theory.
- Able to demonstrate their knowledge of algorithms by solving concrete problems.
- To apply graph theory based tools in solving practical problems.

UNIT I **INTRODUCTION** **9**

Spanning trees – Fundamental circuits – Spanning trees in a weighted graph – cut sets – Properties of cut set – All cut sets – Fundamental circuits and cut sets – Connectivity and separability – 1-Isomorphism – 2-Isomorphism – Combinational and geometric graphs – Planar graphs – Different representation of a planar graph.

UNIT II **TREES, CONNECTIVITY& PLANARITY** **9**

Spanning trees – Fundamental circuits – Spanning trees in a weighted graph – cut sets Properties of cut set – All cut sets – Fundamental circuits and cut sets Connectivity and separability – 1-Isomorphism – 2-Isomorphism –Combinational and geometric graphs – Planar graphs – Different representation of a planar graph.

UNIT III **MATRICES, COLOURING & COVERING** **9**

Incidence matrix – Sub matrices – Circuit Matrix - Fundamental circuit matrix – Cut set, Path, Adjacency Matrix - Chromatic number – Chromatic partitioning – Chromatic polynomial – Matching – Covering – Four colour problem .

UNIT IV **DIRECTED GRAPH** **9**

Directed graphs – Types of directed graphs – Digraphs and binary relations – Directed paths and connectedness – Euler graphs – Trees with Directed edges – Matrices of Digraphs.

UNIT V **GENERATING FUNCTIONS & RECURRENCE RELATIONS** **9**

Generating functions - Partitions of integers - Exponential generating function – Summation operator – Recurrence relations – First order and second order – Non-homogeneous recurrence relations –Method of generating functions.

TOTAL: 45PERIODS

TEXT BOOKS:

1. N P Shrimal, Nita H Shah,"Recent Advancements in Graph Theory ", CRC Press, 2020.
2. S B Singh, "Combinatorics and Graph Theory ", Khanna Publishing House, 2022.

REFERENCES:

1. Harun Pirim, "Recent Applications in Graph Theory", Intechopen, 2022.
2. Mark Anderson, Jonathan L Gross, Jay Yellen, "Graph Theory and its Applications", CRC Press, 2024.
3. Karin R Saoup, "Graph Theory", Chapman and Hall/CRC, 2021.

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ONLINE RESOURCES:

1 https://swayam.gov.in/nd1_noc20_ma05/preview
2 https://dzone.com/articles/the-top-13-resources-for-understandinggraph-theory
3 http://www.nitttrc.edu.in/nptel/courses/video/106104170/L22.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain concepts of graph theory that is walk, path, isomorphism etc.
CO2 Apply various substructures of trees and investigate the planarity of graphs.
CO3 Apply the concepts of Colouring, matching and chromatic number in theorems.
CO4 Explain digraphs and Euler graphs.
CO5 Solve recurrence relations using generating functions.

CO - PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	1	-	-	-	-
CO3	3	2	1	2	-	-	-	1	-	-	-	1
CO4	2	2	1	1	-	-	-		-	-	-	1
CO5	3	2	1	1	-	-	-	1	-	-	-	-

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U23OE204 **OPERATIONS RESEARCH** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand different methods involved in linear programming models, transportation and assignment models.
- To appropriately formulate various OR models and apply optimization techniques and algorithms to solve decision theory and project scheduling.
- To enhance the students to acquire the knowledge about inventory controls and queuing models.

UNIT I **LINEAR PROGRAMMING MODELS** 9

Introduction – Mathematical formulation of LPP – graphical solution – simplex method – duality.

UNIT II **TRANSPORTATION AND ASSIGNMENT MODELS** 9

Mathematical formulation of transportation problem – Methods for finding initial basic feasible solution – optimum solution – degeneracy – mathematical formulation of assignment models – Hungarian Algorithm – Travelling salesman problem.

UNIT III **DECISION THEORY AND PROJECT SCHEDULING** 9

Decision trees – Game theory – two people zero sum – mixed strategies – 2xn and mx2 games. Project scheduling: CPM and PERT – crashing networks and cost considerations – resource levelling and resource smoothening.

UNIT IV **SEQUENCING AND INVENTORY MODELS** 9

Sequencing model – 2 machines n jobs, m machines n jobs – n jobs 2 machines. Inventory model – deterministic and probabilistic models.

UNIT V **QUEUEING MODELS** 9

Queuing models – Poisson arrival and exponential service times – single & multi-server models.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. H A Eiselt ,Carl Louis Sandblom, "Operation Research", Springer, 2022.
2. Girish G Pathak, "Operation Research", Tech Knowledge Publications, 2021.

REFERENCES:

1. S Hillier Frederick, J Lieberman Gerald, Nag Bodhibroto, Basu Preetam, "Introduction to Operation Research", Tata McGraw Hill, 2021.
2. Bhupander Singh, Pundir S K, Amardeep, "Operation Research", A Pragati Edition, 2020.
3. Pundir S.K, "Operation Research", CBS, 2020.

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ONLINE RESOURCES:

1. https://nptel.ac.in/courses/111/105/111105100/
2. https://nptel.ac.in/courses/112/106/112106134/
3. https://freevideolectures.com/course/2678/advanced-operations research

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Solve linear programming models.
CO2 Apply the concepts of transportation and assignment models in real life applications.
CO3 Analyze the project schedule and the cost-time trade-offs in the context of a project network and optimal decisions using graphical approach.
CO4 Estimate the total elapsed time for the problems of multiple jobs and machines in a production line and understand the various selective inventory control techniques and its applications.
CO5 Analyze the quantitative metrics of performance for queuing systems.

CO- PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	-	-	-	-	1
CO2	3	2	1	2	-	-	-	-	-	-	-	1
CO3	3	3	2	2	-	-	-	1	-	-	-	-
CO4	3	3	2	3	-	-	-	1	-	-	-	1
CO5	3	3	2	2	-	-	-	1	-	-	-	-

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U23OE205	SCIENTIFIC PRINCIPLES IN HISTORICAL MONUMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To recall the historical background of the monuments.
- To recognize the different scientific principles in the maintenance of historical monuments.
- To identify the knowledge of construction techniques used in historical period.

UNIT I **CHARACTERISTICS OF MONUMENTS** 9

Definition - Materials used - Purpose-Functions - Types: religious, secular, palaces, forts, tombs, bridges - irrigation systems - need for conservation.

UNIT II **HISTORY OF CONSTRUCTION TECHNOLOGIES** 9

Chronological development - Ancient civilizations - Ancient period - Medieval construction-construction in the modern period - technical achievements.

UNIT III **BASIC PHYSICS PRINCIPLES** 9

Stability and equilibrium: leaning tower of Pisa – Tension, stress and strain: bridges – Overcoming forces: sledges, pulleys and elevators.

UNIT IV **TECHNIQUES OF CONSTRUCTION** 9

Mechanical energy to move large stones –use of counter weights and counter ramps.

UNIT V **ANCIENT TECHNIQUES** 9

Hydraulic transport of building material –use of levers and pivot walking.

TEXT BOOKS:

1 Halliday , Resnick, "Principles of Physics", 12th Edition , John Wiley & Sons, 2023.
2 Mila Powers, "Conservation science for Cultural Heritage", Willford Press, 2022.

REFERENCES:

1. Paula Pires, Joao Mascarenhas, "History of Construction Cultures", Taylor & Francis, 2021.
2. Claire Smith, "Encyclopedia of Global Archaeology", Springer, 2021.
3. Paul G Hewitt, "Conceptual Physics", 13th Edition, Pearson Education, 2024.

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ONLINE RESOURCES:

1 https://doi.org/10.1038/s40494-025-01640-y

2 https://orcid.org/0000-0003-0049-8171

3 https://doi.org/10.70102/afts.2024.1631.036

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the characteristics of historical monuments.

CO2 Summarize the different scientific principles in designing and construction of historical monuments.

CO3 Apply the basic physics principles in maintenance of historical monuments.

CO4 Describe the history of construction technologies in various era.

CO5 Explain the techniques of construction used in olden days.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE206	NON-CONVENTIONAL ENERGY SOURCES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To compare different forms of energy.
- To acquire knowledge of different methods of harvesting energy.
- To recognize the use of alternate sources of energy.

UNIT I **SOLAR ENERGY** **9**

Sun Earth radiation spectra – Solar Radiation Data – Measurement of Solar Radiation data – Solar collectors – Solar water Heater – Solar cookers – Solar Greenhouse effect – Solar Cell fundamentals – a typical solar electric installation for home (solar panels, battery and inverter)

UNIT II **WIND ENERGY** **9**

Origin of wind – Nature of wind – Wind Turbine Siting – Major Applications of Wind Power – Main components of the horizontal axis wind turbine – Wind Energy Conversion systems – Wind – Diesel Hybrid System.

UNIT III **BIOMASS ENERGY** **9**

Introduction – Photosynthesis Process – Biofuels – Biomass Resources – Biomass conversion technologies – Urban Waste to Energy Conversion – Biomass Gasification – Biomass to Ethanol production – Biogas Production from Waste Biomass.

UNIT IV **CHEMICAL ENERGY SOURCES** **9**

Fuel cells – design and principle of operation of a fuel cell – Classification of fuel cells – Types of Fuel cells – Hydrogen and fossil fuel cell – Advantages and disadvantages of fuel cells.

UNIT V **DIFFERENT TYPES OF BATTERY** **9**

Batteries : Basic battery theory – Different types of battery arrangement – classification of batteries – Lead – Acid battery – Nickel cadmium battery – Li-ion battery – batteries used in portable devices (laptops, cell phones, pace makers).

TOTAL:45 PERIODS

TEXT BOOKS:

1. B H Khan , "Non-Conventional Energy Resources", Tata McGraw Hill, 2024.
2. G D Rai , "Non-Conventional Energy Sources", 4th Edition, Khanna Publishers, 2023.

REFERENCES:

1. D P Kothari, K C Singal, Rakesh Ranjan, "Renewable energy sources and emerging technologies", 3rd Edition, Prentice Hall of India, 2022.
2. Mehmet Kanoglu, Yunus A Cengel, John M Imbala, "Fundamentals and Applications of Renewable Energy", 2nd Edition, Tata McGraw Hill, 2023.
3. G S Sawhney, "Non-Conventional Energy Resources", Prentice Hall of India, 2024.

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ONLINE RESOURCES:

1. https://www.ipcc.ch/site/assets/uploads/2018/03/Chapter-7-Wind-Energy-1.pdf
2. https://archive.nptel.ac.in/content/storage2/courses/108108078/pdf/S
3. https://ebooks.inflibnet.ac.in/esp07/chapter/biomass-as-an-energy-source/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamentals of different forms of solar energy.
CO2 Describe the origin, nature and applications of wind energy.
CO3 Explain the process involved in production and conversion of biomass energy.
CO4 Describe the design and principles of fuel cells.
CO5 Explain the basic theory and types of batteries.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE207 **ENVIRONMENTAL PHYSICS** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To relate the connection between physics and human environment.
- To recognize the structure, composition of the atmosphere and the global weather conditions.
- To identify the use of renewable energy resources.

UNIT I **PHYSICS IN HUMAN ENVIRONMENT** 9

Laws of thermodynamics – thermodynamics and the human body – Energy and metabolism - Energy transfers: Concepts of Conduction, Convection, Radiation and Evaporation – Survival in cold and hot climates.

UNIT II **THE URBAN ENVIRONMENT** 9

Townscape – Energy in the city – Transportation – Water for urban environment – Lighting – Urban pollution – Smog – Acid rain – Car as an urban pollutant – Noise pollution.

UNIT III **ENERGY FOR LIVING** 9

World energy demand – World energy supplies – Basic concepts of Energy sources: Fossil fuels – Wind energy – Solar energy – Tidal energy.

UNIT IV **GEOTHERMAL AND HYDRO ENERGY** 9

Geothermal Resources – Geothermal Technologies – Hydro Energy: Hydropower resources – hydropower technologies – environmental impact of hydro power sources.

UNIT V **RADIATION PROTECTION** 9

Nuclear radiation: exposure rate, dose rate, equivalent dose rate, population dose – quantitative effects of radiation on the human species – calculation – nuclear reactor – shielding.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Abel Rodrigues, Gabriel Pita, Raul Albuquerque Sardinha, "Fundamental Principles of Environmental Physics", Springer, 2022.

2 Pranav Kumar, "Fundamentals of Ecology and Environment" , 2nd Edition, Pathfinder Publication, 2021.

REFERENCES:

1 Khan B H, "Non-Conventional Energy Resources", Tata McGraw Hill, 2024.

2 Kyle Forinash, "Foundations of Environmental Physics", Island Press, 2022.

3 C Francesco, "Advances in Environmental Applied Physics", MDPI, 2023.

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ONLINE RESOURCES:

1 http://en.wikipedia.org/wiki/Renewable_energy

2 https://www.uprm.edu/aret/docs/Ch_3_Ocean.pdf

3 https://ebooks.inflibnet.ac.in/esp07/chapter/applications-of- solar- energy/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the different laws related to human environment.
CO2 Describe the importance of physics in urban living.
CO3 Summarize the basic concepts of energy sources.
CO4 Apply the basic concepts of geothermal and hydro energy on environmental impact.
CO5 Explain about the radiation protection and dosage measurements.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-
CO4	3	2	1	2	-	-	-	-	-	-	-	1
CO5	2	2	1	1	-	-	-	-	-	-	-	-

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U23OE208	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To equip and develop the learners entrepreneurial skills and qualities essential to undertake business.
- To Gain knowledge on innovation, its types, role of technology in innovation, patents and licensing.
- To be able to prepare a business plan.

UNIT I **INTRODUCTION** **9**

The Entrepreneur – Definition – Characteristics of Successful entrepreneur. Entrepreneurial scene in India; MSME; Analysis of entrepreneurial growth in different communities – Case histories of successful entrepreneurs. Similarities and Differences between Entrepreneur and Intrapreneur.

UNIT II **INNOVATION IN BUSINESS** **9**

Types of Innovation – Creating and Identifying Opportunities for Innovation – Design Thinking- The Technological Innovation Process – Creating New Technological Innovation and Intrapreneurship – Licensing – Patent Rights – Innovation in Indian Firms.

UNIT III **NEW VENTURE CREATION** **9**

Identifying Opportunities for New Venture Creation: Environment Scanning – Generation of New Ideas for Products and Services. Creating, Shaping, Recognition, Seizing and Screening of Opportunities. Feasibility Analysis: Technical Feasibility of Products and Services – Marketing Feasibility: Marketing Methods – Pricing Policy and Distribution Channels.

UNIT IV **BUSINESS PLAN PREPARATION** **9**

Benefits of a Business Plan – Elements of the Business Plan – Developing a Business Plan – Guidelines for preparing a Business Plan – Format and Presentation; Start-ups and ecommerce Start-ups. Business Model Canvas.

UNIT V **FINANCING THE NEW VENTURE** **9**

Capital structure and working capital Management: Financial appraisal of new project, Role of Banks – Credit appraisal by banks. Institutional Finance to Small Industries – Incentives – Institutional Arrangement and Encouragement of Entrepreneurship.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 R D Hisrich, "Entrepreneurship", 11th Edition, Tata McGraw Hill, 2020.

2 C B Gupta, "Entrepreneurship – Text and Cases", Sultan Chand & Sons, 2023.

REFERENCES:

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1 Desai V, "Small Scale Industries and Entrepreneurship", Himalaya Publishing House, 2018.
2 Bruce R Barringer, R Duane Ireland "Entrepreneurship: Successfully Launching New Ventures", 6th Edition, Pearson Education, 2018.
3 Roy R, "Entrepreneurship", 2nd Edition, Oxford University Press, 2011.

ONLINE RESOURCES:

1 http://www.cengage.com/highered
2 https://roadmapresearch.com/entrepreneurship-beyond-curriculum
3 https://onlinecourses.swayam2.ac.in/cec20_mg19/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain about growth of entrepreneurship in India..

CO2 Describe about innovation, its types, role of technology in innovation, patents and licensing.

CO3 Summarize the concepts of new venture.

CO4 Design a business plan.

CO5 Comprehend the various types of financing available for new ventures.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	1	-	2	-	-	2	2	2	2
CO2	2	2	1	1	-	1	-	2	-	-	2	2	2	2
CO3	2	2	1	1	-	1	-	2	-	-	2	2	2	2
CO4	2	2	1	1	-	1	-	2	-	-	2	2	2	2
CO5	2	2	1	1	-	1	-	2	-	-	2	2	2	2

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U23OE209	BASICS OF BIOENERGY AND BIOFUELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts of biofuels and bio based products.
- To recognize the advancement of biofuels and illustrate the chemistry involved in converting them.
- To impart the knowledge about bioenergy and biofuel technology and its applications.

UNIT I **INTRODUCTION** **9**

Bio power, Bio heat, Biofuel, advanced liquid fuels, drop-in fuels, bio based products.

UNIT II **BIOMASS** **9**

Harvested Feed stocks: First generation biofuels, second generation biofuels, and third generation biofuels. Residue Feedstocks: Agricultural wastes, forestry wastes, farm waste, organic components of residential, commercial, institutional and industrial waste.

UNIT III **PROCESSING TECHNIQUES** **9**

Biochemical conversion – hydrolysis, enzyme and acid hydrolysis, fermentation, anaerobic digestion and trans-esterification, Thermo chemical conversion – Combustion, Gasification, Pyrolysis

UNIT IV **BIOFUELS** **9**

Pros and cons of Biofuels, Algal biofuels, Cyanobacteria and producers of biofuels, Bioethanol, Biomethane, biohydrogen, biobutanol, metabolic engineering of fuel molecules, Engineering aspects of biofuels.

UNIT V **BIO ENERGY SUSTAINABILITY** **9**

Environmental Sustainability, bio energy sustainability, emissions of biomass to power generation applications, emissions from biofuels. Carbon footprint, Advanced low carbon fuels.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R William Oswald, "Introduction to Bioenergy", Springer, 2023.
2. A K S R Reddy, "Principles and Practice", 2nd Edition , CRC Press, 2022.

REFERENCES:

1. Ashok Pandey, R C Kuhad, Vinod Kumar "Biofuels: Biochemistry and Biotechnology", 2nd Edition , Springer, 2023.
2. Anuj Kumar, R K Singh, S K Saha, "Bioenergy and Biofuels: Advanced Biorefineries for sustainable production", 1st Edition , Elsevier, 2022.

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3. L David klass, M John Farewell, "Fundamentals of Bioenergy and Biofuels", 1st Edition, Academic Press (Elsevier), 2022.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc19_bt16/preview
2. https://www.renewableinstitute.org/training/biomass-course/
3. https://www.eesi.org/topics/bioenergy-biofuels-biomass/description

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the concept of bioenergy.
CO2 Evaluate the value of biomass.
CO3 Describe the chemistry involved in the production of bioenergy.
CO4 Explain the principle of biofuel technologies on a small and large scale.
CO5 Describe the use of biofuels in a sustainable manner.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	1
CO2	3	3	2	3	-	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	1	-	-	-	-	1
CO4	2	2	1	1	-	-	2	-	-	-	-	1
CO5	2	2	1	1	-	-	3	1	-	-	-	1

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U23OE210	FOOD SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- This course will enable the students with good scientific and engineering knowledge so as to create new food products and design equipment's for food industries.
- This is necessary for effective understanding of a detailed study of food processing and technology subjects.
- This course will enable students to appreciate the importance of food with respect to the producer, manufacturer and consumer.

UNIT I FOOD PROCESS ENGINEERING OPERATIONS 9

Materials and Energy Balances - Fluid flow applications, Heat transfer applications, Drying, Evaporation, Equilibrium stage process, leaching and Extractions - Application of Mechanical separations and Mixing, in Diary, Meat Industry, Oil and Fat Industry, Cereal processing.

UNIT II FOOD WASTES IN VARIOUS PROCESSES 9

Waste disposal-solid and liquid waste - rodent and insect control - use of pesticides – ETP - selecting and installing necessary equipment.

UNIT III FOOD PRESERVATION AND ITS IMPORTANCE 9

Introduction: Food safety and food poisoning - reasons for food poisoning and its effects. Deterioration and spoilage of processed foods - Shelf life of food products - Types of food based on its perishability. Food Preservation: Preservation methods - Thermal Methods - Pasteurization - Dehydrofreezing -Dosimetry - Transport of food and Preservation Strategies.

UNIT IV DEVELOPMENTS IN FOOD PROCESSING 9

Food Constituents and processing Food emulsions - Food Rheology, Advances in thermal Operation, Extrusion, cooking Spray dryer design - Energy expenditure and Saving Food for developing countries - Food Detoxification - Production of Sweeteners - Starch, Microbial Polysaccharides, Amino acid, Rice bran Tocopherols.

UNIT V FOOD HYGIENE AND QUALITY CONTROL 9

Quality Control in Food Industry - Dose Response Relationship, Health Problem, Chemical and Micro biological aspects - Food analysis, Instruments and Enzymatic Analysis - Food Safety. Food laws and standards.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1. A David Ledford, "Food Science", 8th Edition, Springer International Publishing, 2023.
2. Owen R Fennema, Srinivasan Damodaran, "Food Chemistry", 7th Edition, CRC Press, 2022.

REFERENCES:

1. Srilakshmi B, "Food Science", 8th Edition, New Age International Publishers, 2023.
2. Sanjeev Kumar Sharma, Harshad Kiran Kalwit, "Objective Food Science", 12th Edition, Jain Brothers Publication, 2023.
3. P R Ashoh Kumar, K Suresh Babu, "Food Processing Technology: Principles and practice", 3rd Edition, CRC Press, 2022.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/103107088
2 https://archive.nptel.ac.in/courses/126/105/126105015/
3 https://onlinecourses.nptel.ac.in/noc21_ag01/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the food constituents and their energy levels.
CO2 Explain the food waste disposal in various processes.
CO3 Describe the preservative techniques to improve the shelf life of food products.
CO4 Explain the various methods of food processing and storage.
CO5 Describe the food quality control and its importance.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	1	1	-	-	-	-	1
CO2	2	2	1	1	-	1	1	-	-	-	-	1
CO3	2	2	1	1	-	1	1	-	-	-	-	1
CO4	2	2	1	1	-	1	1	-	-	-	-	1
CO5	2	2	1	1	-	1	1	1	-	-	-	1

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U23OE211	FUNDAMENTALS OF CROP PRODUCTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The goal of the course is to provide knowledge about the fundamentals of agricultural production.
- Students will learn about influence of weather on crop growth, soil-water-plant relationships, disease and crop weed management.
- Outlining the function of agricultural engineers in connection to different methods of crop production

UNIT I **INTRODUCTION** **9**

Introduction to agriculture and its crop production sub-sectors - field crop production and horticulture -Factors affecting crop growth and production. Benefits of agriculture - economic benefits, environmental benefits, social and cultural benefits, health, nutrition and food accessibility benefits.

UNIT II **CROP SELECTION AND SETTLEMENT** **9**

Regional and seasonal selection of crops - Systems of crop production - Competition among crop plants - Spacing and arrangement of crop plants - Field preparation for crops including systems of tillage - Establishment of an adequate crop stand and ground cover, including selection and treatment of seed, and nursery growing.

UNIT III **HORTICULTURAL CROPS PRODUCTION** **9**

Important groups of horticultural crops in Tamil Nadu such as vegetable crops, fruit crops, flower crops -Cultivation practices of representatives of each group - Special features of production of horticultural crops - green house cultivation.

UNIT IV **MODERN CONCEPTS** **9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops.

UNIT V **AGRICULTURAL WASTE MANAGEMENT** **9**

Concept, scope and maintenance of waste management - recycle of organic waste, garden wastes- solid waste management - scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Dr Rajendra Prasad, "Textbook of Field Crops Production Food Grains Crops", 2020.
2. Alok Kumar, Abhishek Pratap Singh, Abhishek Sonkar, Mohit Pal, Chahak Tandon, "Text Book on Production Technology of Fruit Crops", 2022.

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REFERENCES:

1. Dr Panda S C, "Modern concepts and advance principles of crop production", M/s AGROBIOS (INDIA), 2023.
2. Beena Nair, K P Singh, P Chand, "Fundamentals of Vegetable Crop Production", Scientific Publishers, 2019.
3. S R Reddy , C Nagamani, "Principles of Crop Production", Kalyani Publishers, 2019.

ONLINE RESOURCES:

1. https://www.classcentral.com/course/youtube-agriculture-crop-production-fundamentals-bcpp-47529
2. https://onlinecourses.nptel.ac.in/noc24_ag08/preview
3. https://onlinecourses.nptel.ac.in/noc23_ag08/preview

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Summarize the principles behind crop production and various parameters that influence the crop growth on roof tops.
CO2 Explain the methods of land preparation.
CO3 Evaluate weed establishment and its management.
CO4 Describe crop water requirement and irrigation water management on roof tops.
CO5 Describe the concept of waste management on roof tops.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	3	-	-	-	1	1
CO2	2	2	1	1	-	-	3	-	-	-	1	1
CO3	3	3	2	3	-	-	3	-	-	-	1	1
CO4	2	2	1	1	-	-	3	-	-	-	-	1
CO5	2	2	1	1	-	-	3	-	-	-	-	1

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U23OE212	WATER POLLUTION AND CONTROL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The goal of the course is to provide knowledge about the fundamentals of water pollution.
- To impart knowledge on the causes, effects and control or prevention measures of water pollution.
- Outlining the function of agricultural engineers in connection to different methods of water treatments.

UNIT I **SOURCES OF WATER** **9**

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

UNIT II **WATER POLLUTION** **9**

Water Pollution: Classification of Water Pollution - Pathogenic organisms, oxygen demanding Substance - plant nutrients - toxic organics, inorganic chemicals, radioactive substance – thermal pollution – steam pollution. Sources of contamination: Water borne diseases and health effects.

UNIT III **PROCESSES OF WATER TREATMENT** **9**

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation - sand filters - Disinfection - –Construction, Operation and Maintenance aspects.

UNIT IV **ADVANCED WATER TREATMENT** **9**

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange – Membrane Systems - Iron and Manganese removal - Defluoridation – Construction, Operation and Maintenance aspects.

UNIT V **LAWS AND ACTS** **9**

Centre ground - water board and organizational set up – guidelines for water abstraction, clearance for ground water abstraction - national water policy – Tamil Nadu ground water authority and its function. River linking projects – National and International conflicts and issues. Water act 1974 and rules 1983, act 1977 and rules 1978.

TOTAL: 45 PERIODS

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TEXT BOOKS:

1. S K Gupta, I C Gupta, "Water Pollution and Quality Management", Scientific Publishers, 2023.
2. Margaret Barton, "Water Pollution: Effects, control and Treatment", 2nd Edition, Larsen and Keller Education Publishers, 2020.

REFERENCES:

1. Neha Saxena, M D Merajul Islam, Deepa Sharma, "Water Pollution and Remediation: A Gobal Concern", Springer, 2024.
2. G L Asawa, "Irrigation and Water Resources Engineering", New Age International Publishers, 2024.
3. O P Gupta, "Elements of Water Pollution Control Engineering", Khanna Publisher, 2019.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/105107207
2. https://archive.nptel.ac.in/courses/105/104/105104102
3. https://archive.nptel.ac.in/courses/105/105/105105201

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the sources of water and their characteristics.
CO2 Summarize the various pollutants present in water.
CO3 Describe the Principles, functions and design of a water treatment plant.
CO4 Explain the different methods of water purification process.
CO5 Describe the guidelines for water abstraction.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	1	3	-	-	-	-	1
CO2	2	2	1	1	-	1	3	-	-	-	-	1
CO3	2	2	1	1	-	1	3	-	-	-	-	1
CO4	2	2	1	1	-	1	3	-	-	-	-	1
CO5	2	2	1	1	-	1	3	-	-	-	-	1

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U23OE213	PERSONALITY DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify their own potentials and accept their own limitations.
- To overcome their limitations and move towards self-esteem.
- To maximize their own potential in enabling a holistic development.

UNIT I **INTRODUCTION TO PERSONALITY DEVELOPMENT** 9

Personality-meaning-Definition-Determinants of personality - The concept of personality – Dimensions and Significance of personality development - Becoming aware of strengths and weaknesses, talents and problems, emotions and ideas - the concept of success and failure, factors responsible for success - What is failure and causes of failure.

UNIT II **ATTITUDE, MOTIVATION AND SELF - MOTIVATION** 9

Attitude - Concept - Significance - Positive attitude – Advantages –Negative attitude-Disadvantages Concept of motivation - Significance – Internal and external motives - Importance of self-motivation-Factors leading to de-motivation Managing change, confusion and uncertainty Socializing the individual.

UNIT III **EMPLOYABILITY QUOTIENT** 9

Memory – Art of listening, learning and writing guidelines – Note making – Seminar presentation, Resume building- The art of participating in Group Discussion – Facing the Personal (HR & Technical) Interview -Frequently Asked Questions - Psychometric Analysis - Mock Interview Sessions.

UNIT IV **ASPECTS OF PERSONALITY DEVELOPMENT** 9

Body language - Problem-solving - Conflict and Stress Management - Decision-making skills - Leadership and qualities of a successful leader – Character building -Team-work – Time management - Work ethics –Good manners and etiquette.

UNIT V **INTEGRATED PERSONALITY DEVELOPMENT** 9

Different dimension personality – Physical, Intellectual, Emotional, Moral, Social and Spiritual and Cultural - Learning the Development process - Tools and Skills - Helping to maximize one's potentials - Enhancing one's self image, self-esteem and self- confidence.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Ark, "Personality Development and Character Building" Finger print Publishing, 2024.

2 Prashant Sharma, "Soft Skills: Personality Development for Life Success", 1st Edition, BPB Publications, 2022.

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REFERENCES:

1 Soma Mahesh Kumar, "Soft Skills: Enhanching Personal and Professional Success" 1st Edition, Tata McGraw Hill, 2023.

2 Sabharwal. D P, "Personality Developmen", Finger print Publishing, 2021.

3 Jeff Butterfield, "Soft Skills for Everyone", 2nd Edition, Cengage India Private Limited 2020.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_hs77/preview

2 https://old podcast.com/best-free-ebooks-personal-development

3 https://www.sircicai.org/images/cabf/Soft%20Skills%20&%20Personality%20Development.pdf

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the significance of personality and its development.
CO2 Analyze the different facets of personality development.
CO3 Apply employability skills of resume, job application and presentation.
CO4 Apply the aspects of personality development in their jobs.
CO5 Apply the technique and skills of personality development to improve their progress.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	3	3	3	-	1
CO2	-	-	-	-	-	-	-	3	3	3	-	1
CO3	-	-	-	-	-	-	-	3	3	3	-	1
CO4	-	-	-	-	-	-	-	3	3	3	-	1
CO5	-	-	-	-	-	-	-	3	3	3	-	1

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U23OE214 **WORKPLACE COMMUNICATION** L T P C

3 0 0 3

COURSE OBJECTIVES:

- To develop in students the competence to select the appropriate language and strategies for effective communication in daily workplace contexts.
- To View real-world facets of challenges faced when communicating in the workplace.
- To Learn how to work in different business environments.

UNIT I **IDENTIFY WORKPLACE PERSONALITIES** 9

Communication process; Analysis of purpose, audience, information and context; Strategies for verbal and nonverbal communication; Selection of communication channels - How communication should be developed, assignment - Studying types of personalities.

UNIT II **NEW MEDIA IN COMMUNICATION** 9

Impact of Technology, Enabled Communication Types: Internet, Blogs, E-mail; social media - Facebook, Twitter and What's App -Advantages & Disadvantages.

UNIT III **WORKPLACE CORRESPONDENCE** 9

Business Letter Writing, Email Writing, Principles of Effective Letter Writing, Email Writing, Four C's of Communication – Correctness, Completeness, Conciseness, Courtesy Parts of a Business Letter, Letter of Recommendation, Letter of Appointment, Letter of Acceptance of Job Offer, Letter of Appreciation, & Letter of Resignation.

UNIT IV **COMMUNICATION AT THE WORKPLACE** 9

Education and Training, Motivation, Persuasion, Raising Morale, Order and Instruction, Warning, Advice, Business Etiquette Office Etiquette, Internet Etiquette/Netiquette, Business Card Etiquette, Handshake Etiquette, Mobile Phone Etiquette and How to Overcome Them.

UNIT V **WORKPLACE CHALLENGES** 9

Working With Others : Leaders And Followers; Managing Your Emotions : Negative Emotions ; Challenging Conversations : Challenging Opposing Views, Sharing Bad News, Dealing With An Angry Customer Or Colleague; Personal Development Planning, Presentations; Telephone Skills; Job Interviews. Group Communication, Planning And Decision Making.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Tena Crews, Cara Norton.,"Professional Communication", Good heart-Willcox Publisher, 2023.
2. Jeanne Marquardt Elmhorst Ronald B. Adler, Jeanne Marquardt Elmhorst "ISE Communicating at Work"., Tata McGraw Hill, 2022.

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REFERENCES:

1. Bovee, L Courtland, Thill, V John , Raina, Lal Rosha, "Business Communication Today" 15th Edition, Pearson Education, 2021.
2. James W Williams, communication Skills Training Series", Alakai Publishing, 2021.
3. McKinsey Company "Building workforce skills at scale to thrive during and after the COVID-19 crisis." 2021.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_hs15/preview
2. https://www.coursera.org/learn/challenges-of-leading-individuals-in-the-tech-industry
3. https://www.udemy.com/course/business-english-writing/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply The Basic Knowledge Of Workplace Communication.
CO2 Apply Different Types Of Media Communication.
CO3 Write Effective Letters Related To Workplace Environment.
CO4 Apply Various Types Of Workplace Etiquette.
CO5 Explain The Strategies Of Overcoming Challenges In The Workplace.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	3	3	3	-	1
CO2	3	-	-	-	-	-	-	3	3	3	-	1
CO3	3	-	-	-	-	-	-	3	3	3	-	1
CO4	3	-	-	-	-	-	-	3	3	3	-	1
CO5	3	-	-	-	-	-	-	3	2	3	-	1

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U23OE215	ENGLISH FOR COMPETITIVE EXAMINATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.

UNIT I **BASIC VOCABULARY** **9**

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

UNIT II **GRAMMAR AND USAGE** **9**

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

UNIT III **EFFECTIVE READING** **9**

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

UNIT IV **WRITING VARIOUS TEXT** **9**

Writing – Pre-writing techniques – Mind Map - Describing pictures and facts -Paragraph structure – organizing points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

UNIT V **INTERACTIVE LISTENING** **9**

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication –Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Dr. Veena Selvam, "English for Science and Technology", Cambridge University Press, 2021.
2. Wren, Martin, "English for Competitive Examinations", S Chand Publishing, 2020.

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REFERENCES:

1. Bovee, Courtland L, Thill, John V Raina, Lal Roshan, "Business Communication Today", 15th Edition, Pearson Education: Upper Saddle River, 2021.
2. Disha, " General English for Competitive Exams" Disha Publication, 2021.
3. Yashpal,Sharma, "Easy to learn General English" Agrawal Group Of Publications (Agrawal Examcart), 2020.

ONLINE RESOURCES:

1. http://www.examenglish.com/, http://www.ets.org/ , http://www.bankxams.com/
2. http://civilservicesmentor.com/, http://www.educationobserver.com
3. http://www.cambridgeenglish.org/in/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply the intricacies of vocabulary in order to develop language skills.
CO2 Analyze the technique of grammar to face competitive examination
CO3 Apply the basic ideas and strategies of reading.
CO4 Write different types of reconstructing passages, report writing and essay writing.
CO5 Apply interactive communication skills in listening texts.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	3	3	3	-	1
CO2	3	-	-	-	-	-	-	3	3	3	-	1
CO3	3	-	-	-	-	-	-	3	3	3	-	1
CO4	3	-	-	-	-	-	-	3	3	3	-	1
CO5	3	-	-	-	-	-	-	3	3	3	-	1

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U23OE216 **ENGLISH FOR PROFESSIONAL EXCELLENCE** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enhance students' ability to listen and speak professionally related to workplace concerns and interactions.
- To improve articulation and comprehension through motivational texts, technical articles, and leadership talks.
- To enable students to write reviews, emails, reports, resumes with cover letters and projects.

UNIT I **FOUNDATIONS OF PROFESSIONAL COMMUNICATION** 9

Listening to concerns and complaints – Responding with thought-provoking solutions – Reading short motivational anecdotes to improve pronunciation – Writing paragraphs based on motivational ideas and proverbial expressions.

UNIT II **EXPRESSIVE AND PERSUASIVE COMMUNICATION** 9

Listening to famous motivational speeches – Practice short speeches like welcome address, vote of thanks and farewell address – Reading technical articles with intonation - Writing reviews and reflections on travel, books or current topics.

UNIT III **WORKPLACE COMMUNICATION AND ETIQUETTE** 9

Listening workplace conversations and discussions – Simulate meetings and practice giving polite instructions– Reading workplace memos and notices – Writing professional emails and reports.

UNIT IV **COMMUNICATION FOR COLLABORATION AND LEADERSHIP** 9

Listening to interview recordings and career talks – Practice introducing yourself and mock interviews – Reading job postings – Drafting resumes and cover letter.

UNIT V **CAREER COMMUNICATION AND PERSONAL BRANDING** 9

Listening to panel discussions – Practice group discussions – Reading leadership talks – Project writing and formal presentation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rajendran, Jayanthi, Jeya Santhi V, Nagalakshmi B, "The Art of English Communication: A Practical Approach", https://notionpress.com, 2025.
2. Horine, Greg, "Project Management Absolute Beginner's Guide" (Updated Edition), Que Publishing, 2023.

REFERENCES:

1. Bryan A. Garner, "HBR Guide to Better Business Writing", Harvard Business Review Press, 2021.
2. Nair, Bhaskaran, P. "Functioning in English" (A Multi-skill Language Course for Undergraduate Programmes), Emerald Publishers, 2018.
3. Enelow, Wendy, Louise Kursmark, "Modernize Your Resume: Get Noticed... Get Hired" (3rd Edition), Emerald Career Publishing, 2023.

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ONLINE RESOURCES:

1. https://reedsy.com/discovery/blog/book-review-examples
2. https://www.indeed.com › Career Guide › Interviewing
3. https://nevonprojects.com/project-ideas/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Apply listening and reading skills to enhance clarity in writing.
CO2 Analyze and internalize motivational speech techniques to develop their oral and written communication proficiency.
CO3 Apply professional communication strategies and compose effective emails and reports.
CO4 Analyze career-oriented communication and draft resumes and cover letter.
CO5 Design engaging formats to present their prepared projects.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	3	-	3	-	1
CO2	3	-	-	-	-	-	-	3	-	3	-	1
CO3	2	-	-	-	-	-	-	3	-	3	-	2
CO4	3	-	-	-	-	-	-	3	-	3	-	2
CO5	3	-	-	-	-	-	-	3	-	3	-	2

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U23OE222	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Understand the Introduction and basic Terminologies safety.
- To provide wide exposure to the students about various legislation applicable to an industrial unit.
- To enable students to Conduct and participate in various Safety activities in the Industry and through various Risk Assessment Techniques.

UNIT I **SAFETY TERMINOLOGIES** **9**

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 II **STANDARDS AND REGULATIONS** **9**

FACTORIES ACT – 1948

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare – special provisions – penalties and procedures-

Tamil Nadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948 - Tamil Nadu safety officer rules 2005.

ENVIRONMENT ACT – 1986

General powers of the central government, prevention, control and abatement of environmental pollution Biomedical waste (Management and handling Rules), 1989- The noise pollution (Regulation and control) Rules, 2000- The Batteries (Management and Handling Rules)

UNIT III **OTHER ACTS AND RULES** **9**

Indian Boiler (Amendments) Act 2007, static and mobile pressure vessel rules (SMPV), motor vehicle rules, the Mines and Minerals (Development & Regulation) Amendment Act, 2015, workman compensation act, rules – electricity act and rules – hazardous wastes (management, handling and transboundary) rules, 2008 - the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules 2016, Explosives Act 1884 - Pesticides Act – E waste (management) rules 2016.

UNIT IV **SAFETY ACTIVITIES** **9**

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site

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Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

UNIT V **HAZARD IDENTIFICATION TECHNIQUES** **9**

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: 45 PERIODS

REFERENCES:

1 Frank P Lees, "Loss Prevention in Process Industries", 4th Edition, Butterworth Heinemann Publications, 2012.
2 John Ridley, John Channing, "Safety at Work", 7th Edition, BH Publications, 2008.
3 Dan Petersen, "Techniques of Safety Management: A System Approach", 4th Edition, Amer Society of Safety Engineers, 2003.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Explain the basic concept of safety.

CO2 Summarize important legislation related to health, Safety and Environment.

CO3 Explain various legislation applicable to an industrial unit

CO4 Describe the safety Activities of the Working Place and to prepare onsite and offsite emergency plans

CO5 Explain the Risk Assessment Techniques

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	3	2	-	-	-	3
CO2	2	2	1	1	-	-	3	2	-	-	-	3
CO3	2	2	1	1	-	-	3	2	-	-	-	3
CO4	2	2	1	1	-	-	3	2	-	-	-	3
CO5	2	2	1	1	-	-	3	2	-	-	-	3

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U23OE223	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the various solar energy and Wind technologies and its applications.
- To explore the various biomass energy technologies and fuel cell.
- To study the ocean and geothermal technologies.

UNIT I **ENERGY SCENARIO** **9**

Control System: Open Loop and Closed Loop – Feedback Control System Characteristics – First Principle Modeling: Mechanical, Electrical and Electromechanical Systems – Transfer Function Representations: Block Diagram and Signal Flow Graph.

UNIT II **SOLAR ENERGY** **9**

Solar Thermal – Flat Plate and Concentrating Collectors – Solar Thermal Power Plant – Solar Photovoltaic Conversion – Solar Cells – PV Applications.

UNIT III **WIND ENERGY** **9**

Basic Components of Wind Energy Conversion System (WECS) - Classification Of WECS - Horizontal Axis - Single, Double And Multi-Blade System. Vertical Axis - Savonius and Darrieus Types.

UNIT IV **BIOMASS ENERGY AND FUEL CELL** **9**

Biomass Direct Combustion – Biomass Gasifier – Biogas Plant – Cogeneration – Biomass Applications - Fuel Cell.

UNIT V **OCEAN AND GEOTHERMAL ENERGY** **9**

Tidal Energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro – Geothermal Energy - Types of Geothermal Power Plants.

TOTAL: 45 PERIODS

REFERENCES

1. John Twidell, "Renewable Energy Resources", 4th Edition, Routledge Publishers, 2021.
2. Bent Sorensen, "Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning", 5th Edition, Academic Press, 2017.
3. Godfrey Boyle, "Renewable Energy: Power for a Sustainable Future",3rd Edition, Oxford University Press, 2012.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Explain the Environmental aspects of energy utilization and Renewable energy scenario.

CO2 Describe the concepts and applications of solar energy systems.

CO3 Describe the concepts and applications of wind energy systems.

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CO4 Summarize the processes of biomass and Fuel Cell.

CO5 Explain on other possible renewable energy sources.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	1	-	-	-	-	-
CO2	2	2	1	1	-	-	1	-	-	-	-	-
CO3	2	2	1	1	-	-	1	-	-	-	-	-
CO4	2	2	1	1	-	-	1	-	-	-	-	-
CO5	2	2	1	1	-	-	1	-	-	-	-	-

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U230E224	INTRODUCTION TO SMART GRID	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know the power industry to observe and control parts of the system at higher resolution in time and space
- To purposes of the smart grid is real time information exchange to make operation as efficient as possible
- To know how to improve reliability of the Electricity networks and make the grid amenable to renewable energy inputs through distributed generation.

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid – Concept - Definitions and Need for Smart Grid- Smart grid drivers - functions - opportunities - challenges and benefits- Difference between conventional & Smart Grid- National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers - Smart energy resources- Smart substations - Substation Automation - Feeder Automation -Transmission systems: EMS - FACTS and HVDC - Wide area monitoring- Protection and control- Distribution systems: DMS- Volt/VAR control- Fault Detection- Isolation and service restoration-

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters- Advanced Metering infrastructure (AMI) drivers and benefitsAMI protocols- standards and initiatives- AMI needs in the smart grid- Phasor Measurement Unit (PMU)- Intelligent Electronic Devices(IED)& their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid- Power Quality issues of Grid connected Renewable Energy Sources- Power Quality Conditioners for Smart Grid- Web based Power Quality monitoring- Power Quality Audit.

UNIT V CONTROLLERS AND THEIR COORDINATION 9

Introduction and role of SCADA in smart grid - Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) - Broad band over Power line (BPL) - IP based Protocols- Basics of Web Service, CLOUD Computing - and Cyber Security Issues.

TOTAL: 45 PERIODS

REFERENCES:

1. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", 1st Edition, CRC Press, 2017.
2. James A Momoh, "Smart Grid: Fundamentals of Design and Analysis", 1st Edition, John Wiley & Sons, 2012.

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3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", 1st Edition, John Wiley & Sons, 2012.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the concepts of Smart Grid and its present developments.

CO2 Describe about the different smart grid technologies.

CO3 Explain about the different smart meters and apply them in advanced metering infrastructure.

CO4 Analyze power quality management in smart grid.

CO5 Summarize LAN, WAN and cloud computing for smart grid.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	-	-	-		-	1
CO4	3	3	1	2	-	-	-	-	-	-	-	1
CO5	2	2	1	1	-	-	-	-	-	-	-	1

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U230E225	BASICS OF POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge on the operation of thermal power plant and the subsystems including fuel Preparation and handling, boiler types.
- To impart knowledge on layout and operation of diesel and gas turbine power plants and nuclear power plants.
- To educate the environmental and cost economics of using renewable energy sources compared to fossil fuels and to introduce the importance of instrumentation, measurement and control techniques in power plants.

UNIT I COAL BASED THERMAL POWER PLANTS 9

Layout of modern coal power plant, Supercritical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment.

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle – Analysis & Optimization. Components of Diesel and Gas Turbine power plants.

UNIT III NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium – Uranium reactor (CANDU), Safety measures for Nuclear Power plants.

UNIT IV ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants.

UNIT V POWER PLANT INSTRUMENTATION AND CONTROL 9

Plant Automation, Plant Optimization, Safety & Protection, Instrumentation & Controls. Importance of measurement and instrumentation in power plants, measurement of water purity, CO2 measurements, measurement of smoke and dust.

TOTAL: 45 PERIODS

REFERENCES:

1 P K Nag, "Power Plant Engineering", 4th Edition, Tata McGraw Hill, 2020.

2 M M El Wakil, "Power Plant Technology", 3rd Edition, Tata McGraw Hill, 2021.

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3 Arora, Domkundwar, "A Course in Power Plant Engineering", 3rd Edition, Dhanpat Rai & Co, 2019.

4 R S Khurmi, J K Gupta, "Thermal Engineering", 3rd Edition, S Chand Publishing, 2021.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Comprehend the layout, construction and working of the components inside a thermal power plant.

CO2 Summarize the process of diesel, gas turbine and combined cycle power plants.

CO3 Explain the different nuclear reactors.

CO4 Summarize the environmental and economic issues of using renewable energy sources compared to fossil fuels.

CO5 Describe the various power plant instrumentation and control techniques.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	1	-	-	-	-	-
CO2	2	2	1	1	-	-	1	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	-	1	-	-	-	-	-
CO5	2	2	1	1	-	-	1	-	-	-	-	-

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U230E226	AUTOMOTIVE ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge on the operation of thermal power plant and the subsystems including fuel Preparation and handling, boiler types.
- To impart knowledge on layout and operation of diesel and gas turbine power plants and nuclear power plants.
- To educate the environmental and cost economics of using renewable energy sources compared to fossil fuels and to introduce the importance of instrumentation, measurement and control techniques in power plants.

UNIT I **INTRODUCTION** **9**

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

UNIT II **IGNITION AND INJECTION SYSTEMS** **9**

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT III **SENSOR AND ACTUATORS IN AUTOMOTIVES** **9**

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.

UNIT IV **ENGINE CONTROL SYSTEMS** **9**

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

UNIT V **CHASSIS AND SAFETY SYSTEMS** **9**

Traction control system – Cruise control system – electronic control of automatic transmission – anti-lock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.

TOTAL: 45 PERIODS

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REFERENCES:

1 James D Halderman, "Automotive Electricity & Electronics", 6th Edition, Pearson Education, 2021.

2 James E Duffy, "Automotive Electricity & Electronics", 7th Edition, GW Publishers, 2021.

3 William B Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, 2019.

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1 Comprehend the importance of emission standards in automobiles.

CO2 Explain the electronic fuel injection/ignition components and their function

CO3 Summarize the sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.

CO4 Describe the chassis and vehicle safety system.

CO5 Explain the various methods of power system earthing.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	-	1
CO5	2	2	1	1	-	-	-	-	-	-	-	1

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U23OE227	FOUNDATION OF AI & PROBLEM SOLVING	L	T	P	C
Prerequisites: Nil		3	0	0	3

COURSE OBJECTIVES:

- To understand basics of intelligent agents.
- To gain knowledge about search strategies.
- To learn about the applications of AI.

UNIT I **INTRODUCTION** 9

Introduction–Definition –Agent based approach - Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems – AI Environments.

UNIT II **PROBLEM SOLVING METHODS** 9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - A* Search – Performance of search algorithms.

UNIT III **KNOWLEDGE REPRESENTATION** 9

First Order Predicate Logic –Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation using First order Predicate logic - Reasoning Systems – Second Order Logic.

UNIT IV **SOFTWARE AGENTS** 9

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V **APPLICATIONS** 9

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving

TOTAL: 45 PERIODS

TEXT BOOKS:

1 S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson Education, 2019.

2 I. Bratko, "Prolog: Programming for Artificial Intelligence", 4th Edition, Addison Wesley Educational Publishers, 2021.

REFERENCES:

1 M. Tim Jones, "Artificial Intelligence: A Systems Approach", 5th Edition, Jones and Bartlett Publishers, 2018.

2 Nils J. Nilsson, "The Quest for Artificial Intelligence", 2nd Edition, Cambridge University Press, 2019.

3 Robert T Nakatsu, "Diagrammatic Reasoning in AI: Decision-making and Problem-solving with Diagrams", 3rd Edition, John Wiley & Sons, 2019.

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ONLINE RESOURCES:

1 https://www.geeksforgeeks.org/problem-solving-in-artificial-intelligence/

2 https://www.udemy.com/course/foundations-of-ai-from-problem-solving-to-machine-learning/?srsltid=AfmBOoozqjf7LO_2TMVunFo1pihQUzpFNu_6p8xYR_4tyDV5eFaTdEpD&couponCode=ST5MT020225BROW

3 https://skillfloor.com/blog/the-foundation-of-artificial-intelligence

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain appropriate search algorithms for any AI problem.

CO2 Explain various problem-solving methods.

CO3 Analyze a problem using first order and predicate logic.

CO4 Analyze various software agents.

CO5 Design applications for NLP that use Artificial Intelligence.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-
CO5	3	3	3	3	-	-	-	-	-	-	-	-

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U23OE228 **INTRODUCTION TO R PROGRAMMING**

L	T	P	C
3	0	0	3

Pre requisites: Nil

COURSE OBJECTIVES:

- To understand the R Studio basics.
- To learn the significance of data manipulation.
- To understand about data analysis.

UNIT I **INTRODUCTION** **9**

Overview of R and its IDEs (RStudio), Basics of R syntax and programming concepts, Data types, variables, and operations in R.

UNIT II **DATA MANIPULATION AND PREPARATION** **9**

Importing and exporting data in R, Data cleaning and preparation with dplyr, Data transformation using tidyr.

UNIT III **DATA ANALYSIS AND STATISTICS** **9**

Descriptive statistics and exploratory data analysis, Hypothesis testing and inferential statistics, Regression analysis and ANOVA.

UNIT IV **DATA VISUALIZATION WITH R** **9**

Principles of effective data visualization, Introduction to ggplot2 and advanced visualization techniques, Creating interactive visualizations with packages like plotly.

UNIT V **ADVANCED ANALYTICS AND MACHINE LEARNING** **9**

Overview of machine learning in R, Classification, regression, and clustering techniques, Model evaluation and tuning.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Hadley Wickham, Garrett Grolemund, " R for Data Analysis," 2nd Edition, O'Reilly Media, 2023.

2 Fischetti, Tony, "R: Data Analysis and Visualization," 2nd Edition, Packt Publishing, 2021.

REFERENCES:

1 Lander, Jared. "R for Everyone: Advanced Analytics and Graphics," 2nd Edition, Pearson Education, 2017.

2 Singh, Ajit. "R Programming: Simply in Depth," 1st Edition, Amazon Digital Services LLC - KDP, 2020,

3 G. Grolemund, " R Programming an Approach to Data Analytics," 1st Edition, MIP Publisher, 2021.

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ONLINE RESOURCES:

1 https://www.datacamp.com/blog/all-about-r
2 https://www.geeksforgeeks.org/r-programming-language-introduction/
3 https://www.w3schools.com/r/r_intro.asp

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the basics of R Programming

CO2 Apply the data manipulation and preparation in R programming.

CO3 Evaluate the need of data analysis and statistics

CO4 Design data visualisation with R

CO5 Design advance analytics and machine learning algorithms.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-
CO5	3	.3	3	3	-	-	-	-	-	-	-	-

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U23OE229 **FOUNDATIONS OF NLP** L T P C

Pre requisites: Nil 3 0 0 3

COURSE OBJECTIVES:

- To learn the fundamentals of NLP, and also to make them for understanding CFG, PCFG in NLP.
- To understand the role of semantics of sentences and pragmatic.
- To learn the basic concepts of speech processing along with analysis and modelling.

UNIT I **INTRODUCTION** 9

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 II **WORD LEVEL ANALYSIS** 9

Unsmoothed n-grams, evaluating n-grams, smoothing, interpolation and backoff – word classes, part-of-speech tagging, rule-based, stochastic and transformation-based tagging, issues in pos tagging – hidden Markov and maximum entropy models.

UNIT III **SYNTACTIC ANALYSIS** 9

Context free grammars, grammar rules for English, treebanks, normal forms for grammar – dependency grammar – syntactic parsing.

UNIT IV **SEMANTICS AND PRAGMATICS** 9

Requirements for representation, first-order logic, description logics – syntax-driven semantic analysis, semantic attachments – word senses, relations between senses, thematic roles, selection restrictions.

UNIT V **SPEECH PROCESSING** 9

Speech fundamentals: articulatory phonetics – production and classification of speech sounds; acoustic phonetics – acoustics of speech production; review of digital signal processing concepts; short-time Fourier transform, filter- bank and lpc methods.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Daniel Jurafsky, James H. Martin," Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", 4th Edition, Pearson Education, 2021.
2. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", 1st Edition, O'Reilly Media, 2022.

REFERENCES:

1 Richard M Reese, "Natural Language Processing with Java", 3rd Edition, OReilly Media, 2020.

2 Nitin Indurkhya and Fred J. Damerau, "Handbook of Natural Language Processing", 2nd Edition, Chapman and Hall/CRC Press, 2019.

3 Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", 2nd Edition, Oxford University Press, 2018.

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ONLINE RESOURCES:

1 https://medium.com/@pingsubhak/foundations-of-natural-language-processing-4c575f642f84
2 https://onlinecourses.nptel.ac.in/noc19_cs56/preview
3 https://www.omdena.com/course/foundations-of-natural-language-processing-theory-and-applications

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamentals of natural language processing.

CO2 Apply the use of CFG and PCFG in NLP.

CO3 Analyze the need of syntactic analysis.

CO4 Evaluate the role of semantics of sentences and pragmatic.

CO5 Analyze speech production and related parameters of speech.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-

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U23OE230 **FOUNDATIONS OF SPEECH RECOGNITION** L T P C

Prerequisites: Nil 3 0 0 3

COURSE OBJECTIVES:

- To Understand about the Speech Signal
- To Learn about Signal Processing for Speech Recognition
- To understand Pattern Comparison Techniques

UNIT I **THE SPEECH SIGNAL** 9

Fundamentals of Speech recognition, the process of speech production and perception in human beings, the speech production process, representing speech in time and frequency domains, speech sounds and features

UNIT II **SIGNAL PROCESSING AND ANALYSIS METHOD FOR SPEECH RECOGNITON** 9

Spectral analysis models, The Bank-of-filters front-end processor, Linear predictive coding model for Speech recognition, Vector quantization.

UNIT III **PATTERN COMPARISON TECHNIQUES** 9

Introduction, Speech detection, Distortion measures- Mathematical considerations, Distortion measures- Perceptual considerations, Spectral distortion measures.

UNIT IV **THEORY AND IMPLEMENTATION OF HIDDEN MARKOV MODELS** 9

Introduction, Discrete time Markov processes, Extensions to Hidden Markov models, Three basic problems for HMMs, Types of HMMs, Continuous observation densities in HMMs, comparison of HMMs.

UNIT V **CONTIUOUS SPEECH RECOGNITION** 9

Introduction, Sub word speech units, sub word unit models based on HMMs, Training of sub word units, Language models for large vocabulary speech recognition, Statistical language modelling.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", 1st Edition, Pearson Education, 2017.

2 Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, "Fundamentals of Speech Recognition", 3rd Edition, Pearson Education, 2019.

REFERENCES:

1 Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", 1st Edition, John Wiley and Sons, 2018.

2 Rederick Jelinek, "Statistical Methods of Speech Recognition", 1st edition, MIT Press, 2015.

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3 Thomas F Quatieri, "Discrete-time speech signal processing: principles and practice", 4th Edition, Pearson Education, 2023

ONLINE RESOURCES

1 https://www.coursera.org/courses?query=speech%20recognition

2 https://www.futurelearn.com/courses/speech-recognition-systems

3 https://www.simplilearn.com/tutorials/python-tutorial/speech-recognition-in-python

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain speech recognition principles, methods, models and implementation.

CO2 Apply speech recognition principles and methods to characterize the speech signal and to recognize the speech.

CO3 Apply the Pattern Comparison Techniques and Hidden Markov Models to recognise the speech.

CO4 Analyze the speech recognition methods, pattern comparison techniques and Hidden Markov Models.

CO5 Apply Continuous speech recognition on HMMs.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-
CO5	3	2	1	2	-	-	-	-	-	-	-	-

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U23OE231	ESSENTIALS OF DATA SCIENCE AND ANALYTICS	L	T	P	C
Prerequisites:	Nil	3	0	0	3

COURSE OBJECTIVES:

- 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.

UNIT I **INTRODUCTION** **9**

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 – Basic Statistical descriptions of Data.

UNIT II **DESCRIBING DATA** **9**

Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores.

UNIT III **DESCRIBING RELATIONSHIP** **9**

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 – regression towards the mean.

UNIT IV **DATA PRE-PROCESSING** **9**

Data cleaning – data integration – Data Reduction Data Transformation and Data Discretization. Evaluation of classification methods – Confusion matrix, Students T-tests and ROC curves.

UNIT V **DATA ANALYSIS** **9**

Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA – The Data Science Process. Importing Matplotlib – Line plots – 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.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from the Frontline", 2nd Edition, O'Reilly Media, 2021.

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REFERENCES:

1 Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, 2nd Edition, O'Reilly Media, 2016.

2 Joel Grus, "Data Science from Scratch: First Principles with Python", 1st Edition, O'Reilly Media, 2015.

3 Luca Massaron, John Paul Mueller, "Python for Data Science for Dummies", 2nd Edition, John Wiley & Sons, 2019.

ONLINE RESOURCES:

1 https://www.coursera.org/learn/foundations-of-data-science
2 https://www.geeksforgeeks.org/data-science-fundamentals/
3 https://www.datacamp.com/blog/what-is-data-science-the-definitive-guide

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the basics of Data Science.
CO2 Explain different types of data description for data science process.
CO3 Apply the knowledge of describing data in normal distributions.
CO4 Describe data pre-processing techniques.
CO5 Apply visualization Libraries for data analysis.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	3	2	1	2	-	-	-	-	-	-	-	-

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U23OE232	FUNDAMENTALS OF NETWORK SECURITY	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To understand the basic concepts of security
- To learn various network security attacks.
- To understand the IP and Web security.

UNIT I **FUNDAMENTALS OF NETWORKING SECURITY** **6**

Overview of networking security- Security Services -Confidentiality, Authentication, Integrity, Non-repudiation, access Control - Availability and Mechanisms- Security Attacks -Interruption, Interception

UNIT II **AUTHENTICATION AND SECURITY** **6**

Authentication overview - Authentication protocols - Authentication and key establishment - key exchange - mediated key exchange - User Authentication –password based authentication - password security - Certificate Authority and key management - digital signatures - digital Certificates.

UNITIII **PUBLIC-KEY CRYPTOGRAPHY** **6**

Basics of cryptography -cryptographic hash functions - symmetric and public-key encryption - public key cryptography principles & algorithms - cipher block modes of operation - Secure Hash Functions – HMAC.

UNIT IV **SECURITY ATTACKS** **6**

Buffer overflow attacks & format string vulnerabilities - Denial-of-Service Attacks - Hijacking attacks: exploits and defences - Internet worms – viruses – spyware –phishing – botnets - TCP session hijacking - ARP attacks.

UNIT V **IP SECURITY AND WEB SECURITY** **6**

Network defence tools: Firewalls, VPNs, Intrusion Detection, and filters - Email privacy: Pretty Good Privacy (PGP) and S/MIME - Network security protocols in practice- Introduction to Wire shark – SSL - IPsec, and IKE -DNS security.

30 PERIODS

PRACTICAL EXERCISES:

1. Implementation of Symmetric Key Algorithms.
2. Implementation of Asymmetric Key Using RSA Algorithm.
3. Implementation of Digital Signatures Schemes using Secure Hash Algorithm.
4. Installation of wire shark, TCP dump and observe data transferred in client-server communication using UDP/TCP and identify the UDP/TCP datagram.
5. Check message integrity and confidentiality using SSL.
6. Implementation of Eaves dropping attack.
7. Implementation of Man in the middle attacks.

30 PERIODS

TOTAL: 60 PERIODS

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TEXT BOOKS:

1 Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", 1st Edition, Notion Press, 2021.

2 Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 2nd Edition, John Wiley & Sons, 2016.

REFERENCES:

1 David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", 1st Edition, Jones & Bartlett Learning, 2018.

2 Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made easy", 2nd Edition, Elsevier B.V, 2019.

3 Kimberly Graves, "CEH Official Certified Ethical Hacker Review Guide", 1st Edition, John Wiley & Sons, 2017.

ONLINE RESOURCES:

1 https://www.udemy.com/topic/network-security

2 https://www.coursera.org/courses?query=network%20security

3 https://archive.nptel.ac.in/courses/106/105/106105162/

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe network security fundamental concepts and principles.

CO2 Explain the concept of authentication protocols and digital signatures.

CO3 Apply cryptographic principles, including public-key encryption, hash functions, to design secure systems.

CO4 Describe various network security attacks.

CO5 Explain about IP security and Web security.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	1	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	2	2	1	1	1	-	1	-	-	-	-	-
CO5	2	2	1	1	1	-	-	-	-	-	-	1

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U23OE233	CYBER LAWS AND ETHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of cyber security and the importance of securing information and systems.
- To expose the theoretical and practical aspects of cyber law.
- To learn the importance of ethical values in digital age.

UNIT I **CYBER SECURITY** **6**

Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks.

UNIT II **INFORMATION TECHNOLOGY ACT** **6**

Overview of IT Act, 2000, Amendments and Limitations of IT Act, Digital Signatures, Cryptographic Algorithm, Public Cryptography, Private Cryptography, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offences.

UNIT III **CYBER LAW AND RELATED LEGISLATION** **6**

Patent Law, Trademark Law, Copyright, and Software – Copyright or Patented, Domain Names and Copyright disputes, Electronic Data Base and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant Sections of Indian Evidence Act.

UNIT IV **CYBERSPACE AND THE LAW & CYBER FORENSICS** **6**

Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science.

UNIT V **CYBER ETHICS** **6**

The Importance of Cyber Law, Significance of cyber-Ethics, Need for Cyber regulations and Ethics. Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles, Introduction to Block chain Ethics.

TOTAL: 30 PERIODS

TEXT BOOKS:

1 Anirudh Rastogi, "Cyber Law: The Law of the Internet and Information Technology" 1st Edition, Lexis Nexis, 2014.
2 Agarwala Kamlesh N. & Lal Ajay Kumar "Cybersecurity and Cyber Laws", 1st Edition, Whitesmann, 2024.
3 Sumit Belapure, Nina Godbole, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 1st Edition, John Wiley & Sons, 2011.

REFERENCES

1 Mark Grabowski, Eric P. Robinson, "Cyber Law and Ethics: Regulation of the Connected", 1st Edition, Routledge (Taylor& Francis), 2021.

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2 Sushma Arora and Raman Arora," Cyber Crimes & Laws", 4th Edition, Whitesmann, 2021.
3 Richard A. Spinello, "Cyber Ethics-Morality and Law in cyberspace", 7th Edition, Jones & Bartlett, 2020.

ONLINE RESOURCES:

1 https://www.udemy.com/topic/network-security
2 https://www.coursera.org/courses?query=network%20security
3 https://archive.nptel.ac.in/courses/106/105/106105162/

COURSEOUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the concepts and assess various harmful acts in cyber space.
CO2 Analyze cybercrime and offences in the context of IT law.
CO3 Comprehend a thorough understanding of cyber law and their scope and limitations.
CO4 Analyze the significance of cyber security policy and regulation.
CO5 Apply the need of cyber regulations in the real-world applications.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	1	-	-	-	-
CO2	3	2	1	2	-	2	2	-	-	-	-	-
CO3	2	2	1	1	-	-	-	1	-	-	-	-
CO4	3	3	2	2	-	1	-	1	-	-	-	-
CO5	3	2	1	2	-	2	1	-	-	-	-	-

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U23OE234	TRUST MANAGEMENT IN E-COMMERCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand basic concepts of trust management in E-Commerce and Security techniques.
- To learn Reputation Systems in E-Commerce and vendor verification.
- To understand various advanced trust technologies.

UNIT I **INTRODUCTION** **9**

Overview of E-Commerce, Importance of Trust in E-Commerce, Types of Trust: Cognitive, Institutional and Personal Trust -Challenges in Establishing Trust Online.

UNIT II **SECURITY IN E-COMMERCE** **9**

Fundamentals of Cybersecurity in E-Commerce, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Encryption Techniques (Symmetric and Asymmetric), Authentication Mechanisms: Passwords, OTP, and 2FA.

UNIT III **REPUTATION MANAGEMENT** **9**

Reputation Systems in E-Commerce (e.g., eBay, Amazon), Role of Feedback and Reviews in Building Trust, Fake Reviews and Counterstrategies, Role of User Interface (UI) in Building Trust, Designing Intuitive and Accessible E-Commerce Platforms.

UNIT IV **VENDOR AND PRODUCT AUTHENTICATION** **9**

Vendor Verification Techniques-Product Authentication and Anti-Counterfeiting Measures- Block chain for Supply Chain Transparency.

UNIT V **ADVANCED TRUST TECHNOLOGIES** **9**

Artificial Intelligence in Trust Management, Machine Learning Models for Fraud Detection, Block chain Applications in E-Commerce Trust, Contracts for Secure Transactions.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 David Whiteley, "E-Commerce Strategy, Technologies and Applications", 1st Edition, Tata McGraw Hill, 2015.
2 P.T.Joseph, S.J., "E-Commerce - An Indian Perspective", 4th Edition, Prentice Hall of India, 2012.

REFERENCES:

1 Ravi Kalakotar and Andrew B.Whinston, "Frontiers of Electronic Commerce", 1st Edition, Pearson Education, 2017.
2 Kenneth C. Laudon, "E-Commerce: Business, Technology, Society", 4th Edition, Pearson Education, 2019.
3 Li, Fen, "Trust in E-services: Technologies, Practices and challenges", 1st Edition, Pearson Education, 2018.

ONLINE RESOURCES:

1 https:// nptel/courses/video/110105148/lec35

2 https:// nptel.ac.in/courses/106/105/106105162/

3 https:// nptel.ac.in/courses/110/105/110105083

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COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe basic concepts of E-Commerce.
CO2 Comprehend various security techniques of E-Commerce.
CO3 Analyze repudiation management in E-Commerce.
CO4 Summarize vendor verification and product Authentication.
CO5 Describe various technologies of trust management in E-Commerce.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	3	3	2	2	1	-	-	-	-	-	-	1
CO4	2	2	1	1	2	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	1

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U23OE235	LINUX FUNDAMENTALS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To know the knowledge of Linux helps to understand OS level programming.
- To learn about the kernel concepts, basics commands, shell scripting, file processing, Socket programming, Processes, Inter process communication.

UNIT I **INTRODUCTION TO LINUX AND LINUX UTILITIES** 6

A brief history of LINUX, architecture of LINUX, features of LINUX, introduction to vi editor. Linux commands - PATH, man, echo, printf, script, passwd , uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, , tar, gzip, file handling utilities, security by file permissions, process utilities, disk utilities, networking commands, unlink, du, df, mount, umount, find, unmask, ulimit, ps, w, finger, arp.Text Processing utilities and backup utilities , tail, head , sort, nl, uniq, grep, , cut, paste, join, pg, comm, cmp, diff, tr, awk, cpio.

UNIT II **INTRODUCTION TO SHELLS** 6

Linux Session, Standard Streams, Redirection, Pipes, Tee Command, Command Execution, Command-Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Options, Shell/Environment Customization. Filters: Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters.

UNIT III **FILE STRUCTURE** 6

GREP: Operation, grep Family, Searching for File Content. Sed :Scripts, Operation, Addresses, commands, Applications, grep and sed. UNIX FILE STRUCTURE: Introduction to UNIX file system, inode (Index Node), file descriptors, system calls and device drivers. File Management :File Structures, System Calls for File Management – create, open, close, read, write, lseek, link, symlink, unlink, stat, fstat, lstat, chmod, chown, Directory API – opendir, readdir , closedir, mkdir, rmdir, umask.

UNIT IV **PROCESS AND SIGNALS** 6

Process, process identifiers, process structure: process table, viewing processes, system processes, process scheduling, starting new processes: waiting for a process, zombie processes, orphan process, fork, exit, wait, waitpid, exec, signals functions, kill, raise, alarm, pause, abort,signal sets. File locking: creating lock files, locking regions, use of read and write with locking, deadlocks.

UNIT V **INTER PROCESS COMMUNICATION** 6

Pipe, process pipes, the pipe call, parent and child processes, and named pipes: fifos, semaphores: semget, semop, semctl, message queues: ms

30 PERIODS

PRACTICAL EXERCISES:

1. Linux Basics Commands and File Management.
2. Text Processing and Backup Utilities Commands.
3. Shell Basics and Scripting.
4. Filters and File Comparison (file sorting and line manipulation).
5. File Structures and System Calls. (use of link, symlink, unlink)
6. Process and Signal Handling (Implement zombie and orphan process scenarios).

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7. Implement semaphore and message queue operations using system calls.

30 PERIODS

TOTAL: 60 PERIODS

TEXT BOOKS:

1 W. Richard. Stevens, Advanced Programming in the UNIX Environment, 3rd Edition, Pearson Education, 2017.

2 Behrouz A. Forouzan, Richard F. Gilberg.Thomson," Unix and shell Programming ", 1st Edition, Cengage Learning, 2018.

REFERENCES:

1 Daniel J. Barrett," Linux System Programming, Robert Love, 4th Edition, O'Reilly Media, SPD", 2013.

2 Advanced Programming in the UNIX environment, 2nd Edition, W.R. Stevens, Pearson Education, 2017.

3 William E. Shotts Jr "The Linux Command Line: A Complete Introduction", 1st Edition, Pearson Education, 2019.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/106/117106113/

2 https://www.classcentral.com/course/youtube-electronics-linux-programming-scripting-47539

3 https:// nptel.ac.in/courses/106/105/106105162/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe various Linux commands that are used to manipulate system operations.

CO2 Analyze Shell Programming using Linux commands.

CO3 Design application to manipulate internal kernel level Linux File System.

CO4 Analyze IPC- APIs to control various processes for synchronization.

CO5 Apply Network Programming on different machines in a network.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	3	3	3	1	-	-	1	-	-	-	-
CO4	3	3	2	2	2	-	-	1	-	-	-	-
CO5	3	2	1	2	-	-	-	-	-	-	-	-

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U23OE236	CYBER THREAT INTELLIGENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of Information Security and legal and ethical issues in Information Security.
- To understand the information security policy and concepts of access control.

UNIT I INTRODUCTION 9

Security Trends, OSI security architecture, Security attacks, security services, security mechanisms, Security System Development Life cycle – Legal, Ethical and Professional issues

UNIT II THREAT ANALYSIS 9

Risk Management - Identifying and Assessing Risk - Assessing and Controlling Risk. Blueprint for Information Security - Information Security Policy

UNIT III SECURITY TECHNOLOGY 9

Intrusion Detection and Prevention Systems (IDPS)-Terminology-Types-Detection methods. Honeypots, Honeynets and padded cell systems. Scanning and Analysis Tools Port Scanners-Firewall analysis tools, Operating system detection tools-Vulnerability Scanners-Packet Sniffers-Wireless security tools.

UNIT IV AUDITING 9

Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities Assessment-Case study: Wireshark, FAW.

UNIT V ANALYSIS AND VALIDATION 9

Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition – Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics. Case Study: Toolsley

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Michael E Whitman and Herbert J Mattord, "Principles of Information Security", 1st Edition, Cengage Learning, 2011.

2 Nelson, Phillips, Enfinger, Steuart, "Computer Forensics and Investigations",1st Edition, Cengage Learning, 2008.

REFERENCES:

1 Micki Krause, Harold F. Tipton, "Handbook of Information Security Management", 6th Edition, CRC Press, 2007.

2 John R. Vacca, "Computer Forensics", 1st Edition, Cengage Learning, 2005.

3 Scott J. Roberts, Rebekah Brown, "Intelligence- Driven Incident Response: Outwitting the Adversary", 1st Edition, Pearson Education, 2017.

ONLINE RESOURCES:

1 https://www.coursera.org/projects/web-application-security-testing-with-owsap-zap

2 http://www.infocobuild.com/education/audio-video-courses/computer-science/InformationSecurity1-IIT-Madras/lecture-59.html

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3 https://github.com/hslatman/awesome-threat-intelligence

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the basics of information security and legal and ethical issues in Information Security.

CO2 Analyze the risk management and information security policy.

CO3 Analyze intrusion detection and prevention techniques using different tools.

CO4 Summarize Vulnerabilities Assessment using web applications.

CO5 Analyze forensics data.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-

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U23OE237 NANOMATERIALS AND APPLICATIONS	L	T	P	C
	3	0	0	3

Course Objectives:

- To understand about the nanomaterials, synthesis and its characterization.
- To describe the fabrication of nano composites and nano structures for advanced devices.
- To study about the application of nano materials in various fields of Engineering.

UNIT I BASICS OF NANOTECHNOLOGY 9

Introduction–Scientific revolutions–Time and length scale in structures –Definition of a nano system –Dimensionality and size-dependent phenomena –Surface to volume ratio - Fraction of surface atoms – Surface energy and surface stress – surface defects – Properties at nanoscale (optical, mechanical, electronic and magnetic).

UNIT II SYNTHESIS OF NANOMATERIALS 9

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

UNIT III NANO COMPOSITES 9

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 9

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

UNIT V APPLICATIONS OF NANO MATERIALS 9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mick Wilson, Kamali Kannangara, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 1st Edition, Overseas Press, 2018.
2. G Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications", 1st Edition, Imperial College Press, 2019.

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REFERENCES:

1. William A Goddard, "Handbook of Nanoscience, Engineering and Technology", 3rd Edition, CRC Taylor and Francis group, 2018.
2. R H J Hannink, A J Hill, "Nanostructure Control", 1st Edition, Wood Head Publishing Ltd., 2016.
3. Ivor Brodie, Julius J Muray, 'The physics of Micro/Nano – Fabrication", 1st Edition, Springer International Edition, 2020.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/118104008
2. https://onlinecourses.nptel.ac.in/noc22_mm33/preview
3. https://link.springer.com/book/10.1007/978-981-10-6214-8

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the basic properties such as structural, physical, chemical properties of nano materials and their applications.

CO2 Explain the knowledge about the different types of nano material synthesis.

CO3 Describe about the shape, size, structure of composite nano materials and their interference.

CO4 Describe the different characterization techniques for nanomaterials.

CO5 Explain the application of nanomaterials in different fields.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	2	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-	2	-

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U23OE238	PLASTIC MATERIALS FOR ENGINEERS	L	T	P	C
		3	0	0	3

Course Objectives:

- Understand the advantages, disadvantages and general classification of plastic materials, manufacturing, sources, and applications of engineering thermoplastics.
- Understand the basics as well as the advanced applications of various plastic materials in the industry.
- To understand the preparation methods of thermosetting materials, Select suitable specialty plastics for different end applications.

UNIT I INTRODUCTION TO PLASTIC MATERIALS 9

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behaviour, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP).

UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, actual resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU).

UNIT III THERMOSETTING PLASTICS 9

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications.

UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanoates (PHA), PBAT, Bio plastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1 Marianne Gilbert, Brydson's, "Plastics Materials", 8th Edition, Elsevier, 2018.

2 J A Brydson, "Plastics Materials", 7th Edition, Butterworth Heinemann. 2019.

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REFERENCES:

1. Manas Chanda, Salil K Roy, "Plastics Technology Handbook", 4th Edition, CRC press, 2018.
2. A Brent Strong, "Plastics: Materials and Processing", 3rd Edition, Pearson Prentice Hall of India, 2019.
3. Olagoke Olabisi, Kolapo Adewale, "Handbook of Thermoplastics", 2nd Edition, CRC press, 2018.

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/112/103/112103279/
2. https://nptel.ac.in/courses/112107221
3. https://www.sciencedirect.com/materials-science/engineering-plastic

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the importance, advantages and classification of plastic materials.

CO2 Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics.

CO3 Describe the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins.

CO4 Explain the manufacturing properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU.

CO5 Describe the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	1	-	-	-	-	-	2	-
CO2	2	2	1	1	-	-	1	-	-	-	-	-	2	-
CO3	2	2	1	1	-	-	1	-	-	-	-	-	2	-
CO4	2	2	1	1	-	-	1	-	-	-	-	-	2	-
CO5	2	2	1	1	-	-	1	-	-	-	-	-	2	-

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U23OE239	PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS	L	T	P	C
		3	0	0	3

Course Objectives:

- Discuss the basic concept and function of Production and Operation Management for entrepreneurship.
- Understand the Production process and planning.
- Describe the Production and Operations Management Control for business owners

UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT **9**

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research.

UNIT II PRODUCTION & OPERATION SYSTEMS **9**

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry.

UNIT III PRODUCTION & OPERATIONS PLANNING **9**

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning.

UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS **9**

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters -- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT **9**

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

TOTAL : 45 PERIODS

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TEXT BOOKS:

1. Mikell P Groover, "Automation Production Systems, and Computer-Integrated Manufacturing", 1st Edition, Pearson Education, 2018.
2. Amitabh Raturi, "Production and Inventory Management", 1st Edition, Tata McGraw Hill Publications, 2018.

REFERENCES:

1. Adam Jr Ebert, "Production and Operations Management", 1st Edition, Prientice Hall of India Publication, 2020.
2. Muhlemann, Okland, Lockyer, "Production and Operation Management", 1st Edition, Macmillan, 2019.
3. Chary S N, "Production and Operations Management", 1st Edition, Tata McGraw Hill Publications, 2019.

ONLINE RESOURCES:

1. https://openstax.org/books/introduction-business/pages/10-1-production-and- operations-management-an-overview
2. https://onlinecourses.nptel.ac.in/noc20_mg06/preview
3. https://www.vssut.ac.in/lecture_notes/lecture1429900757.pdf

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

- **CO1** Explain the basics and functions of Production and Operation Management for owners.
- **CO2** Summarize the concept of the Production & Operation Systems.
- **CO3** Explain the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
- **CO4** Describe the Production & Operations Management Processes in organisations.
- **CO5** Explain the techniques of controlling, Production and Operations in industries.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO2	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO3	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO4	2	2	1	1	-	-	-	1	-	-	-	-	2	-
CO5	2	2	1	1	-	-	-	1	-	-	-	-	2	-

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U23OE240	QUALITY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Analysing and understanding the process capability study.

UNIT I **INTRODUCTION** **9**

Quality Dimensions–Quality definitions–Inspection-Quality control–Quality Assurance– Quality planning-Quality costs–Economics of quality– Quality loss function.

UNIT II **CONTROL CHARTS** **9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u- Construction and application.

UNIT III **SPECIAL CONTROL PROCEDURES** **9**

Warning and modified control limits, control chart for individual measurements, multi- vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative- sum and exponentially weighted moving average control charts.

UNIT IV **STATISTICAL PROCESS CONTROL** **9**

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

UNIT V **ACCEPTANCE SAMPLING** **9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables,MIL-STD-105DandMIL- STD-414E&IS2500 standards.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Douglus C Montgomery, "Introduction to Statistical Quality Control", 7th Edition, Jone Wiley & sons, 2018.
2. Krishnaiah K, "Applied Statistical Quality Control and Improvement", 1st Edition, Prientice Hall of India, 2020.

REFERENCES:

1. Amitava Mitra, "Fundamentals of Quality Control and Improvement", 3rd Edition, John Wiley& sons, 2018.
2. Eugene L Grant and Richard S. Leaven Worth, "Statistical Quality Control", 7th Edition, Tata McGraw- Hill, 2019.
3. Manohar Mahajan, "Statistical Quality Control", 1st Edition, Dhanpal Rai & Sons, 2021.

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ONLINE RESOURCES:

1 https://nptel.ac.in/courses/116102019

2 https://github.com/johnros/qualityEngineering/blob/master/Class_notes/notes.pdf

3 https://archive.nptel.ac.in/courses/112/107/112107259/

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Describe the quality of processes using control charts for variables in manufacturing industries.

CO2 Describe the occurrence of defective products and the defects in manufacturing companies.

CO3 Describe the occurrence of defects in services.

CO4 Analyze the statistical and process capability study.

CO5 Create the acceptance sampling procedures for incoming raw material.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	-	2	1
CO2	2	2	1	1	-	-	-	1	-	-	-	-	2	1
CO3	2	2	1	1	-	-	-	1	-	-	-	-	2	1
CO4	3	3	2	2	-	-	-	1	-	-	-	-	2	1
CO5	3	3	3	3	-	-	-	1	-	-	-	-	2	1

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U23OE241	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Analysing the various legal aspects and applications of reverse engineering in product design and development and discuss about 3D scanning hardware & software operations and procedure to generate 3D models.

UNIT I INTRODUCTION & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT III DATA PROCESSING 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV 3D SCANNING AND MODELLING 9

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

UNIT V INDUSTRIAL APPLICATIONS 9

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Robert W Messler, "Reverse Engineering: Mechanisms, Structures, Systems & Materials", 1st Edition, Tata McGraw-Hill Education, 2019.
2. Wego Wang, "Reverse Engineering Technology of Reinvention", 1st Edition, CRC Press, 2019.

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REFERENCES:

1 Scott J Lawrence, "Principles of Reverse Engineering", 1st Edition, Kindle, 2022.

2 Kevin Otto, Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", 1st Edition, Prentice Hall of India, 2019.

3 Linda Wills, "Reverse Engineering", 1st Edition, Kluver Academic Publishers, 2020.

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/112104265

2 https://archive.nptel.ac.in/courses/112/104/112104265/

3 http://www.digimat.in/nptel/courses/video/112104230/L49.html

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to

CO1 Explain the fundamental concepts and principles of reverse engineering in product design and development.

CO2 Apply the concept of material characteristics, part durability and life limitation in reverse engineering of product design and development.

CO3 Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.

CO4 Describe the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.

CO5 Summarize the various legal aspect and Applications of reverse engineering in product design and development.

CO – PO - PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	1	-	-	-	-	2	1
CO2	3	2	1	2	-	-	-	1	-	-	-	-	2	1
CO3	3	2	1	2	-	-	-	1	-	-	-	-	2	1
CO4	2	2	1	1	-	-	-	1	-	-	-	-	2	1
CO5	2	2	1	1	-	-	-	1	-	-	-	-	2	1

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