GOVERNMENT COLLEGE OF ENGINEERING
SALEM - 636 011
(An Autonomous Institution Affiliated to Anna University, Chennai)

REGULATIONS 2022

CURRICULUM AND SYLLABUS
(For Candidates admitted from 2022 - 2023 onwards)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
(FULL TIME PROGRAMME)

B.E ELECTRONICS AND COMMUNICATION ENGINEERING (FULL TIME)

VISION

Strive continuously to develop Excellence in Technical Education and Research by producing technically competent Electronics and Communication Engineers to meet the growing demands of technology and socioeconomic needs.

MISSION

- To foster and achieve unmatched excellence in Electronics and Communication Engineering Domain.
- To pursue continuous improvement in infrastructure and state-of-the art laboratories.
- To establish and set best teaching and learning standards among top grade Engineering Departments across the nation.
- To encourage learning, research, creativity, innovation and professional activity by offering ambience and support.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO'S)

PEO 1: The graduates will utilize their expertise in Engineering to solve industry's technological problems.

PEO 2:Analyze real life problems, design appropriate system to provide solutions that are technically sound, economically feasible and socially acceptable.

PEO 3:Exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning.

PROGRAM OUTCOMES(PO'S)

PO 1: An ability to apply knowledge of Mathematics, Science, and Engineering in the Electronic and Communication Engineering.

PO 2: An ability to design and conduct experiments, as well as to analyze and interpret data.

PO 3: An ability to design a System, or Process to meet desired needs within realistic constraints such as Economic, Environmental, Social, Ethical, Health care and Safety, Manufacturability, and Sustainability.

PO 4: An ability to identify, formulate and solve complex problems in the area of Electronics and Communication Engineering.

PO 5: An ability to use the techniques, skills, and modern Engineering tools necessary for Engineering practice.

PO 6: Knowledge of contemporary issues relevant to professional Engineering practice.

PO 7: The broad education necessary to understand the impact of Engineering solutions in Global, Economic, Environmental and Social context.

PO 8: An understanding of Professional and Ethical responsibility.

PO 9: An ability to function on multidisciplinary teams.

PO 10: An ability to communicate effectively.

PO 11: Recognition of the need for, and an ability to engage in research and to involve in life-long learning.

PO 12: An ability to work as a leader in a team, to manage projects in Multidisciplinary Environments.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To analyse, design and develop solutions for the real time problems and to apply the technical knowledge for developing quality products for Electronics and Communication based Industry.

PSO2: To adapt to emerging Information and Communication technologies and to develop innovative ideas and solutions in RF & Communication, Networking, Embedded Systems, and VLSI.

PSO3: An ability to make use of acquired technical knowledge to get employed in the field of Electronics and Communication and also to become successful Entrepreneur.

CURRICULUM

B.E – ELECTRONICS AND COMMUNICATION ENGINEERING (FULL TIME)

SEMESTER I

S. No.	Course Code	Course Title	Cat.	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	FE	Total
1	22MC101	Induction Program	MC	-	-	-	0	-	-	-
THEORY										
2	22EN101	Communicative English (Theory cum Practical)	HS	2	0	2	3	50	50	100
3	22MA101	Matrices, Calculus and Ordinary Differential Equations	BS	3	1	0	4	40	60	100
4	22PH102	Materials Science for Engineering	BS	2	1	0	3	40	60	100
5	22CY101	Engineering Chemistry	BS	3	1	0	4	40	60	100
6	22CS101	Problem Solving and C Programming	ES	3	0	0	3	40	60	100
7	22MC102	Heritage of Tamil/ தமிழர் மரபு	HS MC	1	0	0	1	100	-	100
PRACTICAL										
8	22CS102	Computer Practice and C Programming Laboratory	ES	0	0	3	1.5	60	40	100
9	22ME102	Workshop Manufacturing Practices	ES	0	0	4	2	60	40	100
TOTAL				14	3	9	**21.5**	430	370	800

SEMESTER II

S. No.	Course Code	Course Title	Cat.	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22MA203	Linear Algebra, Partial Differential Equations and Vector Calculus	BS	3	1	0	4	40	60	100
2	22PH201	Physics- Electromagnetism	BS	2	1	0	3	40	60	100
3	22HS201	Universal Human Values	HS	2	1	0	3	40	60	100
4	22EE201	Principles of Electrical Engineering	ES	3	1	0	4	40	60	100
5	22ME101	Engineering Graphics and Design	ES	1	0	4	3	40	60	100
6	22MCIN01	Engineering Sprints	EE	0	0	2	1	100	-	100
7	22MC201	Tamils and Technology/ தமிழரும்தொழில் நுட்பமும்	HS MC	1	0	0	1	100	-	100
8	22NC201	NCC COURSE – I (only for NCC Students)	NC	3	0	0	3*	40	60	100
PRACTICAL										
9	22EN102	Professional Skills Laboratory	HS	0	0	2	1	60	40	100
10	22PH103	Physics Laboratory	BS	0	0	3	1.5	60	40	100
11	22CY102	Chemistry Laboratory	BS	0	0	3	1.5	60	40	100
12	22EE202	Principles of Electrical Engineering Laboratory	ES	0	0	3	1.5	60	40	100
TOTAL				15	3	17	24.5	680	520	1100

***NCC credit course level I is offered for NCC students only. The grades earned by the students will be recorded in the Mark sheet, however the same shall not be considered for the computation of CGPA.**

SEMESTER III										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credit**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22MA304	Fourier Series, Complex Variables and Transforms	BS	3	1	0	4	40	60	100
2	22EC301	Semiconductor Devices and Circuits	PC	3	0	0	3	40	60	100
3	22EC302	Digital System Design	PC	3	0	0	3	40	60	100
4	22EC303	Network Theory and Synthesis	PC	3	0	0	3	40	60	100
5	22EC304	Transmission Lines and Waveguides	PC	3	0	0	3	40	60	100
6	22EC305	Analog Communication	PC	3	0	0	3	40	60	100
7	22MC301	Indian Constitution	MC	2	0	0	0	100	-	100
8	22MCIN02	Innovation Sprints	EE	0	0	2	1	100	-	100
9	22NC301	NCC Course – II (Only for NCC Students)	NC	3	0	0	3*	40	60	100
PRACTICAL										
10	22EC306	Semiconductor Devices and Circuits Laboratory	PC	0	0	4	2	60	40	100
11	22EC307	Digital System Design Laboratory	PC	0	0	4	2	60	40	100
TOTAL				20	1	10	**24**	560	440	1100

SEMESTER IV										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credit**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22MA402	Probability and Stochastic Processes	BS	3	1	0	4	40	60	100
2	22EC401	Analog Circuits	PC	3	0	0	3	40	60	100
3	22EC402	Microprocessors and Microcontrollers	PC	3	0	0	3	40	60	100
4	22EC403	Signals and Systems	PC	3	0	0	3	40	60	100
5	22EC404	Control Systems	PC	3	0	0	3	40	60	100
6	22EC405	Antenna and Wave Propagation	PC	3	0	0	3	40	60	100
7	22MCIN03	Design Sprints	EE	0	0	2	1	100	-	100
8	22CYMC01	Environmental Science	MC	2	0	1	0	100	-	100
PRACTICAL										
9	22EN401	Placement and Soft Skills Laboratory	HS	0	0	4	2	60	40	100
10	22EC406	Analog Circuits Laboratory	PC	0	0	4	2	60	40	100
11	22EC407	Microprocessors and Microcontrollers Laboratory	PC	0	0	4	2	60	40	100
TOTAL				20	1	15	**26**	620	480	1100

***NCC credit course level II is offered for NCC students only. The grades earned by the students will be recorded in the Mark sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER V										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credit**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22EC501	Digital Communication	PC	3	0	0	3	40	60	100
2	22EC502	Digital Signal Processing	PC	3	0	0	3	40	60	100
3	22EC503	Embedded Systems	PC	3	0	0	3	40	60	100
4	22ECMG501	Principles of Management	HS	3	0	0	3	40	60	100
5	22__OExx	Open Elective -1	OE	3	0	0	3	40	60	100
6	22MCIN04	Ideation Sprints	EE	0	0	2	1	100	-	100
PRACTICAL										
7	22EC505	Communication Systems Laboratory	PC	0	0	4	2	60	40	100
8	22EC506	Digital Signal Processing Laboratory	PC	0	0	4	2	60	40	100
TOTAL				15	0	10	**20**	420	380	800

SEMESTER VI (Regular Stream)										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credit**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22ECPE6xx	Professional Elective – 1	PE	3	0	0	3	40	60	100
2	22ECPE6xx	Professional Elective – 2	PE	3	0	0	3	40	60	100
3	22ECPE6xx	Professional Elective – 3	PE	3	0	0	3	40	60	100
4	22__OExx	Open Elective – 2	OE	3	0	0	3	40	60	100
5	22__OExx	Open Elective -3	OE	3	0	0	3	40	60	100
6	22__OExx	Open Elective – 4	OE	3	0	0	3	40	60	100
PRACTICAL										
7	22EC601	Mini Project	EE	0	0	6	3	60	40	100
TOTAL				18	0	6	**21**	300	400	700

SEMESTER VI (Protosem Stream)										
S. No.	Course Code	Course Title	Cat.	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22PSPE01	Computational Hardware	PE	3	0	0	3	100	-	100
2	22PSPE02	Coding for Innovators	PE	3	0	0	3	100	-	100
3	22PSPE03	Industrial Automation	PE	3	0	0	3	100	-	100
4	22PSOE01	Applied Design Thinking	OE	3	0	0	3	100	-	100
5	22PSOE02	Startup Fundamentals	OE	3	0	0	3	100	-	100
6	22PSOE03	Prototype Development	OE	3	0	0	3	100	-	100
PRACTICAL										
1	22PSEE01	Robotics	EE	3	0	0	3	100	-	100
TOTAL				21	0	0	**21**	700	-	700

SEMESTER VII										
S. No	Course Code	Course Title	Cat.	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22EC701	VLSI Design	PC	3	0	0	3	40	60	100
2	22EC702	Wireless and Mobile Communication	PC	3	0	0	3	40	60	100
3	22EC703	Optical Communication	PC	3	0	0	3	40	60	100
4	22EC704	Microwave Engineering	PC	3	0	0	3	40	60	100
5	22ECPE7xx	Professional Elective – 4 (Industry based)	PE	3	0	0	3	40	60	100
PRACTICAL										
6	22EC705	Optical and Microwave Engineering Laboratory	PC	0	0	4	2	60	40	100
7	22EC706	VLSI Design and Embedded Systems Laboratory	PC	0	0	4	2	60	40	100
TOTAL				15	0	8	**19**	320	380	700

SEMESTER VIII										
S. No	Course Code	Course Title	Cat.	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22ECPE8xx	Professional Elective - 5	PE	3	0	0	3	40	60	100
2	22ECPE8xx	Professional Elective - 6	PE	3	0	0	3	40	60	100
PRACTICAL										
3	22EC801	Project Work	EE	0	0	14	7	80	120	200
TOTAL				6	0	14	**13**	200	200	400

Electronics and Communication Engineering Scheme of Credits: 169

PROFESSIONAL ELECTIVES (PE)

S.No	Course Code	Course Title	Cat.	Hours/Week				Max.Marks		
				L	T	P	C	CA	FE	Total
SEMESTER VI										
PROFESSIONAL ELECTIVE - 1										
1.	22ECPE61	Electronic Measurements	PE	3	0	0	3	40	60	100
2.	22ECPE62	Computer Architecture	PE	3	0	0	3	40	60	100
3.	22ECPE63	Digital Image Processing	PE	3	0	0	3	40	60	100
4.	22ECPE64	Machine Learning	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE - 2										
5.	22ECPE65	Modern Sensors and its Applications	PE	3	0	0	3	40	60	100
6.	22ECPE66	Radar Communication	PE	3	0	0	3	40	60	100
7.	22ECPE67	Internet of Things	PE	3	0	0	3	40	60	100
8.	22ECPE68	Virtual Instrumentation	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE - 3										
9.	22ECPE69	Software Defined Radio	PE	3	0	0	3	40	60	100
10.	22ECPE610	High Speed Networks	PE	3	0	0	3	40	60	100
11.	22ECPE611	Robotics	PE	3	0	0	3	40	60	100
12.	22ECPE612	Computer Networks	PE	3	0	0	3	40	60	100
SEMESTER VII										
PROFESSIONAL ELECTIVE - 4										
13.	22ECPE71	Automotive Electronics	PE	3	0	0	3	40	60	100
14.	22ECPE72	Embedded C	PE	3	0	0	3	40	60	100
15.	22ECPE73	Wireless Sensor Networks	PE	3	0	0	3	40	60	100
16.	22ECPE74	Telecommunication and Switching Networks	PE	3	0	0	3	40	60	100
SEMESTER VIII										
PROFESSIONAL ELECTIVE - 5										
17.	22ECPE81	Multimedia Compression and Communication Techniques	PE	3	0	0	3	40	60	100
18.	22ECPE82	VLSI Physical Design	PE	3	0	0	3	40	60	100
19.	22ECPE83	RF & EMI/EMC Testing	PE	3	0	0	3	40	60	100
20.	22ECPE84	Deep Learning	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE - 6										
21.	22ECPE85	Network Security	PE	3	0	0	3	40	60	100
22.	22ECPE86	Satellite Communication	PE	3	0	0	3	40	60	100
23.	22ECPE87	Bio Medical Electronics	PE	3	0	0	3	40	60	100
24.	22ECPE88	Cognitive Radio	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVE COURSES

S.No.	Course Code	Course	Cat	Hours/Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
COURSES OFFERED BY THE DEPARTMENT OF MATHEMATICS										
1	22MAOE01	Sampling Theory	OE	3	0	0	3	40	60	100
2	22MAOE02	Numerical Methods	OE	3	0	0	3	40	60	100
3	22MAOE03	Probability and Queuing Theory	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF CIVIL ENGINEERING										
4	22CEOE01	Environmental Management	OE	3	0	0	3	40	60	100
5	22CEOE02	Disaster Mitigation and Management	OE	3	0	0	3	40	60	100
6	22CEOE03	Repair and Rehabilitation of Building Elements	OE	3	0	0	3	40	60	100
7	22CEOE04	Mechanics of Deformable bodies	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
8	22CSOE01	Object Oriented Programming Concepts	OE	3	0	0	3	40	60	100
9	22CSOE02	Operating Systems Principles	OE	3	0	0	3	40	60	100
10	22CSOE03	Computer Communications and Networks	OE	3	0	0	3	40	60	100
11	22CSOE04	Python Programming	OE	3	0	0	3	40	60	100
12	22CSOE05	Introduction to Programming in Java	OE	3	0	0	3	40	60	100
13	22CSOE06	Computer Organization	OE	3	0	0	3	40	60	100
14	22CSOE07	Data Structures using C++	OE	3	0	0	3	40	60	100
15	22CSOE08	Cloud Computing Fundamentals	OE	3	0	0	3	40	60	100
16	22CSOE09	Artificial Intelligence and Machine Learning	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING										
17	22ECOE01	Fundamentals of Electron Devices	OE	3	0	0	3	40	60	100
18	22ECOE02	Principles of Modern Communication Systems	OE	3	0	0	3	40	60	100
19	22ECOE03	Microcontrollers and its applications	OE	3	0	0	3	40	60	100
20	22ECOE04	Computer Networks	OE	3	0	0	3	40	60	100
21	22ECOE05	Basics of Embedded Systems	OE	3	0	0	3	40	60	100
22	22ECOE06	Basics of Internet of Things	OE	3	0	0	3	40	60	100
23	22ECOE07	Basics of Artificial Intelligence	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
24	22EEOE01	Renewable Energy Sources	OE	3	0	0	3	40	60	100
25	22EEOE02	Industrial Drives	OE	3	0	0	3	40	60	100
26	22EEOE03	Energy Conservation and Management	OE	3	0	0	3	40	60	100
27	22EEOE04	Electric Vehicles	OE	3	0	0	3	40	60	100

COURSES OFFERED BY THE DEPARTMENT OF MECHANICAL ENGINEERING										
28	22MEOE01	Design of Machine Elements and Machining	OE	3	0	0	3	40	60	100
29	22MEOE02	Industrial Engineering	OE	3	0	0	3	40	60	100
30	22MEOE03	Industrial Robotics	OE	3	0	0	3	40	60	100
31	22MEOE04	Power plant Engineering	OE	3	0	0	3	40	60	100
32	22MEOE05	Principles of Management	OE	3	0	0	3	40	60	100
33	22MEOE06	Professional Ethics in Engineering	OE	3	0	0	3	40	60	100
34	22MEOE07	Renewable Sources of Energy	OE	3	0	0	3	40	60	100
35	22MEOE08	Robotic Process Automation	OE	3	0	0	3	40	60	100
36	22MEOE09	Total Quality Management	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF METALLURGICAL ENGINEERING										
37	22MTOE01	Foundry and Welding Technology	OE	3	0	0	3	40	60	100
38	22MTOE02	Surface Engineering	OE	3	0	0	3	40	60	100
39	22MTOE03	Design and Selection of Materials	OE	3	0	0	3	40	60	100
40	22MTOE04	Nano Science and Technology	OE	3	0	0	3	40	60	100
41	22MTOE05	Materials for Automobile Components	OE	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE COURSES - VERTICALS FOR HONOURS

VERTICAL 1: VLSI DESIGN

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH101	VLSI technology	PE	3	0	0	3
2.	22ECH102	Analog CMOS IC design	PE	3	0	0	3
3.	22ECH103	Device modelling	PE	3	0	0	3
4.	22ECH104	Network on Chip	PE	3	0	0	3
5.	22ECH105	DSP Integrated Circuits	PE	3	0	0	3
6.	22ECH106	VLSI Signal Processing	PE	3	0	0	3
7.	22ECH107	Mixed signal VLSI design	PE	3	0	0	3
8.	22ECH108	VLSI for wireless communication	PE	3	0	0	3
9.	22ECH109	VLSI for IoT systems	PE	3	0	0	3
10.	22ECH110	CAD For VLSI Design	PE	3	0	0	3

VERTICAL 2: NETWORKING

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH201	High Performance Networks	PE	3	0	0	3
2.	22ECH202	Optical Communication Networks	PE	3	0	0	3
3.	22ECH203	Network Security and Management	PE	3	0	0	3
4.	22ECH204	Artificial Neural Networks	PE	3	0	0	3
5.	22ECH205	5G Communication Networks	PE	3	0	0	3
6.	22ECH206	Wireless Adhoc and Sensor Networks	PE	3	0	0	3
7.	22ECH207	Software Defined Networks	PE	3	0	0	3
8.	22ECH208	Embedded System for Networking	PE	3	0	0	3
9.	22ECH209	Cognitive Radio Networks	PE	3	0	0	3
10.	22ECH210	Next Generation Networks	PE	3	0	0	3

VERTICAL 3: COMMUNICATION

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH301	Statistical Theory of Communication	PE	3	0	0	3
2.	22ECH302	Information Theory and Coding	PE	3	0	0	3
3.	22ECH303	Millimeter Wave Communication	PE	3	0	0	3
4.	22ECH304	Spread Spectrum Communication	PE	3	0	0	3
5.	22ECH305	MIMO Communication	PE	3	0	0	3
6.	22ECH306	Smart Antennas	PE	3	0	0	3
7.	22ECH307	RF IC and Microwave MEMs	PE	3	0	0	3
8.	22ECH308	Cognitive Radio	PE	3	0	0	3
9.	22ECH309	Satellite Positioning and Navigation Systems	PE	3	0	0	3
10.	22ECH310	Remote Sensing	PE	3	0	0	3

VERTICAL 4: SIGNAL PROCESSING

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH401	Advanced Digital Signal Processing	PE	3	0	0	3
2.	22ECH402	Speech Processing	PE	3	0	0	3
3.	22ECH403	Software Defined Radio	PE	3	0	0	3
4.	22ECH404	Wavelet Signal Processing	PE	3	0	0	3
5.	22ECH405	Pattern Recognition and Machine Learning	PE	3	0	0	3
6.	22ECH406	Adaptive/Array Signal Processing	PE	3	0	0	3
7.	22ECH407	Multimedia Processing	PE	3	0	0	3
8.	22ECH408	Biomedical Signal And Image Processing	PE	3	0	0	3
9.	22ECH409	VLSI in Signal Processing	PE	3	0	0	3
10.	22ECH410	Radar Signal Processing	PE	3	0	0	3

MINOR DEGREE - VERTICALS

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

VERTICAL - I	VERTICAL - II	VERTICAL - III	VERTICAL - IV	VERTICAL - V	VERTICAL - VI
Civil Engineering	**Computer Science and Engineering**	**Electronics and Communication Engineering**	**Electrical and Electronics Engineering**	**Mechanical Engineering**	**Metallurgical Engineering**
22CEM01 Construction Materials	22CSM01 Programming in C++	22ECM01 Electron Devices	22EEM01 – Linear and Digital Electronics Circuits	22MEM01 Engineering Thermodynamics	22MTM01 Advanced Physical Metallurgy
22CEM02 Building Construction & Equipment	22CSM02 Advanced Data Structures and Algorithms	22ECM02 Digital Electronics	22EEM02 – Microprocessor and Microcontrollers	22MEM02 Fluid Mechanics and Machinery	22MTM02 Metallurgical Thermodynamics and kinetics
22CEM03 Concrete Technology	22CSM03 Computer Organization and Design	22ECM03 Electronic Circuits	22EEM03 – Control Systems	22MEM03 Manufacturing Processes	22MTM03 Mechanical Behaviour of Materials
22CEM04 Environmental Engineering	22CSM04 Advanced Operating Systems	22ECM04 Signal Processing	22EEM04 – Measurement and Instrumentation	22MEM04 Materials Engineering	22MTM04 Rate Processing in Metallurgy
22CEM05 Basics of Transportation Engineering	22CSM05 Data Communication and Computer Networks	22ECM05 Fundamentals of Microprocessors and Microcontrollers	22EEM05 – Electrical Machines	22MEM05 Kinematics of Machinery	22MTM05 Corrosion and Surface Engineering
22CEM06 Repair and Rehabilitation Structures	22CSM06 Programming Essentials in Python	22ECM06 Analog and Digital Communication	22EEM06 – Electric Drives and Control	22MEM06 Hydraulics and Pneumatics	22MTM06 Characterization of Materials
22CEM07 Green Building Technology	22CSM07 Advanced Database System Concepts	22ECM07 Communication Networks	22EEM07 – Electric Vehicle and Control	22MEM07 Design of Machine Elements	22MTM07 Automotive, Aerospace and Defense Materials
-----	22CSM08 Virtualization and Cloud Computing	22ECM08 Fundamentals of IoT	22EEM08 – Electrical Energy Conservation and Auditing	22MEM08 Heat and Mass Transfer	-----
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-----	-----	22ECM10 Fundamentals of Embedded Systems	22EEM10 –Utilization of Electrical Energy	22MEM10 Dynamics of Machinery	-----

LIST OF MINOR DEGREE - VERTICALS

S.No.	Course Code	Course	Cat	Hours/Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
CIVIL ENGINEERING										
1	22CEM01	Construction Materials	OE	3	0	0	3	40	60	100
2	22CEM02	Building Construction & Equipment’s	OE	3	0	0	3	40	60	100
3	22CEM03	Concrete Technology	OE	3	0	0	3	40	60	100
4	22CEM04	Environmental Engineering	OE	3	0	0	3	40	60	100
5	22CEM05	Basics of Transportation Engineering	OE	3	0	0	3	40	60	100
6	22CEM06	Repair and Rehabilitation of Structures	OE	3	0	0	3	40	60	100
7	22CEM07	Green Building Technology	OE	3	0	0	3	40	60	100
COMPUTER SCIENCE AND ENGINEERING										
1	22CSM01	Programming in C++	OE	3	0	0	3	40	60	100
2	22CSM02	Advanced Data Structures and Algorithms	OE	3	0	0	3	40	60	100
3	22CSM03	Computer Organization and Design	OE	3	0	0	3	40	60	100
4	22CSM04	Advanced Operating Systems	OE	3	0	0	3	40	60	100
5	22CSM05	Data Communication and Computer Networks	OE	3	0	0	3	40	60	100
6	22CSM06	Programming Essentials in Python	OE	3	0	0	3	40	60	100
7	22CSM07	Advanced Database System Concepts	OE	3	0	0	3	40	60	100
8	22CSM08	Virtualization and Cloud Computing	OE	3	0	0	3	40	60	100
ELECTRONICS AND COMMUNICATION ENGINEERING										
1	22ECM01	Electron Devices	OE	3	0	0	3	40	60	100
2	22ECM02	Digital Electronics	OE	3	0	0	3	40	60	100
3	22ECM03	Electronic Circuits	OE	3	0	0	3	40	60	100
4	22ECM04	Signal Processing	OE	3	0	0	3	40	60	100
5	22ECM05	Fundamentals of Microprocessors and Microcontrollers	OE	3	0	0	3	40	60	100

6	22ECM06	Analog and Digital Communication	OE	3	0	0	3	40	60	100
7	22ECM07	Communication Networks	OE	3	0	0	3	40	60	100
8	22ECM08	Fundamentals of IoT	OE	3	0	0	3	40	60	100
9	22ECM09	Wireless sensors and networking	OE	3	0	0	3	40	60	100
10	22ECM10	Fundamentals of Embedded systems	OE	3	0	0	3	40	60	100
ELECTRICAL AND ELECTRONICS ENGINEERING										
1	22EEM01	Linear and Digital Electronics Circuits	OE	3	0	0	3	40	60	100
2	22EEM02	Microprocessors and Microcontrollers	OE	3	0	0	3	40	60	100
3	22EEM03	Control Systems	OE	3	0	0	3	40	60	100
4	22EEM04	Measurements and Instrumentation	OE	3	0	0	3	40	60	100
5	22EEM05	Electrical Machines	OE	3	0	0	3	40	60	100
6	22EEM06	Electric Drives and Control	OE	3	0	0	3	40	60	100
7	22EEM07	Electric Vehicles and Control	OE	3	0	0	3	40	60	100
8	22EEM08	Electrical Energy Conservation and Auditing	OE	3	0	0	3	40	60	100
9	22EEM09	SMPS and UPS	OE	3	0	0	3	40	60	100
10	22EEM10	Utilization of Electrical Energy	OE	3	0	0	3	40	60	100
MECHANICAL ENGINEERING										
1	22MEM01	Engineering Thermodynamics	OE	3	0	0	3	40	60	100
2	22MEM02	Fluid Mechanics and Machinery	OE	3	0	0	3	40	60	100
3	22MEM03	Manufacturing Processes	OE	3	0	0	3	40	60	100
4	22MEM04	Materials Engineering	OE	3	0	0	3	40	60	100
5	22MEM05	Kinematics of Machinery	OE	3	0	0	3	40	60	100
6	22MEM06	Hydraulics and Pneumatics	OE	3	0	0	3	40	60	100
7	22MEM07	Design of Machine Elements	OE	3	0	0	3	40	60	100
8	22MEM08	Heat and Mass Transfer	OE	3	0	0	3	40	60	100
9	22MEM09	Metrology and Quality Control	OE	3	0	0	3	40	60	100

10.	22MEM10	Dynamics of Machinery	OE	3	0	0	3	40	60	100
METALLURGICAL ENGINEEING										
1	22MTM01	Advanced Physical Metallurgy	OE	3	0	0	3	40	60	100
2	22MTM02	Thermodynamics and Kinetics in Metallurgy	OE	3	0	0	3	40	60	100
3	22MTM03	Mechanical Behaviour of Materials	OE	3	0	0	3	40	60	100
4	22MTM04	Rate Processes in Metallurgy	OE	3	0	0	3	40	60	100
5	22MTM05	Corrosion and Surface Engineering	OE	3	0	0	3	40	60	100
6	22MTM06	Materials Characterization	OE	3	0	0	3	40	60	100
7	22MTM07	Automotive, Aerospace and Defence Materials	OE	3	0	0	3	40	60	100

SUMMARY

Course component	Credits Per Semester								Total Credits
	I	II	III	IV	V	VI	VII	VIII	
HS	3	4		2	03				12
ES	6.5	8.5							15
BS	11	10	4	4					29
PC			19	19	13		16		67
PE						09	03	6	18
OE					3	09			12
EE		1	1	1	1	3		7	14
MC/HSMC	1	1							02
Total	**21.5**	**24.5**	**24**	**26**	**20**	**21**	**19**	**13**	**169**

Course Category	Credits as per AICTE	Credits % as per AICTE	Credits as per Anna University	Credits % as per Anna University	Credits	Credit %
Humanities and Social Science/HSMC	15	9.37	12	7.41	14	8.28
Basic Science	23	14.37	25	15.43	29	17.15
Engineering Science	17	10.63	21	12.96	15	8.88
Program Core	61	38.13	58	35.80	67	39.64
Professional Electives	12	7.5	18	11.11	18	10.65
Open Electives	12	7.5	12	7.41	12	7.10
EEC	20	12.5	16	9.88	14	8.28
	160	**100**	**162**	**100**	**169**	**100**

SYLLABUS

PROFESSIONAL CORE COURSES

ELECTRONICS AND COMMUNICATION ENGINEERING- FULL TIME

REGULATION 2022 – SYLLABUS

SEMESTER-I

22MC101	INDUCTION PROGRAM		Semester			I
PREREQUISITES		Category	MC	Credit		0
		Hours/Week	L	T	P	TH
			0	0	0	0

INDUCTION PROGRAM (MANDATORY) - 3 WEEKS DURATION

LIST OF EXPERIMENTS

- Physical activity.
- Creative Arts.
- Universal Human Values.
- Literary.
- Proficiency Modules.
- Lectures by Eminent People.
- Visits to local Areas.
- Familiarization to Dept./Branch & Innovations.

Total = 21 Days

22EN101	COMMUNICATIVE ENGLISH			SEMESTER		I
PREREQUISTIES		**CATEGORY**	**HS**	**Credit**		**3**
Basic language skills listening, speaking, reading and writing		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**0**	**2**	**4**

COURSE OBJECTIVES	
1.	To develop the communicative skills of learners by engaging them in reading, writing and grammar learning activities
2.	To inculcate learners' ability to read texts, summaries, articles and user manuals
3.	To assist learners to acquire writing skills for academic, social and professional purposes
4.	To improve learners' vocabulary and grammar to supplement their language use at different contexts

UNIT I	**COMPREHENSION**	**6**	**0**	**6**	**12**

Listening – Interview with personal assistant, An interview with a business consultant, Describing changes in a company, Describing dimensions of products.
Speaking - Self-introduction, name, home background, study details, area of interest, hobbies, strengths and weaknesses, etc.**Reading** - Reading for detailed comprehension, specific information, Understanding notices, messages, timetables, graphs relevant to technical contexts. **Writing** – Dialogue writing in a business context. **Grammar** - Parts of speech, Tenses, Voices, Common errors in English, Subject-Verb agreement, Noun-Pronoun agreement, Prepositions and Articles.

UNIT II	**RECOMMENDATION**	**6**	**0**	**6**	**12**

Listening – An interview about a production process, Telephone conversations, Making and changing appointments, Description of how a product is advertised. **Speaking** - Personal interview, dress code, body language, required skills, corporate culture and mock interview.**Reading** - Reading technical texts from journals, newspapers and technical blogs.**Writing** - Writing checklists, Recommendations. **Grammar** - Prefix and suffix, Synonyms, Antonyms, Verb forms - Auxiliary verbs, Modal verbs, Phrasal verbs, Pronouns, Adverbs and Adjectives.

UNIT III	**CONVERSATION**	**6**	**0**	**6**	**12**

Listening - Conversation between two employees, Interview about change in job and corporate gift giving, Creating good teams: a presentation. **Speaking** - Role play - examiner and candidate, customer and sales manager, team leader and team member, interviewer and applicant, industrialist and candidate.
Reading - Reading advertisements, gadget reviews, user manuals. **Writing** - Providing instruction, **Writing** E-mails - Attending workshops, Paper submission for seminars and conferences, Arranging and cancelling a meeting. **Grammar** - Conditional statements, Redundancies, Collocations and Meanings of individual words.

UNIT IV	**REPORTING**	**6**	**0**	**6**	**12**

Listening – Working in an international team, Statistical information, Interview with investor relations, Radio interviews. **Speaking** – Giving a speech, Describing given data, Discussing company information, Summarizing an article. **Reading** - Reading longer technical texts, cause and effect essays, newspaper articles, company profiles. **Writing** - Essay writing on social topics, Technical Report Writing – Status reports on projects, Feasibility reports and event reports on seminars, conferences, meeting. **Grammar** - Compound words, Conjunctions, Sentence completion, Negation in statements and questions.

UNIT V	**INTERPRETATION**	**6**	**0**	**6**	**12**

Listening – An interview with career advisor and recruitment agent, Feedbacks, Meeting extracts. **Speaking** – Qualities required for employability, Improving employee productivity, presentation on problem-solving skills, teamwork, creativity and leadership quality. **Reading** - Reading brochures, telephone messages, social media messages relevant to technical contexts. **Writing** - Letter Writing – Formal Letters and Informal Letters - cover letter with resume, Mind maps, **Charts** - interpreting statistical data, charts, graphs and tables. **Grammar** - One word substitution, Abbreviations and acronyms in technical contexts and technical vocabulary, Idioms.

Total (30L + 30P) = 60 Periods

REFERENCE BOOKS:	
1.	Meenakshi Raman and Sangeeta Sharma. Professional English. Oxford University Press, New Delhi, 2019.
2.	Krishna Mohan, Meera Bannerji. Developing Communication Skills. Macmillan India Ltd, Delhi, 1990.
3.	Sanjay Kumar, Pushp Lata. English Language and Communication Skills for Engineers. Oxford University Press, 2018.
E-RESOURCES:	
1.	https://learnenglish.britishcouncil.org/
2.	https://www.bbc.co.uk/learningenglish

COURSE OUTCOMES: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	comprehend the main ideas, key details and inferred meanings of technical texts	Understanding
CO2	:	use language effectively at technical and professional contexts	Applying
CO3	:	apply the academic and functional writing skills in formal and informal communicative contexts	Applying
CO4	:	interpret pictorial representation of statistical data and charts	Applying

COURSE ARTICULATION MATRIX

COs /POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	1	-	-	-	-	1	3	-	1	-	-	1
CO2	-	-	-	1	-	-	-	-	1	3	-	2	-	-	2
CO3	-	-	-	2	-	-	-	-	1	3	-	1	-	-	1
CO4	-	-	-	3	-	-	-	-	1	3	-	1	-	-	1
Avg	-	-	-	1.75	-	-	-	-	1	3	-	1.25	-	-	1.25
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22MA101	MATRICES, CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS			SEMESTER			I
PREREQUISITES			Category	BS	Credit		4
Basic 12th level Matrices, Differential Calculus, Integral Calculus and ODE			Hours/Week	L	T	P	TH
				3	1	0	4
Course Objectives							
1	To know the use of matrix algebra needed by engineers for practical applications.						
2	To understand effectively both the limit definition and rules of differentiation.						
3	To familiarize in solving maxima and minima problems in two variables.						
4	To obtain the knowledge of multiple integration and their related applications.						
5	To obtain the knowledge to solve second order differential equations with constant and variable coefficients.						
Unit I	MATRICES			9	3	0	12
System of linear equations – Characteristic equation of a Matrix – Eigenvalues and Eigenvectors – Properties – Cayley-Hamilton theorem (excluding proof) – Diagonalization of Matrices - Reduction of quadratic form to canonical form by orthogonal transformation.							
Unit II	DIFFERENTIAL CALCULUS			9	3	0	12
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules -Maxima and Minima of the function of a single variable.							
Unit III	FUNCTIONS OF SEVERAL VARIABLES			9	3	0	12
Partial derivatives – Euler’s theorem for homogeneous functions – Total Derivatives –Jacobians – Maxima, Minima and Saddle point – Method of Lagrangian multipliers – Taylor’s series.							
Unit IV	MULTIPLE INTEGRALS			9	3	0	12
Multiple integrals- Double integrals – Change of order of integration in double integrals – Change of variables (Cartesian to Polar) – Application to Areas – Evaluation of Triple integrals – Application to volumes.							
Unit V	ORDINARY DIFFERENTIAL EQUATIONS			9	3	0	12
Second order linear differential equations with constant and variable coefficients –Cauchy-Euler equation and Cauchy-Legendre’s linear equation - Method of variation of parameters –Simultaneous first order linear equations with constant coefficients.							
							Total (45+15T) = 60 Periods

Text Books:	
1	Grewal. B.S, “Higher Engineering Mathematics”, 43rd Edition, Khanna Publications, Delhi, 2015.
2	Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, 3rd Edition, Narosa Publications, New Delhi, 2007.
Reference Books:	
1	James Stewart, “Essential Calculus”, 2nd edition, Cengage Learning, New Delhi, 2014.
2	P. Kandasamy, K. Thilagavathy and K. Gunavathy, “Engineering Mathematics (For I year B.E., B. Tech)”, 9th Edition, S. Chand & Co. Ltd. New Delhi, 2010.
3	Srimanta pal and Subath.C. Bhumia, “Engineering Mathematics”, Oxford University Publications, New Delhi, 2015.
4	Erwin Kreyszig, “Advanced Engineering Mathematics”, 9th Edition, John Wiley & Sons, 2007.
5	Siva Ramakrishna Das.P, Ruknmangadachari.E. “Engineering Mathematics”, 2nd Edition, Pearson, Chennai & Delhi, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Learn the fundamental knowledge of Matrix theory.	Understanding
CO2	Use both the limit definition and rules of differentiation to differentiable functions.	Applying
CO3	Apply differentiation to solve maxima and minima problems.	Applying
CO4	Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to a change of order and change of variables.	Applying
CO5	Apply various techniques in solving differential equations.	Applying

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO4	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO5	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
Avg	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-

3/2/1 – indicates strength of correlation (3- High, 2- Medium, 1- Low)

<table>
<tr><td>22PH102</td><td colspan="2">MATERIALS SCIENCE FOR ENGINEERING</td><td colspan="3">Semester</td><td>I</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>BS</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Basic knowledge in engineering materials</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Objectives</td></tr>
<tr><td>1</td><td colspan="6">To understand the concept of classical free electron theory and band theory of solids.</td></tr>
<tr><td>2</td><td colspan="6">To gain knowledge in the basic concept of semiconductors.</td></tr>
<tr><td>3</td><td colspan="6">To obtain knowledge in Dielectric polarization, dielectric losses and application of dielectrics.</td></tr>
<tr><td>4</td><td colspan="6">To understand the concept of magnetic nature of materials, superconductors and their applications.</td></tr>
<tr><td>5</td><td colspan="6">To acquire knowledge in synthesis of metallic glasses, smart materials and nano phase materials.</td></tr>
<tr><td>UNIT I</td><td colspan="2">CONDUCTING MATERIALS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Conduction in metals - mobility and conductivity – Classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann Franz law – Lorentz number – drawbacks of classical free electron theory – Quantum theory – Fermi distribution function - Effect of temperature on Fermi function – Density of states – Carrier concentration in metals – Band theory of solids - distinction between conductors, semiconductors and insulators</td></tr>
<tr><td>UNIT II</td><td colspan="2">SEMICONDUCTING MATERIALS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Properties of semiconductor - Bonds in semiconductors - Intrinsic semiconductors - Extrinsic semiconductors - N-type and P-type semiconductors – Carrier concentration in intrinsic semiconductors(derivation) –Electrical conductivity and band gap determination in intrinsic semiconductors - Carrier concentration in N-type semiconductor(derivation) –- variation of Fermi level with temperature and doping concentration – Compound semiconductors –Direct and indirect band gap semiconductors - Hall effect - Determination of Hall coefficient – Applications</td></tr>
<tr><td>UNIT III</td><td colspan="2">DIELECTRIC MATERIALS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Electrical susceptibility – Dielectric constant – Dielectric polarization – Electronic , Ionic, Orientational and Space charge polarization – frequency and temperature dependence of polarization – Internal field – Clausius – Mossotti relation (derivation) – dielectric loss – dielectric breakdown – Uses of dielectric materials (capacitor and transformer)-Polymeric dielectric materials.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">MAGNETIC AND SUPERCONDUCTING MATERIALS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Magnetic materials: Origin of magnetic moment – Bohr magneton – Dia, Para and Ferro magnetism – Domain theory of ferromagnetism – Hysteresis – Hard and soft magnetic materials – Antiferro magnetism.
Superconductivity: Properties – Type I & Type II superconductors - BCS theory - Applications – magnetic levitation – SQUID.</td></tr>
<tr><td>UNIT V</td><td colspan="2">MODERN ENGINEERING MATERIALS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Metallic glasses - Preparation, properties, applications – Shape memory alloys (SMA) – Processing, characterization and applications. Nanomaterials: Introduction – top down and bottom up approach – synthesis – Ball milling, Plasma arcing and Sol–Gel technique – properties – applications – Carbon nanotubes – Properties.</td></tr>
<tr><td colspan="7" align="right">Total (30L+15T)= 45 Periods</td></tr>
</table>

Text Books:	
1	P.K.Palanisamy, ‘Materials Science’, Scitech Publications (India) pvt.ltd. Chennai, Second edition, 2009
2	M. Arumugam, ‘Materials Science’, Anuradha Publications, Kumbakonam, 2018.
3	Rajendran V and Marikani A, ‘Materials Science’, Tata McGraw Publications, New Delhi, 2012
4	Jayakumar S, ‘Materials Science’, RK Publishers, Coimbatore, 2011.
Reference Books:	
1	Charles Kittel, ‘Introduction to Solid state Physics’, John Wiley and Sons, 7th Edition, Singapore, 2019.
2	Charles P. Poole and Frank J. Ownen, ‘Introduction to Nanotechnology’, Wiley India, 2007.
3	M.S. Vijaya and G. Rangarajan, ‘Materials Science’, Tata McGraw Hill, New Delhi, 2012.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Uunderstand the concept of classical free electron theory and band theory of solids.	Understanding
CO2	Gain knowledge in the basics of semiconductor and variation of Fermi level with respect to different parameters.	Remembering
CO3	Analyze the various mechanism involved in dielectric polarization and its applications.	Analyzing
CO4	Understand the concept of magnetic and super conducting materials.	Understanding
CO5	Apply various techniques to synthesis modern engineering materials.	Evaluating

COURSE ARTICULATION MATRIX															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	-	-	-	1	-	-	-	-	1	2	2	-
CO2	3	2	1	-	1	1	1	1	-	-	-	2	-	-	1
CO3	3	3	1	-	-	1	1	1	-	-	-	1	1		-
CO4	3	3	2	1	2	1	-	-	-	-	-	2	-	2	-
CO5	2	2	2	2	3	1	-	1	-	-	-	2	-	-	2
Avg	**2.8**	**2.4**	**1.4**	**1.5**	**2**	**1**	**1**	**1**	-	-	-	**1.6**	**1.5**	**2**	**1.5**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22CY101</td><td colspan="2">ENGINEERING CHEMISTRY</td><td colspan="3">Semester</td><td>I</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>BS</td><td colspan="2">Credit</td><td>4</td></tr>
<tr><td colspan="2" rowspan="2">Basic Chemistry</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="7">Course Objectives</td></tr>
<tr><td>1</td><td colspan="6">Basic Principles of Spectroscopy and their applications.</td></tr>
<tr><td>2</td><td colspan="6">Knowledge of different methods for water analysis and purification & Nanomaterials and its application.</td></tr>
<tr><td>3</td><td colspan="6">Various adsorption techniques and basic knowledge of Phase equilibria.</td></tr>
<tr><td>4</td><td colspan="6">Principles of electrochemistry, electrochemical cells, corrosion, and its control.</td></tr>
<tr><td>5</td><td colspan="6">Basis of polymer preparations and applications and enhancement of the quantity and quality of fuels.</td></tr>
<tr><td>Unit I</td><td colspan="2">SPECTROSCOPIC TECHNIQUES</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Beer-Lambert's law (problem) -UV visible spectroscopy: Principle, Chromophores, auxochrome, electronic transitions and instrumentation (No applications). IR spectroscopy: Principles -instrumentation and applications of IR in H_2O, and CO_2. Flame photometry -principle -instrumentation -estimation of sodium by flame photometer. Atomic absorption spectroscopy -principles -instrumentation -estimation of nickel by atomic absorption spectroscopy.</td></tr>
<tr><td>Unit II</td><td colspan="2">WATER TECHNOLOGY AND NANOTECHNOLOGY</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water – Reverse Osmosis. Nano chemistry – preparations and properties of nanomaterials – nanorods – nanowires – nanotubes – carbon nano tubes and their application.</td></tr>
<tr><td>Unit III</td><td colspan="2">SURFACE CHEMISTRY AND PHASE EQUILIBRIA</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm. Phase rule: Introduction, definition of terms with examples, one component system -water system – reduced phase rule – thermal analysis and cooling curves – two component systems – lead-silver system – Pattinson process.</td></tr>
<tr><td>Unit IV</td><td colspan="2">ELECTROCHEMISTRY</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Electrode Potential- Oxidation and Reduction Potentials - Electrochemical series – Significance and application - Electrochemical cell, Cell potential, derivation of Nernst equation for single electrode potential, numerical problems on E, E_0, and E_{cell} - numerical problems. Electrochemical theory of corrosion with respect to iron. Factors influencing the corrosion rate: physical state of the metal, nature of the metal, area effect, over voltage, pH, temperature, and nature of the corrosion product. Types of corrosion: galvanic series; (i) Differential aeration corrosion- oxygen concentration cell, (ii) Stress corrosion- explanation-caustic embrittlement. Corrosion control by i) Cathodic protection- sacrificial anode and impressed current methods i) Protective coatings-metal coatings- galvanizing and tinning.</td></tr>
<tr><td>Unit V</td><td colspan="2">POLYMERS AND FUELS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Polymers – definition – polymerization – types – addition and condensation polymerization – free radical polymerization mechanis – plastics, classification – preparation, properties and uses of PVC, Teflon, polycarbonate, polyurethane, nylon-6,6, PET – Rubbe vulcanization of rubber, synthetic rubbers – butyl rubber, SBR – biopolymers – Nylon-2-Nylon-6 and PHBV. Fuels - classificatio with examples, calorific value-classification (HCV & LCV), determination of calorific value of solid and liquid fuels using Bom calorimeter- Petroleum cracking -fluidized bed catalytic cracking. Knocking in IC engine, its ill effects and prevention of knocking Anti-knocking agent: Leaded and unleaded petrol.</td></tr>
<tr><td colspan="7" align="right">Total (45L+15T) = 60 Periods</td></tr>
</table>

Text Books:	
1	S. S. Dara and S. S. Umare, —A Textbook of Engineering Chemistry | S. Chand & Company LTD, New Delhi, 2015
2	P. C. Jain and Monika Jain, —Engineering Chemistry | Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3	S. Vairam, P. Kalyani and Suba Ramesh, —Engineering Chemistry | Wiley India PVT, LTD, New Delhi, 2013.
Reference Books:	
1	Friedrich Emich, —Engineering Chemistry | Scientific International PVT, LTD, New Delhi, 2014.
2	Prasanta Rath, —Engineering Chemistry | Cengage Learning India PVT, LTD, Delhi, 2015.
3	Shikha Agarwal, — Engineering Chemistry-Fundamentals and Applications | Cambridge University Press, Delhi, 2015.
E- References :	
1	www.onlinecourses.nptel.ac.in/
2	www.ePathshala.nic.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Recall the basic principles of spectroscopy and their applications	Remembering
CO2	Paraphrase the different methods for water analysis & purification and Nanomaterial & its applications	Understanding
CO3	Apply the various adsorption techniques and basic knowledge of Phase equilibria	Applying
CO4	Integrate the principles of electrochemistry, electrochemical cells, corrosion, and its control	Creating
CO5	Assess the basis of polymer preparations & applications and enhancement of the quantity & quality of fuels.	Evaluating

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	1	1
CO2	3	2	-	1	-	2	-	-	-	-	-	-	3	1	1
CO3	3	1	-	1	-	-	-	-	-	-	-	-	2	1	1
CO4	2	1	-	1	-	2	-	-	-	-	-	-	2	3	2
CO5	3	2	-	3	-	2	-	-	-	-	-	-	1	1	1
Avg	2.8	1.8	-	1.8	-	2	-	-	-	-	-	-	2.2	1.4	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22CS101	**PROBLEM SOLVING AND C PROGRAMMING** (Common to CSE, ECE, Civil, Mechanical and Metallurgy)			SEMESTER			I
PREREQUISITES		**CATEGORY**		ES	Credit		3
NIL		**Hours/week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To use general problem-solving techniques to device solutions to problems
2.	To understand the input-output relations of software involved in developing and converting a C program to a executable code.
3.	To provide complete knowledge about the programming concepts of C language.

UNIT I	**SYSTEM SOFTWARE, PROBLEM SOLVING, AND C PROGRAMMING**	**9**	**0**	**0**	**9**

High level programming language – Machine level language – Role of system software (Editor, Compiler, Assembler, Linker, Loader, and Operating System) in developing and executing a C program

C Programming: Character Set – Case sensitivity – Identifiers – Keywords –Literals – Data types – Declaration statement– Variables and their associated information– Formatted and unformatted console input-output statements – Type conversion – Operators – Precedence and Associativity – Pre-processor directives (#include and #define) – the main() function.

General problem-solving Techniques: Algorithm – Flow-chart – Pseudocode – Developing solutions for problems involving only operators and writing their equivalent C programs

UNIT II	**CONTROL STATEMENTS**	**9**	**0**	**0**	**9**

General problem-solving Techniques: Representing Decision making: if-else statement – switch-case statement – Looping statements: for loop, while loop and do-while loop – Branching statements: break and continue with Algorithm, Flow-chart, and Pseudocode.

C Programming: Decision Making: if-else statement – switch-case statement – Looping statements: for loop, while loop and do-while loop – Branching statements: break and continue – Nesting

Developing solutions for problems involving control statements using General problem-solving Techniques and their equivalent C programs

UNIT III	**ARRAYS, POINTERS, AND STRINGS**	**9**	**0**	**0**	**9**

One-dimensional and two-dimensional Arrays: Declaration – Initialization – Processing – Pointers: Declaration – Initialization – Processing – Relation between pointers and arrays – Strings – String operations – C Library support for String handling

Developing solution for problems involving arrays, pointers and strings using General problem-solving Techniques and their equivalent C programs

UNIT IV	**FUNCTIONS**	**9**	**0**	**0**	**9**

Function – Library functions and user-defined functions – Function prototypes and function definitions – Parameter passing mechanisms –Recursion – Storage classes – Working with multiple source files

Developing solution for problems involving functions using General problem-solving Techniques and their equivalent C programs.

UNIT V	**STRUCTURES, UNIONS AND FILE**	**9**	**0**	**0**	**9**

Structure: declaration – definition –Structure within a structure – Passing structures to functions – Array of structures – Pointers to structures – Union – File operations: reading and writing/appending to binary and text files.

Total (45 L)= 45 Periods

Text Books:	
1.	Balagurusamy E, "Programming in ANSI C", Tata Mcgraw-Hill, 8th Edition, 2022.
2.	Yashavant P. Kanetkar, "Let Us C", BPB Publications, 2016.
Reference Books:	
1.	Venugopal, "Mastering C", Second Edition, Tata McGraw-Hill Education. 2006
2.	R. G. Dromey, "How to solve it by computers", Prentice Hall, 2007

3.	Greg Perry and Dean Miller, “C Programming Absolute Beginner’s Guide”, Third Edition, Que Publishing, 2013.
4.	Brain W. Kernighan and Ritchie Dennis, “The C Programming Language”, Second Edition, Pearson, 1988.
E-Reference:	
1.	https://www.learn-c.org/
2.	https://www.programiz.com/c-programming

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Explain the concepts of C programming and roles of system software in programming	Understanding
CO2	Use general problem-solving techniques to develop solutions to problems	Applying
CO3	Apply the concepts of C programming to develop solutions by writing C programs	Analyzing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	-	-	1	-	-	2	2	2	1	-
CO2	3	3	2	2	2	-	-	1	-	-	2	2	2	1	-
CO3	3	3	2	2	2	-	-	1	-	-	2	2	2	1	-
Avg	3	3	2	2	2	-	-	1	-	-	2	2	2	1	-

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22MC102	தமிழர் மரபு B.E (Common to all Branches)				Semester I
முன்நிபந்தனைகள்:		Category	HSMC	Credit	1
இலக்கணம் மற்றும் இலக்கியத்தின் அடிப்படைகள்		Hours/Week	L	T	P	TH
			1	0	0	1

பாடநெறி நோக்கங்கள்: மாணவர்களால்

1.	தமிழ் மொழி மற்றும் இலக்கியம் பற்றிய அறிவைப் பெற முடியும்.
2.	பாரம்பரியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் மற்றும் சிற்பக் கலைகள் பற்றி தெரிந்து கொள்ள முடியும்
3.	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் பற்றி அறிந்து கொள்ள முடியும்
4.	தமிழர்களின் ஒழுக்க நெறிமுறைகளைப் பற்றி தெரிந்து கொண்டு அதன்படி நடந்து கொள்ள முடியும்.
5.	பழங்கால இந்திய தேசிய இயக்கம் பற்றியும், இந்திய மக்களின் பன்பாட்டில் தமிழர்களின் பங்களிப்பு பற்றியும் நன்கு அறிந்து கொள்ள முடியும்.

அலகு I	மொழி மற்றும் இலக்கியம்	3	0	0	3

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

அலகு II	மரபு – பாறைஓவியங்கள்முதல்நவீன ஓவியங்கள் வரைசிற்பக்கலை	3	0	0	3

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

அலகு III	நாட்டுப்புறக்கலைகள்மற்றும்வீரவிளையாட்டுகள்	3	0	0	3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான்கூத்து, ஒயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின்விளையாட்டுகள்.

அலகு IV	தமிழர்களின்திணைக்கோட்பாடுகள்	3	0	0	3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V	இந்தியதேசியஇயக்கம்மற்றும்இந்தியபண்பாட்டிற்குத்த மிழர்களின்பங்களிப்பு	3	0	0	3

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப்பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப்புத்தகங்களின் அச்சு வரலாறு.

Total= 15 Periods

Text Books:	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியல் பணிகள் கழகம்)
2	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

பாடநெறி முடிவுகள்: இந்தப் படிப்பு முடிந்ததும், மாணவர்களால்		**Bloom's Taxonomy Mapped**
CO1	இந்திய மொழிகள், இந்திய மொழிக் குடும்பங்கள் பற்றியும் மற்றும் இலக்கியம், இலக்கியதின் வளர்ச்சி, தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்புகளை பற்றியும் அறிந்து கொண்டனர்.	Understanding
CO2	சிற்பக் கலைகளில் அடங்கியுள்ள பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை பற்றியும், தமிழர்களின் சமூக, பொருளாதார வாழ்வில் கோவில்களின் பங்கினை பற்றியும் தெரிந்து கொண்டனர்.	Understanding
CO3	தமிழர்களின் வாழ்வியல் முறைகளோடு ஒன்றிய நாட்டுபுறக் கலைகள் மற்றும் தமிழர்களின் வீர விளையாட்டுகளை பற்றி அறிந்து கொண்டனர்.	Understanding
CO4	சங்ககாலத்தில் தமிழர்கள் பின்பற்றிய தினைக் கோட்பாடுகள் பற்றி நடந்து கொண்டனர்.	Applying
CO5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்க்குத் தமிழர்களின் பங்கினை பற்றியும் அறிந்து கொண்டனர்.	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			3			2				1			2		
CO2			3			2				1			2		
CO3			3			2				1			2		
CO4			3			2				1			2		
CO5			3			2				1			2		
Avg			**3**			**2**				**1**			**2**		

3 / 2 /1 - indicates strength of correlation (3- High, 2- Medium, 1- Low)

<table>
<tr><td>22MC102</td><td colspan="4">HERITAGE OF TAMILS</td><td colspan="3">Semester</td><td>I</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>HS MC</td><td colspan="3">Credit</td><td>1</td></tr>
<tr><td colspan="3" rowspan="2">Basics of Tamil Language and Literature</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>1.</td><td colspan="8">To Obtain the knowledge of Tamil Language and Literature</td></tr>
<tr><td>2.</td><td colspan="8">To familiarize with painting and Sculpture</td></tr>
<tr><td>3.</td><td colspan="8">To Know about the folks and martial arts</td></tr>
<tr><td>4.</td><td colspan="8">To understand the Thinai concept of Tamils</td></tr>
<tr><td>5.</td><td colspan="8">To know about the contribution of Tamils to Indian National Movement and Indian Culture.</td></tr>
<tr><td>Unit I</td><td colspan="4">LANGUAGE AND LITERATURE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.</td></tr>
<tr><td>Unit II</td><td colspan="4">HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.</td></tr>
<tr><td>Unit III</td><td colspan="4">FOLK AND MARTIAL ARTS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.</td></tr>
<tr><td>Unit IV</td><td colspan="4">THINAI CONCEPT OF TAMILS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.</td></tr>
<tr><td>Unit V</td><td colspan="4">CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.</td></tr>
<tr><td colspan="9">Total = 15 Periods</td></tr>
</table>

Text Books:	
1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
5	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology&TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the knowledge of Tamil Language and Literature	Understanding
CO2	Familiarize about painting and Sculpture	Understanding
CO3	Acquire the knowledge about folks and Martial arts	Understanding
CO4	Learn the knowledge of Thinai concepts of Tamils	Applying
CO5	Acquire the knowledge about contribution of Tamils to Indian national movement and Indian culture	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			3			2				1			2		
CO2			3			2				1			2		
CO3			3			2				1			2		
CO4			3			2				1			2		
CO5			3			2				1			2		
Avg			**3**			**2**				**1**			**2**		

3 / 2 /1 - indicates strength of correlation (3- High, 2- Medium, 1- Low)

22CS102	**COMPUTER PRACTICE AND C PROGRAMMING LABORATORY** (Common to CSE, ECE, EEE, Civil, Mechanical and Metallurgy)		**Semester**			**I**
PREREQUISITES		**Category**	**ES**	**Credit**		**1.5**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives	
1	To provide basic knowledge to work with word processing applications
2	To provide basic knowledge to work with spread sheet applications
3	To promote the programming ability to develop C applications
EXPERIMENTS	
	1. Creating and Formatting documents. 2. Creating Tables and Manipulation 3. Using Equation Editor 4. Inserting Pictures, Shapes and Charts 5. Using Mail merge **B. Spread Sheet** 6. Creating sheets, using built in functions and user-defined formulae 7. Creating different type of charts from data **C. Simple C Programming** 8. Program using different operators 9. Program using Control statements. 10. Program using Loops, Array and Strings. 11. Program using Functions and pointers 12. Program using Structures and Files. **For programming exercises Algorithm, Flow chart and pseudo code are essential**
	Total (45 P)= 45 Periods

Course Outcomes:		**Bloom's Taxonomy Mapped**
After the successful completion of the practical session, the students will be able to		
CO1	Demonstrate the usage of features supported by word processing applications.	Applying
CO2	Demonstrate the usage of features supported by spread sheet applications.	Applying
CO3	Apply general programming techniques to develop digital solutions to problems	Applying
CO4	Implement solutions developed with general programming techniques in C programming language.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	1	-
CO3	3	3	2	2	2	1	1	1	-	-	2	3	2	1	-
CO4	3	3	2	2	2	1	1	1	-	-	2	3	2	1	-
Avg	3	3	2	2	2	1	1	1	-	3	2	3	2	1	-
3 / 2 /1 - indicates strength of correlation (3- High, 2- Medium, 1- Low)															

22ME102	WORKSHOP MANUFACTURING PRACTICES				SEMESTER		I
PRE-REQUISITE		**Category**	**ES**	**Credit**			**2**
		Hours/Week	**L**	**T**	**P**		**TH**
			0	**0**	**4**		**4**

Course Objectives:

1.	To understand the basics of safety measures taken in the laboratory.
2.	To provide exposure to the students with hands-on experience on various basic engineering practices in Civil and Mechanical Engineering.
3.	To know about the various fitting joints and lathe operation.
4.	To gain knowledge in welding and fitting operation.
5.	To understand the fabrication of various models using sheet metals.

LIST OF EXPERIMENTS

1. Introduction to Safety measures and First aid.
2. Study of Lathe, drilling machine -Welding methods and equipment- Casting process and tools- Sheet metal and fitting tools- Carpentry tools and joints.
3. Fitting: V-fitting, square fitting, Curve fitting.
4. Lathe: Facing, turning, taper turning and knurling.
5. Welding: BUTT, LAP and T- joints.
6. Foundry: Greensand preparation- mould making practice.
7. Sheet metal: Cone, tray, cylinder.
8. Carpentry: CROSS, T and DOVETAIL joints.
9. Drilling: simple exercises.

Total = 60 Periods

Reference Books:

1.	Bawa, H.S, “Workshop Practice”, Tata McGraw Hill Publishing Company Limited, 2007.
2.	Jeyachandran, K, Natarajan, K and Balasubramanian, S, “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
3.	Jeyapoovan, T, SaravanaPandian, M and Pranitha, S, “Engineering Practices Lab Manual”, Vikas Publishing House Pvt. Ltd, 2006.
4.	Dr. P.kannan, Mr. T, Satheeskumar&Mr .K .Rajasekar, “Engineering practices laboratory” manual first edition 2017
5.	Dr. V. Rameshbabu “Engineering practices laboratory” VRB publication pvt ld.

E-Reference:

1.	https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-me14/
2.	https://nptel.ac.in/courses/112107083

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom’s Taxonomy Mapped**
CO1	Familiarize the working of various equipment and safety measures.	Understanding
CO2	Prepare fitting of metal and wooden pieces using simple fitting and carpentry tools manually.	Applying
CO3	Fabrication of components using welding, lathe and drilling machine.	Analyzing
CO4	Make the model using sheet metal works.	Analyzing

COURSE ARTICULATION MATRIX															
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO2	-	3	-	2	1	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	2	1	-	-	-	-	-	-	-	-	-	2
CO4	-	3	-	2	1	-	-	-	-	-	-	-	-	-	2
CO5	-	3	-	2	1	-	-	-	-	-	-	-	-	-	2
Avg	-	3	-	3	1	3	-	-	-	-	-	-	-	-	2
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

SEMESTER-II

<table>
<tr><td>22MA203</td><td colspan="5">LINEAR ALGEBRA, PARTIAL DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS
B.E. (ECE)</td><td colspan="2">SEMESTER</td><td>II</td></tr>
<tr><td colspan="5">PREREQUISTIES</td><td>CATEGORY</td><td>BS</td><td>Credit</td><td>4</td></tr>
<tr><td colspan="5" rowspan="2">Basic 12th level knowledge of Matrices, Vector Algebra, PDE, ODE and Integral Calculus.</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="10">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="9">To understand the concepts of vector space and linear transformations.</td></tr>
<tr><td>2.</td><td colspan="9">To apply the concept of inner product spaces in orthogonalization.</td></tr>
<tr><td>3.</td><td colspan="9">To understand the procedure to solve partial differential equations.</td></tr>
<tr><td>4.</td><td colspan="9">To find the solutions of second order differential equation with constant coefficients by Laplace transform methods.</td></tr>
<tr><td>5.</td><td colspan="9">To acquire the knowledge of vector differentiation and integration and its applications.</td></tr>
<tr><td>UNIT I</td><td colspan="5">VECTOR SPACES</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="10">Vector spaces – Subspaces – Linear independence and linear dependence – Bases and dimensions.Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations.</td></tr>
<tr><td>UNIT II</td><td colspan="5">INNER PRODUCT SPACES</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="10">Inner product, norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.</td></tr>
<tr><td>UNIT III</td><td colspan="5">PARTIAL DIFFERENTIAL EQUATIONS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="10">Formation – Solutions of first order equations – Standard types and equations reducible to standard types – Singular solutions – Lagrange‘s linear equation – Integral surface passing through a given curve – Classification of partial differential equations - Solution of linear equations of higher order with constant coefficients.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">LAPLACE TRANSFORM</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="10">Laplace Transform- Properties of Laplace transform – Laplace Transform of periodic Functions – Finding inverse Laplace Transform by different methods, convolution theorem – Evaluation of integrals by Laplace transform- solving second order differential equations with constant coefficients by Laplace transform method.</td></tr>
<tr><td>UNIT V</td><td colspan="5">VECTOR CALCULUS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="10">Vector differentiation- Gradient- Directional derivative - Divergence - Curl, Vector integration- Line integration- work done – Surface and Volume integrals - Green’s theorem , Gauss divergence and Stokes theorem (without proof) – Simple applications involving cubes and rectangular parallelepipeds.</td></tr>
<tr><td colspan="10" align="right">Total (45L+15T) = 60 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Grewal. B.S, “Higher Engineering Mathematics”, 43rd Edition, Khanna publications, Delhi, 2015.</td></tr>
<tr><td>2.</td><td>Friedberg, A.H., Insel, A.J. and Spence, L., “Linear Algebra”, Prentice Hall of India, New Delhi, 2004.</td></tr>
<tr><td>3.</td><td>Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, 3rd Edition, Narosa Publications, New Delhi, 2007.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>James Stewart, “Essential Calculus”, 2ndEdition, Cengage Learning, New Delhi, 2013.</td></tr>
<tr><td>2.</td><td>Erwin Kreyszig, “Advanced Engineering Mathematics”, 9thEdition, John Wiley & Sons, 2006.</td></tr>
<tr><td>3.</td><td>Kumaresan, S., “Linear Algebra – A Geometric Approach”, Prentice-Hall of India, New Delhi, Reprint, 2010.</td></tr>
<tr><td>4.</td><td>Gilbert Strang, “Linear Algebra and its Applications”, 4thEdition, Cengage Learning, New Delhi, 2014.</td></tr>
</table>

<table>
<tr><td colspan="3">Course Outcomes:
Upon completion of this course, the students will be able to:</td><td>Bloom’s TaxonomyMapped</td></tr>
<tr><td>CO1</td><td>:</td><td>Use the concepts of vector space and linear transformations.</td><td>Applying</td></tr>
<tr><td>CO2</td><td>:</td><td>Illustrate the concept of inner product spaces in orthogonalization.</td><td>Understanding</td></tr>
<tr><td>CO3</td><td>:</td><td>Solve various types of partial differential equations in engineering problems.</td><td>Applying</td></tr>
</table>

CO4	:	Apply the knowledge of Laplace transforms method to solve second order differential equations.	Applying
CO5	:	Use Gauss, Stokes and Green's theorems for the verification of line, surface and volume integrals.	Applying

COURSE ARTICULATION MATRIX															
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	3	-	-	-	-	-	-	-	-	2	-	-
CO3	3	1	-	2	-	-	-	-	-	-	-	-	2	-	-
CO4	3	1	-	3	-	-	-	-	-	-	-	-	3	-	-
CO5	3	1	-	2	-	-	-	-	-	-	-	-	2	-	-
Avg	**3**	**1.4**	-	**2.4**	-	-	-	-	-	-	-	-	**2.2**	-	-
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22PH201	PHYSICS – ELECTROMAGNETISM			SEMESTER			II
PREREQUISITES		**CATEGORY**		**BS**	**Credit**		**3**
Basic knowledge in vector calculus, electrostatics		**Hours/Week**		**L**	**T**	**P**	**TH**
				2	**1**	**0**	**3**

Course Objectives:	
1.	To understand the the concept of electrostatics, electric potential and their application.
2.	To obtain the knowledge of dielectrics, Capacitance, Poisson's and Laplace's equations.
3.	To gain knowledge of magnetostatics, magnetic fields in matter and their application.
4.	To acquire knowledge of Faraday's law, Ampere's Law, Maxwell's Equation and their application.
5.	To obtain the knowledge of Electromagnetic waves, and Poynting vector.

UNIT I	**ELECTROSTATICS IN VACUUM**	**6**	**3**	**0**	**9**
Electric field and electric flux density - Gauss's Law - applications of Gauss's law - electric field due to infinite line charge-infinite sheet of charge-uniformly charged sphere; Electric potential - potential due to a point charge- electric potential energy of a system of point charges - relationship between electric field and electric potential; Energy density in electrostatic fields.					
UNIT II	**ELECTROSTATICS IN A LINEAR DIELECTRIC MEDIUM**	**6**	**3**	**0**	**9**
Classification of materials based on conductivity; Electric dipole - electrostatic field and potential of a dipole; Dielectrics - induced dipoles - polarization in dielectrics - dielectric constant and strength; Capacitance - parallel plate capacitor - coaxial capacitor - spherical capacitor; Laplace's and Poisson's equations for electrostatic potential; Electrostatic boundary conditions for Dielectric–Dielectric, Conductor-Dielectric and Conductor-free Space.					
UNIT III	**MAGNETOSTATICS AND MAGNETIC FIELDS IN MATTER**	**6**	**3**	**0**	**9**
Biot-Savart's Law - magnetic induction at point *P* due to a straight filamentary conductor; Ampere's circuit law - applications of ampere's law: infinite line current - infinite sheet of current; Magnetic Lorentz force- force on current carrying conductor - Magnetic Boundary conditions for Dielectric–Dielectric, Conductor-Dielectric and Conductor-free Space.					
UNIT IV	**FARADAY'S LAW AND MAXWELL'S EQUATIONS**	**6**	**3**	**0**	**9**
Faraday's law in terms of emf produced by changing magnetic flux; Lenz's law; Transformer emf; Motional emf ; Electromagnetic breaking and its applications; Self Inductance- self inductance of a solenoid; Mutual Inductance - mutual Inductance of two tightly wound solenoids;Energy density in magnetic Fields; Displacement current - modified ampere's law; Maxwell's equations in vacuum and non-conducting medium.					
UNIT V	**ELECTROMAGNETIC WAVES**	**6**	**3**	**0**	**9**
The wave equation- plane electromagnetic waves in vacuum and its transverse nature, Energy carried by electromagnetic waves Flow of energy and Poynting vector; Radiation pressure.					
					Total (30L+15T)= 45 Periods

Text Books:	
1.	Mathew N. O.Sadiku, 'Elements of Electromagnetics', Oxford University Press, Third Edition, 2007.
2.	Halliday, Resnick, Walker, 'Fundamentals of Physics-Electricity and Magnetism', Wiley India Pvt. Ltd., 2015.
3.	Gangadhar K.A, Ramanthan P.M, 'Field Theory', Khanna Publications, 2002.
Reference Books:	
1.	David J. Griffiths, 'Introduction to Electrodynamics', Prentice-Hall, Inc. 2020.
2.	Kraus and Fleish, 'Electromagnetics with Applications', McGrawHill International Editions, Fifth edition, 2010.
E-Reference	
1	https://nptel.ac.in/courses/115101004
2	https://nptel.ac.in/courses/115101005

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the concepts of electrostatics, electrical potential, and their applications.	Understanding
CO2	:	Analyze the concepts of dielectric and capacitance.	Analyzing
CO3	:	Apply the concepts of magnetostatics, magnetic fields in matter and their application.	Applying
CO4	:	Apply the concepts of Faraday's laws, Ampere's Law, Maxwell's Equation.	Applying
CO5	:	Gain knowledge in the concepts of electromagnetic waves and Poynting vector.	Remembering

COURSE ARTICULATION MATRIX															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	1	-	1	-	-	-	-	-	1	1	-	-
CO2	3	2	2	3	-	1	-	-	-	-	-	2	2	1	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1	1	-	-
CO4	3	3	2	2	-	1	-	-	-	-	-	2	2	1	1
CO5	3	2	2	2	-	-	-	-	-	-	-	2	1	-	2
Avg	2.6	2.4	1.6	1.8	-	1	-	-	-	-	-	1.6	1.4	1	1.3
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22HS201</td><td colspan="3">UNIVERSAL HUMAN VALUES</td><td colspan="3">SEMESTER</td><td>II</td></tr>
<tr><td colspan="3">PRE-REQUISITE:</td><td>Category</td><td>HS</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2"></td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="7">Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.</td></tr>
<tr><td>2.</td><td colspan="7">Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.</td></tr>
<tr><td>3.</td><td colspan="7">Strengthening of self-reflection.</td></tr>
<tr><td>4.</td><td colspan="7">Development of commitment and courage to act.</td></tr>
<tr><td>UNIT I</td><td colspan="3">BASIC CONCEPTS OF HUMAN VALUES</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Course Introduction - Need, Basic Guidelines, Content and Process for Value Education. Purpose and motivation for the course, recapitulation from Universal Human Values-I. Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfil the above human aspirations- understanding and living in harmony at various levels.</td></tr>
<tr><td>UNIT II</td><td colspan="3">UNDERSTANDING HARMONY IN THE HUMAN BEING</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Understanding Harmony in the Human Being - Harmony in Myself! Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’ Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer) Understanding the characteristics and activities of ‘I’ and harmony in ‘I’ Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail Programs to ensure Sanyam and Health.</td></tr>
<tr><td>UNIT III</td><td colspan="3">UNDER STANDING HARMONY IN THE FAMILY AND SOCIETY</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.</td></tr>
<tr><td>UNIT IV</td><td colspan="3">UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Understanding Harmony in the Nature and Existence - Whole existence as Coexistence. Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all- pervasive space. Holistic perception of harmony at all levels of existence.</td></tr>
<tr><td>UNIT V</td><td colspan="3">HOLISTIC UNDERSTANDING OF HARMONY</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Implications of the above Holistic Understanding of Harmony on Professional Ethics. Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics, Strategy for transition from the present state to Universal Human Order.</td></tr>
<tr><td colspan="8" align="right">Total (30L + 15T) = 45 Periods</td></tr>
</table>

Reference Books:	
1.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books:	
1.	JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	The Story of Stuff (Book)
4.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5.	Small is Beautiful - E. F Schumacher.
6.	Slow is Beautiful - Cecile Andrews
7.	Economy of Permanence - J C Kumarappa
8.	Bharat Mein Angreji Raj - PanditSunderlal
9.	Rediscovering India - by Dharampal
10.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11.	India Wins Freedom - Maulana Abdul Kalam Azad
12.	Vivekananda - Romain Rolland (English)
13.	Gandhi - Romain Rolland (English)

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Become more aware of themselves, and their surroundings (family, society, nature) and become more responsible in life	Evaluating
CO2	Handle problems with sustainable solutions, while keeping human relationships and human nature in mind	Applying
CO3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society)	Evaluating
CO4	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.	Applying

COURSE ARTICULATION MATRIX															
CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	1	-	-	1	-	2	-	1	-	3	2	-	1
CO2	-	-	1	-	-	3	-	1	-	1	-	3	1	-	1
CO3	-	-	1	-	-	2	-	1	-	1	-	3	1	-	2
CO4	-	-	2	-	-	1	-	1	-	1	-	3	1	-	1
Avg	-	-	1.25	-	-	1.75	-	1.25	-	1	-	3	1.25	-	1.25
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22EE201	PRINCIPLES OF ELECTRICAL ENGINEERING			SEMESTER			II
PREREQUISITES			**CATEGORY**	**ES**	**Credit**		**4**
Engineering Physics			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**1**	**0**	**4**

Course Objectives:

1.	To understand the basic concepts of electric circuits, measurements techniques and instruments
2.	To study the working principles of DC and AC machines
3.	To understand the components of Electrical installations

UNIT I	**DC CIRCUITS**	**9**	**3**	**0**	**12**
Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin, Norton and Maximum power transfer theorems, Time-domain analysis of first-order RL and RC circuits.					
UNIT II	**AC CIRCUITS**	**9**	**3**	**0**	**12**
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of RL, RC, RLC combinations (series and parallel), resonance, Three-phase balanced circuits, voltage and current relations in star and delta connections.					
UNIT III	**TRANSFORMERS**	**9**	**3**	**0**	**12**
Construction – Working principle – EMF equation – Ideal and Practical transformer – Transformer on no-load – Transformer on load - Equivalent circuit - Losses and Efficiency of transformers – Regulation - Auto-transformer: Saving of Copper, Uses.					
UNIT IV	**ELECTRICAL MACHINES**	**9**	**3**	**0**	**12**
Construction, working and speed control of DC shunt motor, Construction and working of a three phase induction motor, Starting and speed control of three phase induction motor, Working of single phase induction motor and its applications, Construction and working of synchronous generators.					
UNIT V	**ELECTRICAL INSTALLATIONS**	**9**	**3**	**0**	**12**
Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing, Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.					
					Total (45L+15T) = 60 Periods

Text Books:

1.	Basic Electrical Engineering - D.P. Kothari and I.J. Nagrath, 3rd edition, Tata McGraw Hill, 2010.
2.	Basic Electrical Engineering - D.C. Kulshreshtha, Tata McGraw Hill, 2019.

Reference Books:

1.	Fundamentals of Electrical Engineering, L.S. Bobrow, Oxford University Press, 2011
2.	Electrical and Electronics Technology, E. Hughes, 10th Edition, Pearson, 2010
3.	Electrical Engineering Fundamentals, Vincent Deltoro, Second Edition, Prentice Hall India, 1989

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Analyze DC and AC circuits.	Analyzing
CO2	:	Apply electrical circuit theorems to DC circuits.	Applying
CO3	:	Discuss the concepts and working of two-winding and auto-transformers.	Understanding
CO4	:	Explain the working principles of DC and AC Electrical Machines.	Understanding
CO5	:	To choose components of Low Voltage Electrical Installations	Evaluating

COURSE ARTICULATION MATRIX															
COs/POs	**PO1**	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO12**	**PSO 1**	**PSO2**	**PSO3**
CO1	2	2	1	-	-	-	-	-	-	-	1	1	hon	1	1
CO2	2	2	1	-	-	-	-	-	-	-	1	1	1	1	1
CO3	2	1	1	-	-	-	-	-	-	-	1	1	1	1	1
CO4	1	1	-	-	-	-	-	-	-	-	1	1	1	1	1
CO5	1	1	-	-	-	-	-	-	-	-	1	1	1	1	1
Avg	1.6	1.4	1	-	-	-	-	-	-	-	1	1	1	1	1
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22ME101</td><td colspan="3">ENGINEERING GRAPHICS AND DESIGN</td><td colspan="3">Semester</td><td>II</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>ES</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Students should know about the basics of drawings.

Students should be able to construct geometric shapes</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>1</td><td>0</td><td>4</td><td>5</td></tr>
<tr><td colspan="8">Course Objectives</td></tr>
<tr><td>1</td><td colspan="7">To impart knowledge on graphical skills for communications of concepts, ideas and design of engineering products and to provide exposure to design.</td></tr>
<tr><td>2</td><td colspan="7">To expose them to existing national standards related to technical drawings.</td></tr>
<tr><td>3</td><td colspan="7">To understand the basics of points, lines, planes and solids.</td></tr>
<tr><td>4</td><td colspan="7">To understand the basics of the surface of an object.</td></tr>
<tr><td>5</td><td colspan="7">To expose them to isometric and perspective views of simple solids.</td></tr>
<tr><td>Unit I</td><td colspan="3">PROJECTION OF POINTS, LINES AND PLANE SURFACES</td><td>3</td><td>0</td><td>12</td><td>15</td></tr>
<tr><td colspan="8">General principles of orthographic projection- Projection of points, located in all quadrants – Projection of straight lines located in the first quadrant – Determination of true lengths and true inclinations – Projection of polygonal surface and circular lamina inclined to both reference planes.</td></tr>
<tr><td>Unit II</td><td colspan="3">PROJECTION OF SOLIDS</td><td>3</td><td>0</td><td>12</td><td>15</td></tr>
<tr><td colspan="8">Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular to one reference plane and also inclined to one reference plane by change of position method.</td></tr>
<tr><td>Unit III</td><td colspan="3">SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES</td><td>3</td><td>0</td><td>12</td><td>15</td></tr>
<tr><td colspan="8">Sectioning of above solids in a simple vertical position by cutting planes inclined to one reference plane and perpendicular to other – solids inclined position with cutting planes parallel to one reference plane- Obtaining true shape of the section. Development of lateral surfaces of simple and truncated solids – Prisms, pyramids cylinders and cones- Development of lateral surfaces of solids with square and cylindrical cutouts, perpendicular to the axis.</td></tr>
<tr><td>Unit IV</td><td colspan="3">ORTHOGRAPHIC AND ISOMETRIC PROJECTION</td><td>3</td><td>0</td><td>12</td><td>15</td></tr>
<tr><td colspan="8">Orthographic Projection - Visualization concepts and Freehand sketching - Visualization principles - Representation of three-dimensional objects - Layout of views - Freehand sketching of multiple views from pictorial views of objects. Principles of isometric projection – isometric scale - isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.</td></tr>
<tr><td>Unit V</td><td colspan="3">PERSPECTIVE PROJECTION</td><td>3</td><td>0</td><td>12</td><td>15</td></tr>
<tr><td colspan="8">Perspective projection of prisms, pyramids and cylinders by visual ray and vanishing point methods.</td></tr>
<tr><td colspan="8">Total (15L+60P) = 75 Periods</td></tr>
</table>

Text Books:	
1	Bhatt, N.D.,Panchal V M and Pramod R. Ingle, "Engineering Drawing", Charotar Publishing House, 53rd Edition, 201
2	Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015
Reference Books:	
1	Agrawal, B. and Agrawal C.M., "Engineering Drawing", Tata McGraw, N.Delhi, 2008.
2	Gopalakrishna, K. R., "Engineering Drawing", Subhas Stores, Bangalore, 2007.
3	Natarajan, K. V., "A text book of Engineering Graphics", 28^{th} Ed., Dhanalakshmi Publishers, Chennai, 2015.
4	Shah, M. B., and Rana, B. C., "Engineering Drawing", Pearson, 2^{nd} Ed., 2009.
5	Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", New Age, 2008.
E-References	
1.	https://nptel.ac.in/courses/112102304
2.	https://home.iitk.ac.in/~anupams/ME251/EDP.pdf
3.	https://static.sdcpublications.com/pdfsample/978-1-58503-610-3-1.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Familiarize with the fundamentals and standards of engineering graphics.	Understanding
CO2	Ability to understand the fundamental concepts of projection of points, lines and planes.	Analyzing
CO3	Project the solids and section of solids.	Analyzing
CO4	Familiarize and develop the lateral surfaces of solids	Analyzing
CO5	Visualize and project the orthographic, isometric and perspective sections of simple solids.	Analyzing

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O 1	PS O2	PS O 3
CO1	3	1	-	-	-	-	-	-	-	-	-	-	3	1	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	3	1	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-	3	1	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-	3	1	-
CO5	3	1	-	-	-	-	-	-	-	-	-	-	3	1	-
Avg	3	1	-	-	-	-	-	-	-	-	-	-	3	1	-

3/2/1 – indicates strength of correlation (3- High, 2- Medium, 1- Low)

22MCIN01	ENGINEERING SPRINTS				Semester		II
PREREQUISITES			Category	EE	Credit		1
			Hours/Week	L	T	P	TH
				0	2	0	2

Course Learning Objectives	
1	To Strengthen conceptual understanding of fundamental engineering concepts.
2	To Spark curiosity in students Minds.
3	To focus on teaching through a problem-solving approach using Street Fight Engineering principles pioneered.
4	To foster the growth of functional independence and self-driven learning habits.
5	To maximize the interest levels towards learning - as students aspire to create meaningful changes in the world.

Unit I	**STREET FIGHTING ENGINEERING**	**0**	**6**	**0**	**6**
Why streetfight engineering - How to street fight engineering - Decode real-world problems - Observe key patterns - relationship study - Derive actionable inferences - Perform data - driven insights - Generate concepts and case studies.					
Unit II	**PROGRAMMING PARADIGM**	**0**	**6**	**0**	**6**
Need for programming - Outside box thinking to solve problems- Need for algorithms and data structures - Flowcharts & Algorithms - Memory Allocation - Conditions and loops - Creating effective functions - Case studies - Visual Programming - Types of programming languages & paradigms - Getting started with development - Build & test an algorithm - Best practices.					
Unit III	**BRAINS OF MACHINES**	**0**	**6**	**0**	**6**
Key innovations in Tesla Electric car - Case study - Brains of Electric cars - Transdisciplinary systems - Adapting Transdisciplinary systems to Accelerate Innovation - Idea Hexagon - Exercise to think of new innovations using Idea Hexagon - Brains of Digital camera.					
Unit IV	**MACHINES THAT MAKE-UP THE WORLD**	**0**	**6**	**0**	**6**
Basics of Electronics passive components - Need for sensors & Actuators - Analyzing & Understanding electronic circuits - How to Build a Basic Custom Hardware - Bootloader & its purposes.					
Unit V	**ENGINEERING THE REAL WORLD**	**0**	**6**	**0**	**6**
Real-world as systems - Introducing to Systems Thinking - Stock and Flow Diagrams - System Traps - Intervening circuits - Living in a World of Systems.					
Total = 30 Periods					

Text Books:	
1	Sanjoy Mahajan - Street Fighting Mathematics
2	Donald Knuth - The Art of Computer Programming
3	Think like a programmer - An introduction to creative problem solving
4	Thinking in Systems - A Primer
Reference Books:	
1	Learning to code : How to think like a programmer
2	How to find innovative ideas : Ramesh Raskar’s note
3	Case Study ; How Tesla changed the auto industry
4	Ultimate Guide : How to develop a new electronic hardware product

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Apply street fight engineering concepts	L3: Applying
CO2	Construct Flowchart & block diagrams for algorithms	L3: Applying
CO3	Apply the idea Hexagon Tool to understand basic electronics for building basic hardware	L3: Applying
CO4	Examine real-world problems with a system view	L4: Analyzing

COURSE ARTICULATION MATRIX															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO 3**
CO1	2	3	2	2	2	-	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	-	3	3	2
CO3	1	2	2	1	1	-	-	-	-	-	-	-	2	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	-	3	3	3
CO5	2	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Avg	2.2	2.8	2.6	2	2.2	-	-	-	-	-	-	-	2.6	2.6	2.4
3/2/1 – indicates strength of correlation (3- High, 2- Medium, 1- Low)															

<table>
<tr><td colspan="2">22MC201</td><td colspan="2">தமிழரும் தொழில்நுட்பமும்
B.E (Common to all Branches)</td><td colspan="3">Semester</td><td>II</td></tr>
<tr><td colspan="3">முன்நிபந்தனைகள்:</td><td>Category</td><td>HS MC</td><td colspan="2">Credit</td><td>1</td></tr>
<tr><td colspan="3" rowspan="2">இலக்கணம் மற்றும் இலக்கியத்தின் அடிப்படைகள்</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8">பாடநெறி நோக்கங்கள்: மாணவர்களால்</td></tr>
<tr><td>1.</td><td colspan="7">நெசவுத் தொழிலின் நன்மைகள், அதன் பயன்கள், பானைத் தொழில் நுட்பத்தைப் பற்றி நன்கு அறிந்து கொள்ள முடியும்.</td></tr>
<tr><td>2.</td><td colspan="7">கட்டிடம் கட்டுதல் மற்றும் கட்டிடத் தொழிலுள்ள நுட்பங்கள் பற்றி அறிந்து கொள்ள முடியும்.</td></tr>
<tr><td>3.</td><td colspan="7">உற்பத்தி தொழில் நுட்பம், இரும்பு, உலோகம், கனிமம், தொழிற்சாலைகள் பற்றி அறிந்து அவற்றின் பயன்பாடுகளை வெளிப்படுத்த முடியும்.</td></tr>
<tr><td>4.</td><td colspan="7">வேளாண்மை மற்றும் நீர் பாசன முறைகள், தொழில் நுட்பம், ஏர் உழுதல் போன்ற பண்டைய கால நெறி முறைகளைப் பற்றி தெரிந்து நடைமுறைப் படுத்த முடியும்.</td></tr>
<tr><td>5.</td><td colspan="7">இன்றைய கால கட்டத்தில் உள்ளவாறு அறிவியல் வளர்ச்சி, கணினித் தமிழ் பற்றி தெரிந்து கொண்டு அறிவை விரிவாக்க முடியும்.</td></tr>
<tr><td colspan="2">அலகு I</td><td colspan="2">நெசவு மற்றும் பானை தொழில்நுட்பம்</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">சங்க காலத்தில் நெசவுத் தொழில் - பானை தொழில் நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள்- பாண்டங்களில் கீறல் குறியீடுகள்</td></tr>
<tr><td colspan="2">அலகு II</td><td colspan="2">வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும்- சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள்- நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டகமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றம் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ சாரோசெனிக் கட்டிடக் கலை.</td></tr>
<tr><td colspan="2">அலகு III</td><td colspan="2">உற்பத்தித் தொழில் நுட்பம்</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சிடித்தல் - மணி உருவாக்கம் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.</td></tr>
<tr><td colspan="2">அலகு IV</td><td colspan="2">வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">அனை, ஏரி, குளங்கள், மதகு, - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.</td></tr>
<tr><td colspan="2">அலகு V</td><td colspan="2">அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின் பதிப்பு செய்தல் - தமிழ் மென் பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.</td></tr>
</table>

Total = 15 Periods

Text Books:	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியல் பணிகள் கழகம்)
2	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

பாடநெறி முடிவுகள்: இந்தப் படிப்பு முடிந்ததும், மாணவர்களால்		**Bloom's Taxonomy Mapped**
CO1	சங்காலத்தில் இருந்த நல்ல தொழில்களையும் கைவிணை கலைகளால் ஏற்படும் நன்மைகளையும் பற்றி அறிந்து கொண்டனர்.	Understanding
CO2	கட்டிடங்கள் மற்றும் வீட்டுப்பொருட்களை வடிவமைப்பது, சங்காலத்தில் இருந்த கோவில்களை பற்றி அறிந்து கொண்டனர்	Understanding
CO3	உலோகவியல், இரும்பு தொழிற்சாலைகள், தொல்லியல் சான்றுகள், உற்பத்தி தொழல் நுட்பத்தை பற்றி அறிந்து கொண்டனர்.	Applying
CO4	பழங்காலத்தில் வோளண்மை, நீர்பாசனம், மீன் வளம், கால்நடை பராமரிப்பு, அறிவுசார் சமுகம் பற்றி அறிந்து கொண்டனர்.	Applying
CO5	அறிவியல் தமிழன் வளர்ச்சி, கணித்தமிழ் வளர்ச்சி, மென்பொருள் உருவாக்கம், இணைய கல்வி கழகம், இணையத்தில் தமிழ் அகராதிகள் பற்றி அறிந்து கொண்டனர்.	Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1			3			2						1	2	
CO2			3			2						1	2	
CO3			3			2						1	2	
CO4			3			2						1	2	
CO5			3			2						1	2	
Avg			**3**			**2**						**1**	**2**	

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22MC201	TAMILS AND TECHNOLOGY			Semester		II
PREREQUISITES		Category	HS MC	Credit		1
Basics of Tamils Language and Literature		Hours/Week	L	T	P	TH
			1	0	0	1

1.	To Obtain the knowledge of weaving and ceramic technology
2.	To familiarize about design and construction technology during sangam age and British period
3.	To know about the manufacturing technologices
4.	To obtain the knowledge of agriculture and irrigation technology
5.	To know about the development of Scientific Tamil and Tamil computing

Unit I	**WEAVING AND CERAMIC TECHNOLOGY**	**3**	**0**	**0**	**3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.					
Unit II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3**	**0**	**0**	**3**
Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- ThirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.					
Unit III	**MANUFACTURING TECHNOLOGY**	**3**	**0**	**0**	**3**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and goldCoins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.					
Unit IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**	**0**	**0**	**3**
Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.					
Unit V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3**	**0**	**0**	**3**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.					
Total = 15 Periods					

Text Books:

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
5	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology&TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Obtain the knowledge about weaving and ceramic technology.	Understatnding
CO2	Familiarize about design and construction technology during sangam age and British period	Understatnding
CO3	Understanding about the manufacuturing technologies	Applying
CO4	Acquire the skills in agriculture and irrigation technology	Applying
CO5	Acquire the knowledge about the development of Scientific Tamils and Tamil computing.	Understatnding

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1			3			2						1	2	
CO2			3			2						1	2	
CO3			3			2						1	2	
CO4			3			2						1	2	
CO5			3			2						1	2	
Avg			**3**			**2**						**1**	**2**	

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

<table>
<tr><td>22NC201</td><td colspan="3">NCC COURSE-I (Only for NCC Students)</td><td colspan="3">Semester</td><td>II</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>NC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Objectives</td></tr>
<tr><td>1</td><td colspan="7">To maintain the unity and disciplines to the students</td></tr>
<tr><td>Unit I</td><td colspan="3">NCC GENERAL & NATIONAL INTEGRATION AND AWARENESS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Aims, Objectives and Org of NCC – Incentives to NCC cadets – Duties of NCC Cadets – NCC Camps: Types & Conduct; National Integration: Importance and Necessity – Factors affecting National Integration – Unity in Diversity – Threats to National Security.</td></tr>
<tr><td>Unit II</td><td colspan="3">PERSONALITY DEVELOPMENT & LEADERSHIP DEVELOPMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Personality Development Capsule -Self Awareness Empathy, Creative& Creative Thinking, Decision Making - Communication Skills - Group Discussion - Stress emotions, Change Your Mindset, Inter Personal Relations& Team work, Time Managements, Civil Sense - Career Counselling, SSB Procedures & Interview Skills; Leadership Capsule - Traits, Indicators, Motivation, Ethics &Honour code - Case Studies-Shivaji, APG Abdul Kalam & Deepa Malik, MaharanaPratap, Ratan Tata, KiranMajumdar, Jhansi Ki Rani, Narayan Murty, PrakashPadukone, Tipu Sultan, Rabindranath Tagore.</td></tr>
<tr><td>Unit III</td><td colspan="3">DISASTER MANAGEMENT AND HEALTH & HYGIENE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Disaster Management Capsule- SochVichar, Types - Organisation, Capability & Role of NCC Cadets – Fire Service & Fire Fighting – Initiative Training, Organisation Skills, Do’s and Don’ts – Natural Disasters, Man Made Disasters; Health & Sanitation – First aid in Common Medical Emergencies, Treatment & Care of Wounds – Introduction to Yoga & Exercises.</td></tr>
<tr><td>Unit IV</td><td colspan="3">PRINCIPLES OF FLIGHT & GENERAL SERVICE KNOWLEDGE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Laws of Motion – Glossary Terms – Bernoulli’s Principle – Aerofoil – Forces acting on Aircraft – Lift & Drag – Flaps & Slats – Stall – Thrust; Armed Forces & IAF Capsule – Modes of Entry in IAF, Civil Aviation – Aircraft Recognition – Latest Trends & Acquisitions.</td></tr>
<tr><td>Unit V</td><td colspan="3">NAVIGATION, AEROENGINES, AIRCOMPAIGNS & AIRMANSHIP</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Requirements of Navigation – Glossary terms – Maps – Map Reading; Basic Theory – Types of Engines – Piston Engines – Jet Engines – Turbo Prop Engines; Indo Pak war 1971 – Operation Safed Sagar – Famous Air Heroes; Airmanship – Airfield Layout – Rules of the Air – Circuit Procedures – ATC RT Procedures – Aviation Medicine - Survival.</td></tr>
<tr><td colspan="8" align="right">Total = 45 Periods</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Acquired knowledge about the history of NCC, its organization, incentives of NCC, duties, different NCC camps	Analyzing
CO2	Understand the concept of national integration and its importance	Understanding
CO3	Understand the importance disaster management and health and hygiene.	Understanding
CO4	Understand the importance principal of Flight and knowledge about armed services.	Understanding
CO5	Understand and learn the importance of navigation, Aero engines & Airmanship work.	Understanding

22EN102	**PROFESSIONAL SKILLS LABORATORY**		**SEMESTER**			**II**
PRE-REQUISITE		**CATEGORY**	**HS**	**Credit**		**1**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**2**	**2**

Course Objectives:	
1.	To enable learners to improve their reading skills
2.	To make learners show variations while reading
3.	To assist learners to acquire speaking competency in English
4.	To enable learners to strengthen their fluency in speaking

UNIT I	**NARRATION**	**0**	**0**	**6**	**6**
Reading – Reading a short story – learning pronunciation, intonation, and splitting of sentences to form meaningful units. Speaking – Narrating a story without any help of handouts.					
UNIT II	**PRESENTATION**	**0**	**0**	**6**	**6**
Reading – Reading a poem – learning the skill of reciting, appreciate rhyme and music, change in tone as per the emotion of the poem. Speaking – Power-point presentation on a general topic.					
UNIT III	**SHORT SPEECH**	**0**	**0**	**6**	**6**
Reading – Reading newspaper article – learning vocabulary and language pattern of official communication. Speaking - Oral presentation on a topic from basic engineering pertained to their branch.					
UNIT IV	**ORGANIZING EVENTS**	**0**	**0**	**6**	**6**
Reading – Reading dialogue scripts – learning expression, tone, stress and co-operative reading. Speaking –Proposing welcome address, vote of thanks and organizing events.					
UNIT V	**DESCRIBING PROCESS**	**0**	**0**	**6**	**6**
Reading – Reading technical descriptions of gadgets – learning the different parts of devices. Speaking – Describing a process – everyday technical activities like taking printouts, purchasing equipment for a company, booking a hall for meetings etc.,					
Total (30P) = 30 Periods					

Text Books:	
1.	Norman Whitby. Business Benchmark – Pre-Intermediate to Intermediate, Students book, Cambridge University Press, 2014.
Reference Books:	
1.	Reading Fluency. Switzerland, MDPI AG, 2021.
2.	McJacobs, Wade. Dare to Read: Improving Your Reading Speed and skills. Sustralia, Friesen Press, 2021
3.	Hoge, A. J. Effortless English: Learn to Speak English Like a Native. United States, Effortless English LLC, 2014.
E-References:	
1.	https://www.talkenglish.com/
2.	https://www.readingrockets.org/

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	To read passages fluently with good pronunciation	Remembering
CO2	To develop an expressive style of reading	Creating
CO3	To make effective oral presentations in technical and general contexts	Creating
CO4	To excel at professional oral communication	Evaluating

COURSE ARTICULATION MATRIX															
CO/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	-	-	-	1	-	-	-	-	2	3	-	1	-	-	1
CO2	-	-	-	1	-	-	-	-	2	3	-	1	-	-	1
CO3	-	-	-	2	-	-	-	-	2	3	-	1	-	-	1
CO4	-	-	-	2	-	-	-	-	2	3	-	1	-	-	3
Avg	-	-	-	1.5	-	-	-	-	2	3	-	1	-	-	1.5
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22PH103	PHYSICS LABORATORY			SEMESTER		II
PRE-REQUISITE	**CATEGORY**	**BS**		**Credit**		**1.5**
There are no prerequisites for this course	**Hours/Week**	**L**	**T**	**P**		**TH**
		0	**0**	**3**		**3**

Course Objectives:

1.	To handle different measuring instruments.
2.	To understand the basic concepts of interference, diffraction, heat conduction and to measure the important parameters.

LIST OF EXPERIMENTS (Any Eight experiments)

1. Newton's rings – Determination of radius of curvature of a Plano convex lens.
2. Carey Foster's bridge – Determination of specific resistance of the material.
3. Poiseuille's flow – Determination of the Coefficient of viscosity of a liquid.
4. Spectrometer – Grating – Normal incidence – Determination of Wavelength of Mercury lines.
5. Lee's disc – Determination of thermal conductivity of a Bad conductor.
6. Ultrasonic interferometer – Determination of velocity of Ultrasonic Waves in Liquid.
7. Non-uniform bending – Determination of young's modulus of the wooden bar.
8. Determination of Band gap of a given semiconductor.
9. Determination of Wavelength of laser using grating and determination of particle size using Laser.
10. Determination of Acceptance angle and Numerical Aperture of fiber.

Total (45P) = 45 Periods

Text Books:

1.	C. S. Robinson, Dr. Ruby Das, ' A Textbook of Engineering Physics Practical', Laxmi Publication Pvt. Ltd., 2016.
2.	S. Panigrahi, 'Engineering Practical Physics', Cengage Learning India, 2015.

Reference Books:

1.	M.N. Srinivasan, 'Text Book of Practical Physics', Sultan Chand & Sons, 2013
2.	Singh Harman, 'B.Sc. Practical Physics', S Chand & Company Ltd, 2022.

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Handle different measuring instruments and to measure different parameters.	Applying
CO2	Calculate the important parameters and to arrive at the final result based on the experimental measurements.	Analyzing

COURSE ARTICULATION MATRIX

CO/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	-	3	3	-	-	-	3	1	-	2	1	1	1
CO2	3	2	-	2	1	-	-	-	2	-	-	1	1	1	1
Avg	3	2	-	2.5	2	-	-	-	2.5	1	-	1.5	1	1	1

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22CY102	CHEMISTRY LABORATORY				SEMESTER		II
PRE-REQUISITE		**CATEGORY**	**BS**	**Credit**			**1.5**
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			0	**0**	**3**		**3**

Course Objectives:

1.	To gain practical knowledge by applying theoretical principles and performing the following experiments.

LIST OF EXPERIMENTS

1. Estimation of hardness of Water by EDTA
2. Estimation of Copper in brass by EDTA
3. Estimation of Alkalinity in water
4. Estimation of Chloride in water sample (Iodimetry)
5. Estimation of Iron content in the given salt by using external indicator
6. Conductometric titration of Strong Acid and Strong Base
7. Conductometric titration of Mixture of acids and Strong base
8. Determination of strength of Iron by Potentiometric method
9. Estimation of Iron by Spectrophotometry
10. Estimation of Copper by Colorimeter
11. Determination of molecular weight and degree of Polymerization by Viscometry
12. Determination of pKa of the given weak acid by pH meter
13. Estimation of the amount of given HCl using pH meter

Total (45P) = 45 Periods

E-References:	
1.	www.scuolab.com/en/chemistry/
2.	www.onlinelabs.in/chemistry
3.	www.virtuallabs.merlot.org/vl_chemistry

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	To summarize the applicability of the practical skill gained in various fields.	Understanding
CO2	To calculate the composition of brass quantitatively and the molecular weight of polymers.	Applying
CO3	To understand the principle and applications of conductometric and pH titrations, spectrometer, and potentiometric titrations.	Understanding

COURSE ARTICULATION MATRIX															
CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	3	-	-	-	-	-	-	-	-	2	-	-
CO2	1	2	-	3	-	-	-	-	-	-	-	-	2	-	-
CO3	2	2	-	3	-	-	-	-	-	-	-	-	2	-	-
Avg	1.3	1.7	-	3	-	-	-	-	-	-	-	-	2	-	-
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22EE202	PRINCIPLES OF ELECTRICAL ENGINEERING LABORATORY		SEMESTER			II
PREREQUISITES		CATEGORY	ES	Credit		1.5
Engineering Physics		Hours/Week	L	T	P	TH
			0	0	3	3

Course Objectives:

1.	To study hands-on experiments related to electric circuits.
2.	To understand the working of measuring instruments and electrical machines.

List of Experiments:

1. Study of basic safety precautions, measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope and Electrical components.
2. Verification of Kirchhoff's laws.
3. Verification of Superposition theorem.
4. Verification of Thevenin's theorem.
5. Measurement of time constant of an R-C circuit.
6. Measurement of core loss and full-load copper loss in a single phase transformer.
7. Load test on a single phase transformer.
8. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage.
9. Series/Parallel Resonance in R-L-C circuits.
10. Measurement of three-phase power in three-phase circuits.
11. Demonstration of cut-out sections of DC machine, 3-phase induction motor, and 3-phase alternator.

Total (45P)= 45 Periods

Reference Books:

1.	Basic Electrical Engineering - D.P. Kothari and I.J. Nagrath, 3rd edition, Tata McGraw Hill, 2010.
2.	Basic Electrical Engineering - D.C. Kulshreshtha, Tata McGraw Hill, 2019.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the working of measuring instruments and electrical machines.	Understanding
CO2	:	Apply fundamental laws and theorems to electric circuits.	Apply
CO3	:	Estimate parameters in single phase and three phase AC circuits.	Evaluating
CO4	:	Analyze resonance in single phase AC circuits.	Analyzing
CO5	:	Judge the steady state responses of single phase AC circuits.	Evaluating

COURSE ARTICULATION MATRIX															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
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	-	1
CO5	1	1	-	-	-	-	-	-	-	-	1	1	1	-	1
Avg	**1**	**1**	-	-	-	-	-	-	-	-	**1**	**1**	**1**	**-**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

SEMESTER III

22MA304	FOURIER SERIES, COMPLEX VARIABLES AND TRANSFORMS			SEMESTER		III
PREREQUISITES		**CATEGORY**	**BS**	**Credit**		**4**
Basic 12th level knowledge of Taylor series, complec analysis, ODE and Integration.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**1**	**0**	**4**

Course Objectives:	
1.	To introduce the concept of Fourier series.
2.	To familiarize with Fourier, transform of a function and its sine and cosine transforms.
3.	To know about analytic functions with properties, construction of analytic functions and conformal transformations.
4.	To obtain the knowledge of Cauchy's integral theorems, calculus of residues and complex integration around unit circle and semi-circle.
5.	To gain the skills to form difference equations and find its solution by using Z-transform method.

Unit I	**FOURIER SERIES**	**9**	**3**	**0**	**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 TRANSFORM**	**9**	**3**	**0**	**12**
Statement of Fourier integral theorem – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's Identity.					
Unit III	**COMPLEX DIFFERENTIATION**	**9**	**3**	**0**	**12**
Functions of a complex variable – Analytic functions – Cauchy – Riemann equation and sufficient conditions (excluding proof) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Conformal mappings: $w = z + c$, $c z$, $1/z$, z^2 and Bilinear transformations.					
Unit IV	**COMPLEX INTEGRATION**	**9**	**3**	**0**	**12**
Cauchy's integral theorem - Cauchy's integral formula – Taylor's and Laurent's theorems (Statements only) and expansions – Poles and Residues – Cauchy's Residue theorem – Contour integration: Circular and semi-circle contours with no poles on the real axis.					
Unit V	**Z -TRANSFORM AND DIFFERENCE EQUATIONS**	**9**	**3**	**0**	**12**
Z-transform of simple functions and properties – Inverse Z – transform –initial and final value theorems- Convolution theorem - Formation of difference equations – Solution of difference equations using Z – transform technique.					
Total (45L+15T)= 60 Periods					

Text Books:	
1.	Veerarajan T, "Engineering Mathematics (For Semester III)", 3rd Edition, Tata McGraw Hill Education Pvt . Ltd., New Delhi, 2009.
2.	P. Kandasamy, K. Thilagavathy and K. Gunavathy, "Engineering Mathematics, Volume III", S. Chand & Company ltd., New Delhi, 1996.
3.	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2015.
4.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
Reference Books:	
1.	Srimanta pal and Subath C. Bhumia, "Engineering Mathematics", Oxford university publications, New Delhi, 2015
2.	Ewinkreyzig, "Advanced Engineering Mathematics", 9th edition, John Wiley & Sons, 2006.
3.	Grewal, B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
4.	Wylie C. Ray and Barrett Louis, C., "Advanced Engineering Mathematics", Sixth Edition, McGraw-Hill, Inc., New York, 1995.
5.	Andrews, L.A., and Shivamoggi B.K., "Integral Transforms for Engineers and Applied Mathematicians", MacMillan, New York, 1988.

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Acquire the knowledge about Fourier series.	Understanding
CO2	:	Apply the knowledge of Fourier transform in engineering problems.	Applying
CO3	:	Familiar with the concept of Conformal and Bilinear transformations.	Understanding
CO4	:	Acquire the knowledge of Contour integration over unit circle and semi-circle.	Understanding
CO5	:	Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	Applying

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO4	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO5	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
Avg	**3**	**2**	-	**2**	-	-	-	-	-	-	-	-	**2**	-	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC301	SEMICONDUCTOR DEVICES AND CIRCUITS				SEMESTER III			
PREREQUISITES			**CATEGORY**	**PC**	**Credit**		**3**	
NIL			**Hours/Week**	**L**	**T**	**P**	**TH**	
				3	**0**	**0**	**3**	

Course Objectives:

1.	To understand the fundamentals of electron devices and apply the knowledge in electronic circuits.
2.	To design and analyse single stage and multistage amplifier circuits.
3.	To understand and classify different kinds of power and feedback amplifiers.

Unit I	**SEMICONDUCTOR DIODES**	**9**	**0**	**0**	**9**

Semiconductors – Intrinsic Semiconductors – Doped Semiconductors – Current flow in semiconductors – 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 – Schottky barrier diode – Zener diode – Varactor diode –Tunnel diode – Photodiode.

Unit II	**DIODE APPLICATIONS AND POWER SUPPLY**	**9**	**0**	**0**	**9**

Clipper and clamper circuits, Half-wave, full-wave and bridge rectifiers with resistive load. Analysis for V dc and ripple voltage with C, L, L-C and C-L-C filters. Voltage multipliers, Voltage Regulators – Zener diode regulator. Switched Mode Power Supply (SMPS).

Unit III	**TRANSISTOR AMPLIFIERS**	**9**	**0**	**0**	**9**

Bipolar Junction Transistor- device structure and physical operation – Current-Voltage characteristics – Ebers -Moll Model – MOSFET-device structure and physical operation – Current-Voltage characteristics – Biasing schemes for BJT and FET amplifiers – bias stability – various configurations (such as CE/CS, CB/CG, CC/CD) and their features.

Unit IV	**FREQUENCY RESPONSE OF AMPLIFIERS**	**9**	**0**	**0**	**9**

Small signal operation and models of MOSFET and BJT – general shape of frequency response of amplifiers – Low - Frequency Response of Discrete-Circuit Common-Source and Common-Emitter Amplifiers – Internal Capacitive Effects and the High-Frequency Model of the MOSFET and the BJT – High-Frequency Response of the CS and CE Amplifiers – General expression for frequency response of multistage amplifiers - Calculation of overall upper and lower cut off frequencies of multistage amplifiers – The cascade amplifier.

Unit V	**POWER AND FEEDBACK AMPLIFIERS**	**9**	**0**	**0**	**9**

Power amplifiers-various classes of operation (Class A, Class B, Class AB, and Class C), their power-conversion efficiency and power dissipation calculations – cross-over distortion – Feedback topologies: Voltage series, current series, voltage shunt, current shunt – effect of feedback on gain, bandwidth etc., calculation with practical circuits – concept of stability, gain margin and phase margin.

Total (45L)= 45 Periods

Text Books:

1.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.
2.	S. Salivahanan and N. Suresh kumar, “Electronic Devices and Circuits”, 4e, McGraw Hill Education, 2017.

E-References:

1.	https://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/117103063
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the characteristics of diodes and special semiconductor devices.	Understanding
CO2	:	Design and analyze clipper, clamper and power supply circuits.	Analyzing
CO3	:	Acquire knowledge on working principles, characteristics and applications of BJT and FET.	Remembering
CO4	:	Analyse the frequency response characteristics of amplifiers.	Analyzing
CO5	:	Design and analyze power and feedback amplifiers and derive their performance specifications.	Analyzing

COURSE ARTICULATION MATRIX															
COs /POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	3	1	2	-	-	-	-	-	-	-	-	1	1	1
CO2	3	3	2	3	-	-	-	-	-	-	-	-	2	2	1
CO3	3	2	2	3	-	-	-	-	-	-	-	-	1	1	1
CO4	2	3	2	3	-	-	-	-	-	-	-	-	1	2	1
CO5	2	3	2	3	-	-	-	-	-	-	-	-	2	1	1
Avg	2.2	2.8	1.8	2.8	-	-	-	-	-	-	-	-	1.4	1.4	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC302	DIGITAL SYSTEM DESIGN					SEMESTER III
PREREQUISITES		CATEGORY	PC	Credit		3
		Hours/week	L	T	P	TH
			3	0	0	3

Course Objectives:

1	To make the student understand the number system, logic families and Boolean algebra.
2	To design combinational and sequential circuits using gates and flip flops.
3	Deliver the concept of Memories and Programmable Logic Devices and apply the knowledge of these devices in the design of Digital electronic circuits.

Unit I	NUMBER SYSTEMS AND LOGIC GATES	9	0	0	9

Binary – Decimal – Octal - Hexadecimal - Binary codes: BCD– Gray code - Boolean Algebra and Minimization Techniques – Canonical forms – Conversion between canonical forms – Simplifications of Boolean expressions using Karnaugh map – Logic Gates: Implementations of Logic Functions using gates – Logic Families: TTL NAND gate – Specifications – Noise margin -Propagation delay - fan - in - fan - out Tristate TTL - ECL.

Unit II	COMBINATIONAL CIRCUITS	9	0	0	9

Design procedure – Adders / Sub tractor – Serial adder/ Sub tractor - Parallel adder / Sub tractor – Carry look ahead adder - BCD adder - Magnitude Comparator - Multiplexer / De-multiplexer- Encoder / Decoder – Parity checker– Code converters - Implementation of combinational logic using MUX and Decoder.

Unit III	SEQUENTIAL CIRCUITS	9	0	0	9

Design Procedure- Flip flops: SR,JK,T,D and JK Master Slave–Triggering of Flip-flop-Realization of flip flops – Mooreand Mealy circuits–Counters: Asynchronous / Ripple counters – Synchronous counters – Module on counter – Design of Synchronous counters – Register - Shift registers-:Universal shift register–Shift Register counters.

Unit IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS	9	0	0	9

Design of fundamental mode circuits – Primitive state / flow table – Minimization of primitive state table – state assignment – Excitation table – Excitation map - Problems in Asynchronous Circuits: Cycles – Races – Hazards – Design of Hazard Free Switching Circuits: Static – Dynamic - Essential Hazards and Hazard elimination.

Unit V	MEMORY DEVICES	9	0	0	9

Classification of memories – RAM organization — ROM organization — Flash Memory - Programmable Logic Devices: Programmable Logic Array (PLA) - Programmable Array Logic (PAL)- Implementation of combinational logic using ROM,PA Land PLA.

Total(45L) =45 Periods

Text Books:

1.	M. Morris Mano,“ Digital Design”,4th Edition, Pearson Education(Singapore)Pvt. Ltd., NewDelhi,2008.
2.	R.P. Jain,“ Modern digital Electronics” ,Tata McGraw Hill, 4thEdition, 2009

Reference Books:

1.	W.H.Gothmann,“Digital Electronics – An introduction to theory and practice”, PHI, 2ndedition,2006.
2.	D.V. Hall,“ Digital Circuits and Systems”, Tata McGraw Hill, 1989
3.	S.Salivahanan and S.Arivazhagan ,“ Digital Circuits and Design”, 2ndedition,VikasPublishingHousePvt.Ltd,NewDelhi,2004.
4.	Charles H .Roth.“ Fundament also f Logic Design”,Thomson Publication Company,2003.

E-References:

1.	http://nptel.ac.in/noc/individual_course.php?id=noc15-ec01

2.	https://nptel.ac.in/courses/117105080/6
3.	https://nptel.ac.in/courses/117105080/12

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the number system and the functioning of logic gates with various logic families.	Analyzing
CO2	:	Design and analyse combinational logic circuits and Logic gates.	Analyzing
CO3	:	Design the sequential logic circuits using Flip flops	Analyzing
CO4	:	Design and analyse asynchronous sequential logic circuits	Analyzing
CO5	:	Understand the concepts of memories and PLDs and implementation of circuits using memory and PLDs.	Understanding

COURSE ARTICULATION MATRIX															
COs/ POs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	3	2	3	2	-	-	-	-	2	1	-
CO2	3	3	2	2	3	3	2	1	1	-	-	-	3	2	-
CO3	2	2	3	3	2	1	2	1	1	-	-	-	2	2	-
CO4	2	1	2	1	2	2	3	1	-	-	-	-	2	1	-
CO5	2	1	2	1	3	2	1	2	-	-	-	-	3	2	-
Avg	2.4	1.8	2.2	1.8	2.6	2	2.2	1.4	1	-	-	-	2.4	1.6	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC303	NETWORK THEORY AND SYNTHESIS					SEMESTER III
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course objectives:

1.	To impart knowledge on solving circuits using network theorems.
2.	To educate on obtaining the transient response of circuits and resonance in coupled circuits.
3.	To impart knowledge on two-port networks and network synthesis.

Unit I	**NETWORK ANALYSIS TECHNIQUES AND THEOREMS**	**9**	**0**	**0**	**9**
Revision of Mesh and Nodal Analysis - Comparison of Node and Mesh Analysis - Delta — Wye Transformation – Source Transformation and Duality - Network theorems (for both DC and AC circuits): Superposition – Theven in's - Norton's – Maximum Power Transfer – Tellegen's theorem.					
Unit II	**TRANSIENT ANALYSIS AND CIRCUIT ANALYSIS IN S – DOMAIN**	**9**	**0**	**0**	**9**
Transient study in RL, RC, and RLC networks: Response to Step, Impulse and Sinusoidal inputs - Concept of Complex frequency: Driving points and Transfer Functions - Poles and zero so fImmittance function — Properties - Sinusoidal response from pole - zero locations - Convolution theorem.					
Unit III	**MAGNETIC RESONANCE CIRCUITS**	**9**	**0**	**0**	**9**
Series and parallel resonance - Variation of impedance with frequency- Bandwidth of RLC circuit — Q factor – Impedance of RLC circuit near resonance - Selectivity—Magnification- Self - inductance — Mutual inductance - Coefficient of coupling-Dot convention - Analysis of multi - winding coupled circuits — Series and parallel connection – Ideal transformer-Tuned circuits.					
Unit IV	**TWOPORT NETWORKS**	**9**	**0**	**0**	**9**
One port and Two port networks — Z parameters — Y parameters – h parameters – ABCD parameters – Symmetrical and Asymmetrical networks – Characteristic impedance.					
Unit V	**PASSIVE NETWORK SYNTHESIS**	**9**	**0**	**0**	**9**
Elements of Realizability Theory: Stability - Hurwitz Polynomials - Positive Real Functions: Definition – Necessary and sufficient conditions for a function to be positive real - Elements of circuit synthesis - Foster and Cauer forms of LC Networks - Synthesis of RC and RL networks.					
					Total(45L)=45 Periods

Text Books:

1.	S.K. Bhattacharya and Manpteet Singh, "Network analysis and Synthesis", 1stedition, Pearson Publication, 2015.
2.	AbhijitChakrabarthy, "Circuit Theory Analysis and Synthesis", Dhanpath Rai & Sons, NewDelhi, 2011.

Reference Books:

1.	Alexander C. and Sadiku M. N. O "Fundamentals of Electric Circuits", Tata McGraw Hill, NewDelhi, 2013.
2.	Sudhakar A. and Shyammohan S. Pillai, "Circuits and Networks Analysis and Synthesis",McGrawHill,NewDelhi,2015.
3.	John .D. Ryder, "Networks Lines and Fields"-PHI 2ndedition, 2003.
4.	VanValkenburg "Introduction to Modern Network Synthesis", New Age International Publisher, NewDelhi,2001.

E-References:

1.	https://nptel.ac.in/courses/108102042/
2.	https://nptel.ac.in/courses/106105154/2
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/lecture-2/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyse the electric circuit using best suited network theorem	Analyzing
CO2	:	Apply the knowledge of Fourier Transform and Laplace Transform to analyse the circuit	Applying
CO3	:	Understand and analyse the resonance behaviour of circuit and apply the knowledge to design band limited circuits according to the application.	Analyzing
CO4	:	Analyse the linear network parameters, and their interaction with other networks.	Analyzing
CO5	:	Design RLC from a given differential equation and can say the feasibility of the design.	Creating

COURSE ARTICULATION MATRIX

CO//PO	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	-	2	1	-	-	-	-	-	-	-	3	1	-
CO2	3	3	-	2	1	-	-	-	-	-	-	-	3	1	-
CO3	3	3	-	2	1	-	-	-	-	-	-	-	3	1	-
CO4	3	3	-	2	1	-	-	-	-	-	-	-	3	1	-
CO5	3	1	1	2	1	-	-	-	-	-	-	-	3	1	-
Avg	3	2.6	1	2	1	-	-	-	-	-	-	-	3	1	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC304	TRANSMISSION LINES AND WAVEGUIDES		SEMESTER			III
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
1.Physics – Electromagnetism		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course objectives:

1.	To introduce the various types of transmission lines and to discuss the losses.
2.	To compute various parameters for loaded transmission lines using Smith chart and acquire knowledge of stub matching in Transmission Lines.
3.	To impart knowledge on different types of waveguides, planar transmission lines and waveguide resonators

Unit I	**TRANSMISSION LINE THEORY**	**9**	**0**	**0**	**9**
Introduction to Different types of transmission lines – Characteristic impedance and Propagation Constant – General Solution of the transmission line – Input and Transfer Impedance-Open and Short-circuited lines - Wavelength and Velocity of Propagation - Waveform distortion – Distortion less transmission line – Loading and different methods of loading-Reflection on a line not terminated by Zo – Reflection coefficient –Reflection factor and reflection loss					
Unit II	**THE LINE AT RADIO FREQUENCIES**	**9**	**0**	**0**	**9**
Parameters of open wire line and co-axial line at high frequencies - Input impedance of dissipation less line- open and short circuited line – Standing waves and standing wave ratio on a line – $\lambda/8$ line – $\lambda/4$ line– $\lambda/2$ line- The Smith Chart – Applications of the Smith Chart - Solutions of problems using Smith chart – single stub matching and double stub matching.					
Unit III	**RECTANGULAR WAVEGUIDES**	**9**	**0**	**0**	**9**
Waves between parallel planes of perfect conductors – Transverse electric waves - transverse magnetic waves – characteristics of TE and TM Waves – Transverse Electromagnetic waves: Transverse Magnetic waves in rectangular wave guides – Transverse Electric Waves in Rectangular Waveguides – Characteristic of TE and TM Waves – Cut off wavelength and phase velocity – Impossibility of TEM waves in waveguides – Dominant mode in rectangular waveguide – Attenuation of TE and TM modes in rectangular waveguides – Wave impedances– Excitation of modes.					
Unit IV	**CIRCULAR WAVE GUIDES AND RESONATORS**	**9**	**0**	**0**	**9**
Bessel functions – Solution of field equations in cylindrical co-ordinates – TM and TE waves in circular guides – wave impedances and characteristic impedance – Dominant mode in circular waveguide – excitation of modes – Microwave cavities - rectangular cavity resonators - circular cavity resonator.					
Unit V	**PLANAR TRANSMISSION LINES**	**9**	**0**	**0**	**9**
Introduction to planar transmission lines-strip lines, Micro strip lines-coupled lines-slot line, coplanar waveguide (CPW). Micro strip lines-filed distribution-design equations-losses in micro strip lines. Coaxial transmission line (distributed parameters)					
					Total (45L) = 45 Periods

Text Books:

1.	J.D. Ryder “Networks, Lines and Fields”, PHI, New Delhi, 2006.
2.	E.C. Jordan and K.G. Balmain “Electro Magnetic Waves and Radiating System, PHI, New Delhi, 2010.

Reference Books:

1.	David M.Pozar: ”Microwave Engineering”, 4th Edition ,John Wiley, 2012
2.	Annapurna Das and SisirK. Das, “ Microwave Engineering”, TMH, 2000.
3.	Umesh Sinha, “Tranmission Lines & Networks” Sathya Prakashan publication, 2002
4.	David K.Cheng, ”Field and Waves in Electromagnetism”, Pearson Education, 1989.

E-References:

1.	https://www.youtube.com/watch?v=0OwmYAljz4A&list=PL0925FD10648D664E
2.	https://nptel.ac.in/courses/117101056
3.	https://link.springer.com/chapter/10.1007/978-1-4615-6459-1_28

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyse the propagation of signals through transmission lines.	Analyzing
CO2	:	Calculate reflection and transmission coefficients, standing wave ratio and power for transmission lines using HF applications.	Evaluating
CO3	:	Compute various parameters for loaded transmission lines using Smith chart and acquire knowledge of stub matching in Transmission Lines.	Evaluating
CO4	:	Analyse the field components of different waveguides based on various modes of E and H filed.	Analyzing
CO5	:	Understand the concept of planar transmission lines and analyse its field distribution.	Analyzing

COURSE ARTICULATION MATRIX															
CO//PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	1	3	2	2	-	-	-	-	-	-	2	-	2	3	2
CO2	1	3	2	3	-	-	-	-	-	-	2	-	2	3	2
CO3	1	3	3	3	-	-	-	-	-	-	3	-	1	3	1
CO4	1	3	3	3	-	-	-	-	-	-	3	-	2	2	2
CO5	1	3	3	3	-	-	-	-	-	-	3	-	2	2	2
Avg	1	3	2.6	2.8	-	-	-	-	-	-	2.6	-	1.8	2.6	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC305	ANALOG COMMUNICATION			SEMESTER		III
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course objectives:

1. Familiarize the concepts of various analog modulation and demodulation techniques.
2. To understand the sources of noise and its effects in Communication systems and to analyze the performance of receiver in the presence of noise.
3. To study the limits set by Information Theory.

Unit I	**AMPLITUDE MODULATION**	**9**	**0**	**0**	**9**
Introduction to communication systems – Need for modulation – Generation and demodulation of AM, DSB-SC, SSB-SC - VSB signals - Filtering of sidebands - Comparison of amplitude modulation systems - Frequency translation - Frequency division multiplexing - AM Super hetrodyne receiver.					
Unit II	**ANGLE MODULATION**	**9**	**0**	**0**	**9**
Angle modulation: Phase and Frequency modulation - Narrowband and Wideband FM - Transmission bandwidth of FM signals - Generation of FM signal – Direct FM – Indirect FM - Demodulation of FM signals - FM stereo multiplexing - PLL – Nonlinear model and linear model of PLL - FM Super hetrodyne receiver.					
Unit III	**NOISE PERFORMANCE OF DSB, SSB RECEIVERS**	**9**	**0**	**0**	**9**
Noise: Types of Noise - Noise figure - Noise temperature - Noise Equivalent Bandwidth – Noise in cascaded systems - Representation of Narrowband Noise in terms of In-phase and Quadrature components - Receiver Model - Noise in DSB-SC Receiver - Noise in SSB Receiver.					
Unit IV	**NOISE PERFORMANCE OF AM AND FM RECEIVERS**	**9**	**0**	**0**	**9**
Noise in AM receivers: Threshold effect - Noise in FM receivers: Capture effect - FM threshold effect - FM threshold reduction - Pre-emphasis and De-emphasis in FM – Comparing the performance of AM and FM.					
Unit V	**INFORMATION THEORY**	**9**	**0**	**0**	**9**
Uncertainty - Information and entropy - Rate of information - Joint Entropy and Conditional Entropy - Mutual information - Discrete memory less channel - Channel Capacity - Shannon's Theorem - Continuous Channel - Shannon - Hartley Theorem - BW and S/N Trade-off - Huffman and Shannon – Fanocodes.					
					Total (45L)= 45 Periods

Text Books:

1. Simon Haykin,"Communication Systems", 5th Edition,International Student Version, John Wiley & sons, NY, 2010.
2. R.P. Singh &S.D.Spare, "Communication Systems, Analog & Digital", Tata McGraw Hill, 1995.

Reference Books:

1. Taub and Schilling, "Principles of communication systems", TMH, New Delhi, 2008
2. Roddy and Coolen, "Electronic communication", 4thEdition , PHI, New Delhi, 2003.
3. Bruce Carlson.A, Paul B.Crilly, "Communication systems", 5thEdition, McGraw-Hill Int. , 2009.
4. Anokhsingh, "Principles of Communication Engineering", S. Chand & Company Ltd. 2006.

E-References:

1. https://www.telecommunications-tutorials.com/
2. http://www.nptelvideos.in/2012/11/communication-engineering.html
3. https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Gain knowledge on the principles of AM and FM communication systems.	Remembering
CO2	:	Ability to design AM and FM receiver.	Analyzing
CO3	:	The exposure to the sources of noise and its effects in Communication systems.	Applying
CO4	:	Ability to analyze the performance of receiver in the presence of noise.	Analyzing
CO5	:	Ability to measure the capacity of a channel based on the information theory.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO1 2	PSO1	PSO2	PSO3
CO1	2	1	3	-	-	-	-	-	-	-	-	-	1	1	1
CO2	2	1	3	-	-	-	-	-	-	-	-	-	1	2	1
CO3	2	2	2	1	-	-	-	-	-	-	-	-	1	2	1
CO4	2	2	2	1	-	-	-	-	-	-	-	-	1	2	1
CO5	3	1	1	-	-	-	-	-	-	-	-	-	1	2	1
Avg	2.2	1.4	2.2	1	-	-	-	-	-	-	-	-	1	1.8	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22MC301	INDIAN CONSTITUTION				SEMESTER		III
PREREQUISITES			**CATEGORY**	**MC**	**Credit**		**0**
NIL			**Hours/Week**	**L**	**T**	**P**	**TH**
				2	**0**	**0**	**2**

(Common to all branches)

Course Objectives:

1.	learn the salient features of the Indian Constitution
2.	list the Fundamental Rights and Fundamental Duties
3.	present a systematic analysis of all dimensions of Indian Political System
4.	understand the power and functions of the Parliament, the Legislature and the Judiciary

UNIT I	**FUNDAMENTAL RIGHTS**	**6**	**0**	**0**	**6**
Union and its Territory – Citizenship–Fundamental Rights–Directive Principles of State Policy–Fundamental Duties					
UNIT II	**UNION AND TERRITORIES**	**6**	**0**	**0**	**6**
The Union–The States–The Union Territories–The Panchayats – The Municipalities					
UNIT III	**FINANCE, TRADE AND COMMERCE**	**6**	**0**	**0**	**6**
The Co-operative Societies–The scheduled and Tribal Areas–Relations between the Union and the States–Finance, Property, Contracts and Suits–Trade and Commerce within the territory of India					
UNIT IV	**ELECTIONS**	**6**	**0**	**0**	**6**
Services under the Union, the States – Tribunals – Elections– Special Provisions –Relating to certain Classes					
UNIT V	**MISCELLANEOUS AMENDMENTS**	**6**	**0**	**0**	**6**
Languages–Emergency Provisions – Miscellaneous–Amendment of the Constitution					
					Total (6L) = 30 Periods

Text Books:

1.	Subhash C.Kashyap, Our Constitution, National Book Trust, 2017
2.	Durga Das Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.
3.	M.V.Pylee, Constitutional History of India, S.Ch and publishing, 2010
4.	Granville Austin, The Indian Constitution: Cornerstone of a Nation, Oxford University Press,1999

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1	:	Understand the emergence and evolution of the Indian Constitution
CO2	:	Explain the key concepts of Indian Political System
CO3	:	Describe the role of constitution in a democratic society.
CO4	:	Present the structure and functions of the Central and State Governments, the Legislature and the Judiciary

22MCIN02	INNOVATION SPRINTS			Semester		III
PREREQUISITES		Category	EE	Credit		1
		Hours/Week	L	T	P	TH
			0	0	2	2

Course Learning Objectives

1	To Understand the fundamentals of Design thinking & apply in ideating solutions for real world problems.
2	To solve challenges through problem curation, problem curation, problem validation and customer discovery problems

		L	T	P	TH
Unit I	**CHALLENGE CURATION**	0	0	6	6
Introduction: Design Thinking Principles - Design Thinking Values - Design Thinking Methods - Challenge impact setting - Framing the design challenge.					
Unit II	**CUSTOMER - CENTRIC INNOVATION**	0	0	6	6
Understanding Customer needs - Empathy building techniques - gap analysis - adoption barriers - observations and insights - Translating insights into innovation opportunities.					
Unit III	**IDEA GENERATION**	0	0	6	6
Identifying pains & gains - crafting value proposition - Ideation - Divergent Thinking - Ideation methods - Rules of brainstorming -Managing risks - Concept of minimum usable prototypes - Generating solution concepts.					
Unit IV	**PRETOTYPING**	0	0	6	6
Pretotyping concepts - Palm Pilot Experiment - Fake it before make it - Prototyping - The Law of Failure - Building a Prototype - Testing the Prototypes					
Unit V	**PITCH & PRESENTATION**	0	0	6	6
Science of Storytelling - the blueprint for storytelling - Pitch Script - Pitch Presentations - Best Practices to creating a compelling pitch - communication fundamentals.					
					Total = 30 Periods

Text Books:

1	Tim Brown(2019), “Change by Design : How design thinking transforms organizations and inspires innovation”
2	JanChipchase& Simson Steinhardt (2013), “ Hidden in Plain Sight :How to Create Extraordinary Products for Tomorrow’s Customers”, Harper Business 2013.
3	Christian Madsbjerg& Mikkel B. Rasmussen (2014), : The Moment of Clarity”, Harvard Business Review Press.
4	Alexander Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want(Strategyzer) - John Wiley & Sons, 2014.
5	Idris Mootee(2013), Design Thinking for Strategic Innovation, Willey.

Reference Books:

1	Savoia.Alberto, 2009, The Pretotyping Manifesto - https://sites.google.com/a/pretotyping.org/www/the-pretotyping -manifesto-
2	Jazz Factory, All about Presentations - http://bog.jazzfactory.in/

3	Pretotyping Methodology - https://www.pretotyping.org/methodology.html
4	How to give a killer presentation - https://hbr.org/2013/06/how-to-give-a-killer-presentation

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Identify real-world problems	Understanding
CO2	Apply the challenge curation techniques to real-world problems.	Applying
CO3	Analyze the problems and generate solutions to address the challenges	Analyzing
CO4	Build solutions using pertotyping tools & techniques	Applying
CO5	Develop an innovation pitch to effectively communicate the idea to solve the identified problem	Analyzing

COURSE ARTICULATION MATRIX

CO/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	3	1	1	1	-	-	-	-	-	-	1	1	1	2
CO2	1	2	1	1	1	2			2	1		1	1	1	1
CO3	2	3	3	2	2	-	-	-	-	-	-	1	3	3	2
CO4	2	2	3	2	3	-	-	-	-	-	-	1	3	3	3
CO5	1	2	1	1	1	-	-	-	2	3	1	1	1	1	1
Avg	1.4	2.4	1.8	1.4	1.6	2	0	0	2	2	1	1	1.8	1.8	1.8

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22NC301	NCC COURSE-II (Only for NCC Students)			SEMESTER III		
PRE-REQUISITE:		**Category**	**NC**	**Credit**		**0**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To maintain the unity and disciplines to the students

UNIT I	**SOCIAL SERVICE & COMMUNITY DEVELOPMENT**	**9**	**0**	**0**	**9**

Basic of social service and it’s need - Rural Development Program – NGOs Roles & Contribution – Drug abuse and Trafficking – Civic Responsibilities – Causes & prevention of AIDS/HIV – Counter Terrorism – Corruption – Social Evil – RTI & RTE – Traffic Control Organization – Anti Drunken Driving.

UNIT II	**GENERAL AWARENESS & ADVENTURE**	**9**	**0**	**0**	**9**

General Knowledge – Logical & Analytical Reasoning - Modes of Entry to Army, CAPF, Police – SSB Procedure; Para Sailing – Slithering – Rock climbing – Cycling and Trekking.

UNIT III	**AEROENGINES & NAVIGATION**	**9**	**0**	**0**	**9**

Introduction to aero engines and its type – Components of aero engines – Principles of Propulsion – Basic Terminology – Jet engines – Brayton Cycle – Turbo prop engines and its types; Requirements of Navigation - Lines on Earth – Maps and its types - Symbols used in map – Scales of map – Map reading procedure and its aids.

UNIT IV	**AIRFRAME & METEOROLOGY**	**9**	**0**	**0**	**9**

Aircraft Control – Primary and Secondary –Fuselage – Main Plain and Tail Plain – Ailerons, Elevators& Rudders – Landing Gear; Importance of METT in Aviation – Atmosphere – Clouds and Precipitation – Flying Hazards.

UNIT V	**FLIGHT INSTRUMENTS & AEROMODELLING**	**9**	**0**	**0**	**9**

Airspeed Indicator – Altimeter – Artificial Horizon – Radar and Its Type – Instruments Battery Test, Compass; History of Aero Modeling – Basic Materials & Tools – Types of Aero Modelling – Flying/Building of Aero Models – General Safety Procedure.

Total = 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	Acquired knowledge about social and legal responsibilities.	Understanding
CO2	Understand the adventure activities and verbal training on defense examinations.	Understanding
CO3	Understand the technical knowledge on aero engines and map reading.	Understanding
CO4	Understand the structure and control of an aircraft.	Understanding
CO5	Understand and learn the importance of avionic instruments on aircraft control.	Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO1 2**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	-	-	-	-	-	-	-	-	-	-	3	1	1
CO2	3	3	2	3	-	-	-	-	-	-	-	-	3	2	1
CO3	3	2	3	1	-	2	-	-	-	-	-	-	3	2	1
CO4	3	2	2	2	-		-	-	-	-	-	-	3	2	1
CO5	3	-	-	-	-	1	-	-	-	-	-	-	3	3	1
Avg	3	2	2.3	2	-	1.5	-	-	-	-	-	-	3	2	1

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22EC306	SEMICONDUCTOR DEVICES AND CIRCUITS LABORATORY				SEMESTER III		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**	
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**	
			0	**0**	**4**	**4**	

Course objectives:

1.	To provide an insight into the characteristics of electron devices.
2.	To design and analyse various amplifier circuits.
3.	To study the operation of rectifiers and filters.

EXPERIMENTS

1.	Characteristics of PN Junction Diode and Zener Diode.
2.	Characteristics of photodiode.
3.	Design of Clippers and Clampers.
4.	Measurement of ripple factor of Rectifiers with and without capacitor filter.
5.	Characteristics of CE/CB/CC configurations of Bipolar transistors.
6.	Characteristics of MOSFET.
7.	Frequency response of BJT Amplifier using voltage divider bias (self-bias) with and without emitter by pass capacitor.
8.	Frequency response of Multi stage amplifiers.
9.	Determination of efficiency of Class A power amplifier.
10.	Observation of the output of Class B Complementary symmetry power amplifier with and without crossover distortion.
11.	Design and Analysis of Series feedback amplifiers.
12.	Design and Analysis of Shunt feedback amplifiers.
	Total (60 P)= 60 Periods

Text Books:

1.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.
2.	S. Salivahanan and N. Suresh kumar, "Electronic Devices and Circuits", Fourth edition, McGraw Hill Education, 2017.

Reference Books:

1.	Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" 11th edition, PHI, 2017.
2.	Ben G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2015.
3.	S.Poorna Chandra, B.Sasikala, "Electronics Laboratory Primer", S.Chand & Company Ltd, 2010.
4.	L.K. Maheshwari, M.M.S. Anand, "Laboratory Manual for Introductory Electronics Experiments", New age International (P) Limited Publishers, 2010.

E-References:

1.	ttps://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/108101091
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyze the characteristics of diodes and transistors.	Analyzing
CO2	:	Design electronic circuits such as rectifiers and analyse their performance.	Evaluating
CO3	:	Analyze the frequency response of small signal and power amplifiers using discrete components.	Evaluating
CO4	:	Design and analyze the frequency response of feedback amplifiers.	Evaluating
CO5	:	Implement electronic circuits and test their performance.	Creating

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	2	2	2	-	-	-	-	-	-	-	1	1	1
CO2	3	3	2	2	2	-	-	-	-	-	-	-	1	2	1
CO3	3	3	2	2	2	-	-	-	-	-	-	-	2	2	1
CO4	3	3	3	2	2	-	-	-	-	-	-	-	1	1	1
CO5	3	3	3	2	2	-	-	-	-	-	-	-	2	2	1
Avg	2.8	3	2.4	2	2	-	-	-	-	-	-	-	1.4	1.6	1

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22EC307	DIGITAL SYSTEM DESIGN LAB	SEMESTER			III
PREREQUISITES		CATEGORY	PC	Credit	2
NIL		Hours/Week	L	T	P	TH
			0	0	4	4

Course objectives:	
1.	To understand the principles and methodology of digital logic design at the gate and switch level.
2.	To design and testing of combinational circuits, sequential circuits, digital logic families and programmable logic devices.
3.	To get practical experience in design, realization and verification of memory devices.

EXPERIMENTS	
1.	Study of Logic Gates.
2.	Implementation of logic circuits using NAND gate and NOR gate.
3.	Design and construct Adders and sub tractors.
4.	Design and implementation of Multiplexer and De multiplexer using logic gates and IC74159 and IC74154.
5.	Design and construct encoder and decoder using logic gates and study of IC7445 and IC74147.
6.	Study of Flip-Flops.
7.	Construction and verification of 4 bit ripple counter and Mod- N Ripple counters.
8.	Design and implementation of 3-bit synchronous up/down counter.
9.	Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops.
10.	Design and implementation of Hazard free circuits.
11.	Implementation of combinational logic circuits using Multiplexer and Decoder.
12.	Implementation of combinational logic functions using ROM, PLA and PAL.
	Total (60 P)= 60 Periods

Text books:	
1.	R.P. Jain, “Modern digital Electronics”, 4th Edition, Tata McGraw Hill, 2009.
2.	M. Morris Mano, “Digital Design”, 4th Edition, Pearson Education (Singapore) Pvt . Ltd., New Delhi, 2008.
Reference Books:	
1.	W.H.Gothmann,“DigitalElectronics-Anintroductiontotheoryandpractice”, PHI, 2nd edition,,2006.
2.	D.V. Hall,“ Digital Circuits and Systems”, Tata McGraw Hill, 1989
3.	S.SalivahananandS.Arivazhagan,“Digital Circuits and Design”, 2nd edition, Vikas Publishing HousePvt.Ltd,NewDelhi,2004.
4.	Charles H. Roth. “Fundament also f Logic Design”,Thomson Publication Company,2003.
E-References:	
1.	https://nptel.ac.in/courses/117105080/24
2.	https://nptel.ac.in/courses/117106086/
3.	https://www.youtube.com/watch?v=CeD2L6KbtVM

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Demonstrate the truth table of various expressions and combinational circuits using logic gates.	Understanding

CO2	:	Design various combinational circuits such as adders, sub tractors, comparators, multiplexers and demultiplexers.	Analyzing
CO3	:	Design and Construct counters and shift registers.	Analyzing
CO4	:	Understand the concept of flip flops and Hazard free Circuit.	Understanding
CO5	:	Understand the concept ROM, PLA and PAL.	Analyzing

COURSE ARTICULATION MATRIX															
CO//PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	3	2	1	2	-	-	-	-	2	2	-
CO2	2	3	2	2	1	3	2	1	-	-	-	-	3	1	-
CO3	2	2	2	3	2	2	2	1	-	-	-	-	2	-	1
CO4	2	1	2	1	2	2	3	1	-	-	-	-	2	1	-
CO5	2	2	3	2	1	2	1	2	-	-	-	-	-	2	1
Avg	2.2	2	2.2	2	1.8	2.2	1.8	1.4	-	-	-	-	2.25	1.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

SEMESTER IV

22MA402	PROBABILITY AND STOCHASTIC PROCESSES			SEMESTER			IV
PREREQUISITES			**CATEGORY**	**BS**	**Credit**		**4**
Basic12th level knowledge of probability and statistics.			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**1**	**0**	**4**
Course Objectives:							
1.	To learn the axioms of probability and use of Baye's theorem and its applications.						
2.	To learn the standard Probability distribution and its application.						
3.	To learn the two-dimensional random variables.						
4.	To understand the convergence of random sequences and the concepts of strong and weak laws of large numbers and central limits.						
5.	To understand effectively about the stochastic processes and the applications of correlation, spectral densities of the random process.						
Unit I	**PROBABILITY AND ONE DIMENSIONAL RANDOM VARIBLE**			**9**	**3**	**0**	**12**
Axioms of probability – Conditional probability – Total probability- Bayes' theorem- Random variable- Probability mass function- Probability density function- Probability distribution function- Moments- moment generating functions and their properties-Characteristic functions.							
Unit II	**STANDARD DISTRIBUTION**			**9**	**3**	**0**	**12**
Binomial, Poisson, Geometric, Uniform, Normal Distributions and their properties- Functions of a random variable.							
Unit III	**TWO DIMENSIONAL RANDOM VARIABLES**			**9**	**3**	**0**	**12**
Joint Distribution- Marginal and Conditional distributions- Markov, Chebyshev, Chern off bounds.							
Unit IV	**RANDOM PROCESSES**			**9**	**3**	**0**	**12**
Random sequences and modes of convergence (everywhere, almost everywhere, Probability distribution and mean square) – Strong and Weak laws of large numbers- Central limit theorem.							
Unit V	**CORRELATION AND SPECTRAL DENSITIES**			**9**	**3**	**0**	**12**
Classification- Stationary Process- Mean and Covariance functions- Ergodicity-Transmission of Random Processes through LTI- Auto correlation- Cross correlation- Properties- Power spectral density.							
							Total (45L+15T)= 60 Periods

Text Books:	
1.	Veerarajan.T, "Probability, Statistics and Random processes", Tata McGraw- Hill publications, second edition, New Delhi, 2002.
2.	Ross. S, "A First course in Probability", 5th Edition, Pearson Education, Delhi, 2002.
Reference Books:	
1.	H. Stark and John W. Woods , "Probability and Random processes with Applications to Signal processing", Pearson Education, Third Edition, Delhi 2002.
2.	Peebles Jr. P.Z. "Probability Random Variables and Random Signal Principles", Tata McGraw- Hill Publishers, 4th Edition, New Delhi 2002. (Chapter 6, 7 and 8)
3.	K.L. Chung, "Introduction to Probability theory with Stochastic processes", Springer International.
4.	Ochi, M. K, "Applied Probability and Stochastic process", John Wiley & sons, New York, 1990.
5.	Oliver C.Ibe, "Fundamentals of Applied Probability and Random Processes", Elsevier Publication , 2013

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Learn the fundamental knowledge of the Probability concepts	Understanding
CO2	:	Apply the standard distributions	Applying
CO3	:	Analyze the two-dimensional random variables	Analyzing
CO4	:	Understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.	Understanding
CO5	:	Acquire the knowledge of Random Processes and Spectral densities.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO4	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO5	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
Avg	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC401	ANALOG CIRCUITS		SEMESTER IV			
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To give a comprehensive exposure to all types of discrete amplifiers and oscillators. To develop a strong basis for linear and digital integrated circuits.
2	To understand the various linear and non-linear applications of op-amp.
3	To understand the operation of the D/A &A/D converter types and its applications.

Unit I	**OSCILLATORS**	**9**	**0**	**0**	**9**
Block diagram - Bark hausen Criterion - Mechanism for start of oscillation and stabilization of amplitude – Design and analysis of Oscillator using Cascade connection of RC and LC filters: RC phase shift Oscillator – Wien bridge Oscillator and Twin - T oscillators - LC Oscillators: Colpitts — Hartley — Clapp- Miller and Pierce oscillators - Electrical equivalent circuit of Crystal.					
Unit II	**TUNED AMPLIFIERS AND MULTI VIBRATORS**	**9**	**0**	**0**	**9**
Analysis of single tuned and synchronously tuned amplifiers- Class C tuned amplifiers and their applications -Efficiency of Class C tuned Amplifier-Collector coupled and Emitter coupled Astable Multivibrator –Monostable Multivibrator-Bistable Multivibrator-Triggering methods-Monostable and Astable Blocking Oscillators using Emitter and base timing.					
Unit III	**OPERATIONAL AMPLIFIER DESIGN**	**9**	**0**	**0**	**9**
Current mirror: Basic topology and its variants - Differential amplifier: Basic structure and principle of operation - Calculation of differential gain - Common Mode gain, CMRR - OP-AMP design: Differential amplifier stage –Design of gain stages and output stages—compensation-DC and AC characteristics of OP-AMP.					
Unit IV	**APPLICATIONS OF OPERATIONAL AMPLIFIER**	**9**	**0**	**0**	**9**
Inverting and non-inverting amplifiers-Integrator and Differentiator -Summing amplifier -Precision rectifier -Schmitt trigger and its applications - Active filters: Low pass, high pass, band pass and band stop filters - Sine wave oscillators—Comparator-Multivibrator.					
Unit V	**DATA CONVERTERS AND SPECIAL FUNCTIONICs**	**9**	**0**	**0**	**9**
Digital-to-Analog converters (DAC): Weighted resistor - R-2R ladder - Analog to-Digital converters (ADC): Single slope - Dual slope -Successive Approximation - Flash type - IC 555 timer and its applications - IC723 Voltage regulators.					
					Total(45L) =45Periods

Text Books:

1.	B.Visvesvara Rao,K.Raja Rajeswari,P.Chalam Raju Pantulu,K.Bhaskara Rama Murthy,“ElectronicCircuits-II”,PearsonEducation,2012
2.	D.RoyChoudhry, Shail Jain,“Linear IntegratedCircuits”,NewAge International Pvt. Ltd.,2011.

Reference Books:

1.	Millman J. And Taub H., "Pulse Digital and Switchingwaveform",3rd Edition, McGraw-Hill International, 2011.
2.	Sedera & Smith,“Micro ElectronicCircuits”,4thEdition, Oxford University Press, Chennai.
3.	Michael Jacob, ‘Applications and Design with Analog Integrated Circuits’, Prentice Hall of India,1996.
4.	K.R.Botkar,‘Integrated Circuits’,10thedition ,Khanna Publishers,2010.

E-References:

1.	http://nptel.ac.in/courses/117105080/40
2.	http://freevideolectures.com/Course/2915/Linear-Integrated-Circuits
3.	http://nptel.ac.in/courses/117108038/1

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyze different types of oscillators.	Analyzing
CO2	:	Construct and analyse tuned amplifiers and multivibrators.	Creating
CO3	:	Understanding various stages in the design of Operational Amplifier.	Analyzing
CO4	:	Design of linear and non-linear application of Operational Amplifiers.	Analyzing
CO5	:	Understand A/D and D/A converter architectures and analyse special function ICs along with their applications.	Creating

COURSE ARTICULATION MATRIX

CO//PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	2	2	2	-	-	-	-	2	2	1
CO2	2	3	3	2	-	1	-	-	-	-	-	-	1	2	1
CO3	2	-	3	2	-	2	1	-	-	-	-	-	2	3	2
CO4	1	3	-	2	2	2	2	1	-	-	-	-	3	2	2
CO5	2	3	3	2	2	2	3	2	-	-	-	-	2	3	2
Avg	1.8	3	3	2	1.7	1.8	2	2	-	-	-	-	2	2.4	1.6

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22EC402	MICROPROCESSORS AND MICROCONTROLLERS			SEMESTER			IV
PREREQUISITES			**CATEGORY**	**PC**	**Credit**		**3**
NIL			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:	
1.	To familiarise with 8086 and 8051 architectures.
2.	To interface 8086 microprocessor and 8051 microcontrollers with peripherals by programming.
3.	To gain basic knowledge of PIC microcontrollers.

Unit I	**8086 MICROPROCESSOR ARCHITECTURE**	**9**	**0**	**0**	**9**
Overview of Microcomputer systems-8086 Architecture – Pin Assignments – Internal Architecture – Addressing modes-Instruction Formats- Directives and Operators-Assembly process.					
Unit II	**PROGRAMMING AND INTERFACING OF 8086**	**9**	**0**	**0**	**9**
Fundamental I/O considerations- Programmed I/O- Interrupt I/O- Basic 8086 Configurations- Minimum Mode-Maximum Mode-System Bus timing- I/O Interfaces-Peripheral Interfacing using 8255 PPI - 8279 Keyboard/Display controller - 8251 USART.					
Unit III	**8051 ARCHITECTURE**	**9**	**0**	**0**	**9**
8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization - Instruction set — Addressing modes					
Unit IV	**PROGRAMMING AND INTERFACING OF 8051**	**9**	**0**	**0**	**9**
Assembly language programming - 8051Timers - Serial Port Programming - Interrupts Programming - LCD and Keyboard Interfacing - ADC, DAC and Sensor Interfacing - External Memory Interface - RTC Interfacing - Motor Control.					
Unit V	**PIC MICRO CONTROLLERS**	**9**	**0**	**0**	**9**
Main characteristics of PIC microcontrollers – PIC microcontroller families-Memory-Program Memory – RAM Data Memory - EEPROM Data Memory - Instruction set and timers in PIC.					
					Total (45L) = 45 periods

Text Books:	
1.	Yu-Cheng Liu, Glenn A. Gibson," Microcomputer Systems, The 8086/8088 Family", Pearson, 2e, 2019.
2.	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, "The 8051 Microcontroller and Embedded Systems using Assembly and C", 2e, 2022.
Reference Books:	
1.	Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson education, 2011.
2.	Martin Bates ,"PIC Microcontrollers-An Introduction to Microelectronics", 3e, Elsevier,2011.
3.	Mathur Sunil,"Microprocessor 8086 : Architecture, Programming and Interfacing",PHI Learning Pvt. Ltd.,2011.
4.	Salvador Pinillos Gimenez," 8051 Microcontrollers Fundamental Concepts, Hardware, Software and Applications in Electronics", Springer,2019.
E-References:	
1.	Ashraf Almadhoun,"A Detailed Look Into PIC Microcontroller and Its Architecture",Amazon,2020.
2.	https://nptel.ac.in/courses/108105102
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Describe and analyse the architecture of 8086 microprocessor.	Analyzing
CO2	:	Develop assembly language programs and Interface peripherals with 8086.	Applying
CO3	:	Describe and analyze the architecture of 8051 micro controllers.	Analyzing
CO4	:	Develop assembly language programs and interface peripherals with 8051.	Applying
CO5	:	Associate appropriate PIC microcontroller for a given application.	Understanding

COURSE ARTICULATION MATRIX

CO/ / PO	PO1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	-	-	-	-	-	-	-	-	2	-	1	-	-
CO2	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO3	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	-	2	-	-	-	-	-	-	-	-	2	2	-
Avg	2	2	2	2	-	-	-	-	-	-	2	-	1.8	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22EC403	SIGNALS AND SYSTEMS				SEMESTER IV			
PREREQUISITES			**CATEGORY**	**PC**	**Credit**		**3**
NIL			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To introduce basics of signals and system.
2.	To understand and perform Fourier analysis on continuous and discrete time signal and sampling theorem.
3.	To introduce Laplace and Z transform in analysing signals and system

Unit I	INTRODUCTION TO SIGNALS AND SYSTEM	9	0	0	9

Classification of Signals: Even and Odd Signal - Energy and power signals - Continuous time (CT) and Discrete time (DT) signals - Continuous and Discrete amplitude signal - System properties and representation: linearity - Time-invariance – Causality – Stability - Realizability. - Linear Time-Invariant (LTI) systems: Impulse response and step response – Convolution – Correlation - System representation through differential equations and difference equations.

Unit II	FOURIER ANALYSIS OF CONTINUOUS TIME SIGNAL	9	0	0	9

Continuous Time Fourier Series (CTFS) - Properties of CTFS - Continuous Time Fourier Transform (CTFT) – CTFT of CT periodic signals - Properties of CTFT - Frequency response of systems characterized by differential equations.

Unit III	LAPLACE TRANSFORM AND CONTINUOUS-TIME LTI SYSTEMS	9	0	0	9

Laplace Transform - Laplace Transforms of some Common Signals - Region of Convergence -Properties of Laplace Transform- Inverse Laplace Transform - System Function - The Unilateral Laplace Transform -Solving differential equation of CT system.

Unit IV	SAMPLING THEOREM AND Z-TRANSFORMS	9	0	0	9

Representation of continuous time signals by its sample - Sampling theorem – Nyquist rate of sampling – Effects of under sampling (aliasing) – Sampling techniques - Data Reconstruction - Sampling of band pass signals - Z-transform - Relationship between z-transform and Fourier transform - Z-transform for discrete time signals - Region of Convergence – Properties of ROC – Properties of Z-transform - Poles and Zeros - Inverse Z-transform

Unit V	FOURIER ANALYSIS OF DISCRETE TIME SIGNALS	9	0	0	9

Discrete Time Fourier Series (DTFS) - Properties of DTFS – Discrete Time Fourier Transform (DTFT) – Properties of DTFT - Frequency Response of Discrete Time LTI Systems - Discrete Fourier Transform (DFT) – Realization of structures: Direct form I - Direct form – II - Cascade and parallel forms.

Total (45L)= 45 periods

Text Books:

1.	A.Anand Kumar, " Signals and Systems" , 3rd Edition, PHI, 2013.
2.	B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2009.

Reference Books:

1.	Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, "Signals and Systems", 2nd edition, PHI Learning Private Limited, New Delhi, 2010.
2.	Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, 1998.
3.	Hsu.H.P, Rakesh Ranjan "Signals and Systems",2nd Edition Schaum's Outlines, Tata McGraw Hill, 2010.
4.	Krishnaveni.V, Rajeswari.A, "Signals and Systems", 1st Edition, Wiley India Pvt.. Ltd, 2012.

E-References:

1.	https://www.youtube.com/watch?v=4GewDCPU5SQ&list=PLy3nfyfK6Yw6bQ-QXJdFrhzd37mgZzk0r
2.	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
3.	http://nptel.ac.in/courses/117104074/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand and Analyse different types of signals and systems.	Analyzing
CO2	:	Represent continuous and discrete systems in time and frequency domain using different transforms.	Evaluating
CO3	:	Able to perform Fourier analysis of signals.	Analyzing
CO4	:	Sample and reconstruct a signal.	Understanding
CO5	:	Realize various structures for discrete time systems	Understanding

COURSE ARTICULATION MATRIX

CO/ /PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	3	-	-	-	-	-	-	-	2	2	2
CO2	3	2	2	3	3	2	-	-	-	-	-	-	2	2	2
CO3	3	2	2	3	3	2	-	-	-	-	-	-	2	2	1
CO4	3	2	1	3	3	2	-	-	-	-	-	-	2	2	2
CO5	3	2	2	3	3	-	-	-	-	-	-	-	1	2	2
Avg	3	2	2	3	3	2	-	-	-	-	-	-	1.8	2	1.8

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22EC404	CONTROL SYSTEMS			SEMESTER IV			
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**	
Laplace Transform, Partial Differential Equation		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:	
1.	To introduce the components and their representation of control systems.
2.	To learn various methods for an alyzing the time response, frequency response and stability of the systems.
3.	To introduce various methods for the state variable analysis.

Unit I	**MATHEMATICAL MODELS OF PHYSICAL SYSTEMS**	**9**	**0**	**0**	**9**
Basic Elements of Control System - Differential equations of physical systems – Open loop and Closed loop systems - Transfer function - Modelling of Electrical systems - Translational and rotational mechanical systems – Analogy - Block diagram reduction Techniques - Signal flow graph – Mason’ Gain Formula.					
Unit II	**TIME RESPONSE ANALYSIS**	**9**	**0**	**0**	**9**
Standard test signals - Time response analysis - Impulse and Step Response analysis of First and second order systems – Time domain specifications - P, PI, PD and PID controllers - Steady state errors and error constants - Generalized error co-efficient .					
Unit III	**FREQUENCY RESPONSE ANALYSIS**	**9**	**0**	**0**	**9**
Sinusoidal Transfer Functions and frequency Response - Frequency Domain specifications for second order system - Frequency response plots: Bode Plot - Polar Plot –Linear system design: Types of compensators - Lead, Lag and Lead Lag Compensators.					
Unit IV	**STABILITY ANALYSIS**	**9**	**0**	**0**	**9**
Stability - Routh-Hurwitz Criterion - Nyquist Stability Criterion - Relative Stability - Root Locus Technique - Construction of Root Locus - Stability, Dominant Poles - Application of Root Locus.					
Unit V	**STATE VARIABLE ANALYSIS**	**9**	**0**	**0**	**9**
Concept of state , state variable and state model - State space representation of linear Continuous and discrete Time systems – solutions of State equations – Transfer function from State Variable Representation – Concepts of Controllability and Observability					
					Total (45L)= 45 periods

Text Books:	
1.	A.Anand Kumar, “Control Systems”, Prentice Hall of India, 2012
2.	A.Nagoorkani, “Control Systems” 2nd Edition, RBA publications, 2009
Reference Books:	
1.	Norman SNise,”Control Systems Engineering’,Seventhedition,Wiley Publications, 2015
2.	Benjamin.C.Kuo, Automatic Control Systems, 7thEdition, PHI, 2009.
3.	K.Ogata,“ModernControlEngineering”,PHI,5thEdition,2012.
4.	I.J Nagrath and M. Gopal, “Control System Engineering”, 5th Edition, New Age International Edition, 2018.
E-References:	
1.	https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x
2.	https://onlinecourses.nptel.ac.in/noc17_ee12
3.	https://onlinecourses.nptel.ac.in/noc22_ee31/preview

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Frame the transfer function of different physical systems	Understanding
CO2	:	Analyse the time domain specification and calculate the steady state error	Applying
CO3	:	Carryout the frequency response analysis of open loop and closed loop system and apply suitable compensation.	Applying
CO4	:	Analyse the stability of the system using Routh and root locus techniques.	Analysing
CO5	:	Test the controllability and observability of a physical system	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	1	-	-	-	-	-	-	-	3	-	2
CO2	3	1	1	2	1	-	-	-	-	-	-	-	2	-	2
CO3	3	1	1	1	1	-	-	-	-	-	-	-	2	-	1
CO4	3	1	1	1	1	-	-	-	-	-	-	-	3	1	2
CO5	2	1	1	1	1	-	-	-	-	-	-	-	2	-	1
Avg	2.8	1.2	1.2	1.4	1	-	-	-	-	-	-	-	2.4	1	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC405	ANTENNA AND WAVE PROPAGATION			SEMESTER IV		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand the fundamental principles of Antenna theory, and wave propagation with a lucid explanation of the basic concepts and equations.
2.	To understand the design and operation of various antenna types.
3.	To study the fundamental electromagnetic wave propagation indifferent layers of the atmosphere.

Unit I	**ANTENNA FUNDAMENTALS & WIRE ANTENNAS**	**9**	**0**	**0**	**9**

Types of Antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas, Friis Transmission equation. - Fields associated with Hertzian dipole - Alternating current element - Power radiated and radiation resistance of current element - Radiation resistance of half-wave dipole antenna.

Unit II	**ANTENNA ARRAYS**	**9**	**0**	**0**	**9**

Expression for electric field from two and N - element arrays - Uniform linear array - Broadside array - Endfire array - Method of pattern multiplication - Binomial array - Folded dipole antenna - Yagi Uda antenna - Log periodic dipole array.

Unit III	**LOOP , HELICAL AND REFLECTOR ANTENNA**	**9**	**0**	**0**	**9**

Loop Antennas: small loop and general case - Radiation resistance of loops – Directivity of circular loop – Helical antenna: Helical geometry – normal mode and axial-mode helical antenna - Radiation from a traveling wave on a wire - Rhombic antenna: Analysis & Design of Rhombic antennas - Reflector antennas: Flat sheet reflector - Corner reflector – Paraboloid reflector - Feed systems.

Unit IV	**APERTURE ANTENNAS**	**9**	**0**	**0**	**9**

Huygens' principle-radiation from rectangular aperture- Radiation from circular aperture- design considerations, Babinet's principle– Slot antennas - Pattern of slot antennas in flat sheets - Impedances of slot antennas - Method of feeding slot antennas - Field on the axis of an E-Plane sectoral horn – Radiation from pyramidal horns, design concepts.

Unit V	**WAVE PROPAGATION**	**9**	**0**	**0**	**9**

Sky wave propagation: Structure of the ionosphere - Effective dielectric constant of ionized region - Mechanism of refraction - Refractive index - Critical frequency - Skip distance - Effect of earth's magnetic field - Maximum usable frequency - Fading and Diversity reception - Space wave propagation - Reflection from ground for vertically and horizontally polarized waves - Reflection characteristics of earth - Resultant of direct and reflected ray at the receiver - Duct propagation - Ground wave propagation: Attenuation characteristics for ground wave propagation - Calculation of field strength at a distance.

Total(45L)=45Periods

Text Books:

1.	E.C .Jordan and Balmain ," Electro Magnetic Waves and Radiating Systems",PHI,1968,Reprint2010.
2.	John D.Kraus and Ronalatory Marhefka,"Antennas", Tata McGraw – Hill Book Company,2010.

Reference Books:

1.	Terman, F.E., "Radio Engineers Handbook", Tata McGraw - Hill, 1985.
2.	Constantine A. Balan is, "Antenna Theory Analysis and Design", John Wiley & Sons,2012.
3.	R.E. Collins, 'Antennas and Radio Propagation ", McGraw - Hill, 1987.
4.	Elliot, R.S, "Antenna theory and design", PHI, NewDelhi,1985.

E-References:

1.	https://www.youtube.com/watch?v=LF9kebBTWXo&list=PLAULbhIvfai5yvvLIm-oIb89dGNp1BtM6
2.	https://www.youtube.com/watch?v=jA8aTA1Pg4s&list=PLCcWs0lpRgKcOu8LAX7GlZLIAHgyN1oVS

3.	https://link.springer.com/chapter/10.1007/978-1-4615-6459-1_28

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand and derive the behaviour of the antenna and its performance parameters.	Understanding
CO2	:	Design and analyse antenna arrays.	Analysing
CO3	:	Design and analyse Loop, Helical and Reflector antenna.	Analysing
CO4	:	Design and analyse aperture antennas.	Analysing
CO5	:	Study radio wave propagation and its effects.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	-	-	-	-	-	-	-	1	1	1
CO2	3	2	2	2	1	-	-	-	-	-	-	-	1	2	2
CO3	3	2	2	2	1	-	-	-	-	-	-	-	1	2	2
CO4	3	2	2	2	1	-	-	-	-	-	-	-	1	2	2
CO5	3	1	1	1	1	-	-	-	-	-	-	-	-	-	-
Avg	3	2	1.6	1.6	1	-	-	-	-	-	-	-	1	1.75	1.75
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22MCIN03	DESIGN SPRINTS			Semester		IV
PREREQUISITES		Category	EE	Credit		1
		Hours/Week	L	T	P	TH
			0	0	2	2

Course Learning Objectives

1	Develop key skill areas essential for a product designer from the perspective of design, its inherent complexity and supports them with tools & techniques to prototype rapidly.
2	To enable the participants to visualize the experience for a user.
3	To learn the roles & responsibilities of a designer in creating and shaping experiences for the user.
4	The participants shall learn through the lenses of system thinking of how existing products work.
5	Learn to select & apply various practice tools to aid them in rapid prototyping

Unit I	DESIGN FUNDAMENTALS	0	0	6	6

Introduction to Visual Design, History and Modernism, Design Thinking methodology, seven elements of design, principles of design, principles of good design, designing a product and a service

Unit II	SYSTEM THINKING AND REVERSE ENGINEERING	0	0	6	6

System Thinking for Engineering Problem Solving, Understanding Systems, Examples and understandings, Complex Systems, Reverse Engineering Methodology, Identify building blocks/Components - Re-Engineering a complex system

Unit III	USER INTERFACE & USER EXPERIENCE	0	0	6	6

Introduction to UI/UX, Human-Computer interface, user-centered Design Principles, User research techniques, UX Design workflow, Information Architecture, UI Components, need for UI prototyping, Wireframes

Unit IV	MECHANICAL PROTOTYPING	0	0	6	6

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Introduction - Working with Fusion 360 - 3D Modeling - 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

Unit V	ELECTRONIC & SOFTWARE PROTOTYPING	0	0	6	6

Introduction to Lumped Circuits - Electronic Prototyping - Tinker CAD - Designing in KI CAD - PCB design - Source code management and version control - GitHub - GitHub Actions - GitBash - Continuous Integration - Platform as service - Heroku - Build Packs

Total = 30 Periods

Text Books:	
1.	Thinking in systems - Donella Meadows, 2015
2.	Rapid Prototyping And Engineering Applications: A Toolbox For Prototype Development - Frank W.Liou, 2007
3.	Rapid Prototyping Technology: Selection And Application - COOPER K. G, 2001
Reference Books:	
1.	https://thesystemsthinker.com/wp-content/uploads/2016/03/Introduction-to Systems-Thinking-IMS013Epk.pdf
2.	https://formlabs.com/blog/ultimate-guide-to-prototyping-tools-for-hardware-and product-design/
3.	https://docs.kicad-pcb.org/
4.	https://www.tinkercad.com/learn/circuits
5.	https://docs.github.com/en/free-pro- team@latest/actions/guides

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Understand the elements and principles of product and service design	Applying
CO2	Apply system thinking concepts in reverse engineering	Applying
CO3	Apply user research techniques to meet the UX needs of a customer and design a visual prototype	Applying
CO4	Develop prototyping models using the tools from mechanical prototyping models	Applying
CO5	Develop prototyping models using the tools from electrical and software prototyping methods	Applying

COURSE ARTICULATION MATRIX

CO/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	1	3	1	1	-	-	-	-	-	-	-	3	2	2
CO2	2	3	3	2	2	-	-	-	-	-	-	-	3	3	3
CO3	2	2	3	1	3	-	-	-	-	1	-	-	3	2	2
CO4	3	2	3	1	3	-	-	-	-	-	-	-	3	3	3
CO5	3	2	3	2	3	-	-	-	-	-	-	-	3	3	3
Avg	2.4	2	3	1.4	2.4	-	-	-	-	1	-	-	3	2.6	2.6

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

<table>
<tr><td>22CYMC01</td><td colspan="2">ENVIRONMENTAL SCIENCE</td><td colspan="4">SEMESTER IV</td></tr>
<tr><td colspan="2">PREREQUISTIES</td><td>CATEGORY</td><td>MC</td><td colspan="2">Credit</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>3</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="6">To learn the concept of non-conventional energy systems.</td></tr>
<tr><td>2.</td><td colspan="6">To explore the environmental impact assessment and to learn about the consequence of different types of pollutants.</td></tr>
<tr><td>3.</td><td colspan="6">To have an ancient wisdom drawn from Vedas.</td></tr>
<tr><td>4.</td><td colspan="6">To acquire activity-based knowledge to preserve environment.</td></tr>
<tr><td>5.</td><td colspan="6">To learn about conservation of water and its optimization.</td></tr>
<tr><td colspan="3">ENVIRONMENTAL AWARENESS</td><td>30</td><td>0</td><td>0</td><td>30</td></tr>
<tr><td colspan="7">Various types of traditional power Plant --Advantage and Disadvantage of conventional Power Definition of non-conventional energy sources Plants – Conventional vs. Non-conventional power generation. – types of non-conventional energy sources - India's current energy resources and their long-term viability – India’s Energy requirement and management
Solar Energy Basics- Solar Thermal Energy- Solar Photovoltaic Energy- Benefits and Drawbacks -Effects on the environment and safety. Wind turbine power and energy- India's wind energy potential- Wind turbine types. Environmental benefits and impacts of offshore wind energy.
Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water Pollution-Sources and its remedy, Soil Pollution-Sources and its remedy, disposal of solid waste. Greenhouse gases – effect, acid rain. Noise pollution reduction. Aspects of pollution from various power plants.</td></tr>
<tr><td colspan="3">ENVIRONMENTAL ACTIVITIES</td><td>0</td><td>0</td><td>15</td><td>15</td></tr>
<tr><td colspan="7">Group activity on water management – Group discussion on recycle of waste (4R’s)- Slogan making contest – Poster making event – Expert lecture on environmental awareness – Imparting knowledge on reduction of electricity usage. Identification and segregation of biodegradable and non-biodegradable waste – Campus cleaning activity – Plantation of trees in the college campus and local waste lands – Identification of varieties of plants and their usage – Shutting down the fans and ACs of the campus for an hour.</td></tr>
<tr><td colspan="7">Total (30L+15P) = 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Elements of Environmental science and Engineering, P.Meenakshi, Prenitce — Hall of India, New Delhi 2009.</td></tr>
<tr><td>2.</td><td>A Textbook of Environmental Chemistry and Pollution Control: (With Energy, Ecology, Ethics and Society) Revised Edition, Dr. S.S. Dara, D.D. Mishra Published by S. Chand & Company Ltd, 20 14.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>Introduction to Environmental Engineering and Science, Gilbert M. Masters; Wendell P. Ela Publisher Prentice-Hall India, 3rd Edition, 2008.</td></tr>
<tr><td>2.</td><td>Environmental Science, F;ldren D. Enger, Bredley F.Smith, WCD McGraw Hill 14"'
Edition 2015.</td></tr>
<tr><td colspan="2">E-Reference</td></tr>
<tr><td>1</td><td>www.onlinecourses.nptel.ac.in/</td></tr>
<tr><td>2</td><td>www.ePathshala.nic.in</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	To identify about the major renewable energy systems and will investigate the environmental impact of various energy sources as well as the consequences of various pollutants.	Analysing
CO2	:	Predict the methods to conserve energy and ways to make optimal use of the energy for the future.	Applying

COURSE ARTICULATION MATRIX															
COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	3	-	-	3	1	1	-	-	-	1	2	-	1
CO2	-	1	3	-	-	3	1	1	-	-	-	1	2	-	1
Avg	-	1	3	-	-	3	1	1	-	-	-	1	2	-	1
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EN401	PLACEMENT AND SOFT SKILLS LABORATORY					SEMESTER IV	
PREREQUISITES		**CATEGORY**	**HS**	**Credit**		**2**	
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**	
			0	**0**	**4**	**4**	

1.	Basic knowledge in reading skill and writing skill
2.	Basic ability in listening skill and speaking skill
Course Objectives:	
1.	To develop the students' confidence and help them to attend interviews successfully
2.	To express opinions, illustrate with examples and conclude in group discussions
3.	To acquire knowledge to write error free letters and prepare reports
4.	To enhance the employability and soft skills of students

Unit I	**WRITING SKILLS**	**12**	**+**	**0**
Letter seeking permission to go on industrial visit, Letter of invitation, Resume and cover letter, Job application, E-mail writing, Report writing, progress in project work				
Unit II	**SPEAKING SKILLS**	**12**	**+**	**0**
Welcome address and vote of thanks, Analysing and presenting business articles, Power point presentation, Presenting the visuals effectively, Group discussion, Participating in group discussions, Understanding group dynamics, Brain-storming the topics				
Unit III	**SOFT SKILLS**	**12**	**+**	**0**
Employability and career skills, Self-introduction, Introducing oneself to the audience, introducing the topic, Interview skills, Interview etiquette, Dress code, Body language, Attending job interviews				
Unit IV	**VERBAL ABILITIES**	**12**	**+**	**0**
Error Spotting, Listening Comprehension, Reading comprehension, Rearranging Jumbled sentences, Vocabulary.				
Unit V	**REASONING ABILITIES**	**12**	**+**	**0**
Series completion, Analogy, Classification, Coding-Decoding, Blood relations, Seating Arrangements, Directional Sense, Venn Diagram, Logical reasoning, Statements and Conclusions.				
				Total (60P) = 60 periods

List of Exercises:

1) Cover Letter and Resume
2) Letter Writing
3) Email Writing
4) Report Writing
5) Power point Presentation
6) Self-Introduction
7) Job Interview
8) Group Discussion
9) Welcome Address
10) Vote of Thanks
11) Presentation of Business Article
12) Jumbled Sentences
13) Error Spotting
14) Reading Comprehension
15) Series completion
16) Analogy
17) Coding-decoding
18) Blood relations
19) Seating arrangements
20) Logical reasoning

Reference Books:	
1.	Campus Recruitment Complete Reference, Praxis Groups (5th edition), Hyderabad, 2017.

2.	John Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi, 2004.
3.	R.S. Aggarwal. A Modern Approach to Verbal & Non-Verbal Reasoning. 2018 S Chand Publication, 2018
E-References:	
1.	https://prepinsta.com/
2.	https://www.indiabix.com/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	To participate in group discussion and interview confidently	Applying
CO2	:	To develop adequate soft skills and career skills required for the workplace	Evaluating
CO3	:	To make effective presentations on given topics	Evaluating
CO4	:	To apply their verbal ability and reasoning ability in campus interviews	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO 1	PSO 2	PSO3
CO1	-	-	-	1	-	-	-	-	2	3	-	1	-	-	1
CO2	-	-	-	2	-	-	-	-	2	3	-	1	-	-	2
CO3	-	-	-	2	-	-	-	-	1	3	-	1	-	-	1
CO4	-	-	-	1	-	-	-	-	2	3	-	1	-	-	2
Avg	-	-	-	1.5	-	-	-	-	1.75	3	-	1	-	-	1.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22EC406	ANALOG CIRCUITS LABORATORY			SEMESTER			IV
PREREQUISITES		**CATEGORY**		**PC**	**Credit**		**2**
NIL		**Hours/Week**		**L**	**T**	**P**	**TH**
				0	**0**	**4**	**4**

Course Objectives:

1.	To understand the analysis and design of LC and RC oscillators, amplifiers and multi vibrators.
2	To apply operational amplifiers in Linear and Nonlinear Applications.
3	To uses imulation tools for circuit design.

EXPERIMENTS

1.	Design of RC Phase shift oscillator and Wein Bridge oscillator.
2.	Design of Hartley and Colpitts oscillator.
3.	Design of Tuned Class C power Amplifier.
4.	Design of Astable, Monostable and Bistable multivibrators using BJ T.
5.	Simulation of Astable, Monostable and Bistable multivibrators.
6.	Design and verification of basic Circuits using Op - amp 741.
7.	Active Low pass, High pass and Band pass filter using Op - amp 741.
8.	Astable, Mon stable multivibrators using Op-Amp.
9.	Schmitt Trigger using op-amp.
10.	Phase shift and Wien bridge oscillator using op-amp.
11.	Astable and Monostable multivibrators using 555 Timer.
12.	High voltage regulator using LM723.
	Total(60P)=60 Periods

References:

1.	Analog Electronic circuits Laboratory Manual.2. David A.Bell,“ Electronic Devices and Circuits”,5th Edition, Oxford University Press,
2.	B.Sasikala,S.PoornachandraRao,“Handbook of experiments in Electronics and Communication Engineering”,Vikas Publishing,2007.

E-References:

1.	http://www.srmuniv.ac.in/sites/default/files/2017/15EI205L-manual-full.pdf
2.	http://www.gopalancolleges.com/gcem/course-material/ece/manuals/sem-lll/analog-electronics-laboratory-manual-10ESL37.pdf
3	https://www.slideshare.net/vampec/ec-ii-lab-manual

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom’s Taxonomy Mapped
CO1	:	Design oscillators, multivibrators and power amplifiers for the variety of engineering applications.	Creating
CO2	:	Design Filters Using Op amp and perform experiment and plot frequency response.	Analysing
CO3	:	Design and simulate multivibrators using simulation tool.	Analysing
CO4	:	Design scillators and multivibrators using operational amplifiers	Creating
CO5	:	Understand the concept of high voltage regulators	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	3	-	-	-	-	-	-	1	1	1	2	-
CO2	2	3	3	3	-	-	-	-	-	-	1	1	-	2	-
CO3	2	2	-	-	3	-	-	-	-	-	-	-	1	-	2
CO4	2	2	-	3	3	-	-	-	-	-	-	-	-	3	-
CO5	2	-	2	2	3	-	-	-	-	-	1	1	2	-	1
Avg	2	2.5	2.7	2.75	3	-	-	-	-	-	1	1	1.3	2.3	1.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC407	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY			SEMESTER		IV
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**4**	**4**

Course Objectives:	
1.	To introduce students with the architecture and operation of 8086 microprocessor and 8051 microcontroller.
2.	To familiarize the students with the programming and interfacing of 8086 microprocessor and 8051 microcontroller.
3.	To provide strong foundation for designing real world applications using 8086 microprocessor and 8051 microcontroller.
EXPERIMENTS	
8086 Programs	
1.	Kit Familiarization.
2.	Implementation of Basic Arithmetic and Logic operations.
3.	Implementation of Square, Square root and Cube Program.
4.	Implementation of Code conversion and Matrix operations.
5.	Implementation of String manipulation operations and Sorting and Searching.
6.	Peripheral Interfacing of keyboard and display.
7.	Implementation of Traffic light Control.
8.	Implementation of Serial and Parallel Communication.
9.	Design of programs for Digital clock and Stop watch.
10.	Implementation of Stepper Motor Control.
8051 Programs	
11.	Implementation of basic arithmetic and Logical operations.
12.	Implementation of finding Square and Cube, 2‘s complement of a number.
13.	Implementation of programs on different addressing modes.
14.	A/D and D/A interfacing.
15.	Waveform generation using 8051.
	Total (60P)= 60 Periods

References:	
1.	“ Microprocessors and Microcontrollers Lab Manual” prepared by ECE Department.
2.	https://www.studocu.com/in/document/anna-university/microprocessor-and-microcontroller/microprocessor-microcontroller-labaratory-manual-pdf/17250102

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Perform basic operations in 8086 microprocessor and 8051 microcontroller.	Understanding
CO2	:	Interface peripherals with 8086 microprocessor.	Applying
CO3	:	Generate waveforms using Microcontroller.	Applying
CO4	:	Develop assembly language programs for various applications using 8051 microcontroller	Applying
CO5	:	Interface peripherals with 8051 microcontroller.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	-	-	-	-	-	-	-	-	-	-	2	2	-
CO2	2	3	-	2	2	-	-	-	-	-	-	-	2	3	-
CO3	2	3	-	2	2	-	-	-	-	-	-	-	2	2	-
CO4	2	3	-	2	2	-	-	-	-	-	-	-	2	3	2
CO5	2	3	-	2	2	-	-	-	-	-	-	-	2	2	-
Avg	2	3	-	2	2	-	-	-	-	-	-	-	2	2.4	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

SEMESTER V

22EC501	DIGITAL COMMUNICATION					SEMESTER V
PREREQUISITES:		CATEGORY	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

1.	Analog Communication

Course Objectives:

1.	Understand the building blocks of digital communication system and to prepare mathematical background for communication signal analysis.
2.	Express pass-band data transmission and comparison of Digital modulation systems.
3.	Analyze the error performance of a digital communication system in the presence of noise and other interferences. Understand the concept of spread spectrum communication system.

Unit I	DETECTION , ESTIMATION AND SAMPLING PROCESS	9	0	0	9

Model of Digital Communication System - Gram-Schmidt orthogonalization procedure – Geometric interpretation of signals – Detection of known signals in noise - Probability of error - Correlation receiver - Matched filter receiver – Detection of signals with unknown phase in noise – Estimation: concepts and criteria - Sampling process: proof for sampling and reconstruction– PAM - Other forms of pulse modulation –TDM - Waveform coding techniques: PCM - DPCM - Delta modulation – Adaptive Delta Modulation.

Unit II	BASEBAND TRANSMISSION OF DIGITAL SIGNALS	9	0	0	9

Discrete PAM signals - Inter Symbol Interference - Nyquist's criterion for Distortion less Base band Binary Transmission - Correlative level coding - Duo binary and modified duo binary signalling – Eye patterns – Baseband M-ary PAM Systems – Adaptive Equalization for data transmission.

Unit III	PASSBAND TRANSMISSION OF DIGITAL SIGNALS	9	0	0	9

Digital Modulation Formats - Coherent Binary Modulation Techniques: Generation – Detection - Signal space diagram - Bit error probability - Power spectra and waveforms of BPSK, BFSK, QPSK and MSK schemes – Non Coherent Binary Modulation Techniques: BFSK, Differential phase shift keying – Comparison of binary and quaternary modulation techniques – Introduction to M – ary Modulation techniques – Synchronization: Carrier and symbol synchronization - Applications.

Unit IV	ERROR CONTROL CODING	9	0	0	9

Rationale for coding and types of codes - Discrete memory less channels – Linear block codes - Cyclic codes - Cyclic redundancy check codes - Convolutional codes – Maximum likelihood decoding of convolutional codes-Viterbi Algorithm - Trellis coded Modulation - Maximum length and Gold codes.

Unit V	SPREAD SPECTRUM MODULATION AND MULTIPLE ACCESS TECHNIQUES	9	0	0	9

Pseudo-Noise sequences – A notion of spread spectrum – Direct sequence spread spectrum with coherent binary phase shift keying – Signal space Dimensionality and processing gain –Probability of error – Frequency Hop Spread Spectrum (FHSS) - Applications --Multiple Access Techniques: TDMA , FDMA, CDMA and SDMA.

Total (45L)= 45 periods

Text Books:

1.	Simon Haykins, "Digital Communications" John Wiley, 2017.
2.	Theodore S.Rappaport , "Wireless Communications :Principles and Practice", 2nd Edition.", Pearson,2012.

Reference Books:	
1.	Taub & Schilling, "Principles of Digital Communication", 28th reprint , Tata McGraw-Hill, 2014.
2.	R.N.Mutagi,"Digital Communication", 2nd Edition, Oxford University Press, 2013
3.	Dennis Roddy, John Coolen,"Electronic Communications", 10th impression, Pearson Prentice Hall, 2013.
4.	John G.Proakis, "Digital Communication", 3rd Edition, Tata McGraw-Hill, 1995.
E-References:	
1.	http://www.nptelvideos.in/2012/11/communication-engineering.html
2.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-973-communication-system-design-spring-2006/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the concept of pulse code modulation and analyze the sampling process and the performance of various estimation and filters technique	Understanding
CO2	:	Able to analyse the baseband system using eye patterns.	Applying
CO3	:	Able to analyse the pass band digital modulation schemes for particular	Applying
CO4	:	Design digital communication system for error free communication.	Analysing
CO5	:	Understand the concept of secured communication and multiple access techniques	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO2	PSO3
CO1	2	2	2	2	1	-	-	-	-	-	-	-	2	-	2
CO2	2	1	1	2	1	-	-	-	-	-	-	-	1	-	2
CO3	1	1	1	1	1	-	-	-	-	-	-	-	1	-	1
CO4	2	1	1	1	1	-	-	-	-	-	-	-	2	2	2
CO5	2	1	1	1	1	-	-	-	-	-	-	-	2	-	1
Avg	1.8	1.2	1.2	1.4	1	-	-	-	-	-	-	-	1.6	2	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC502	DIGITAL SIGNAL PROCESSING			SEMESTER V			
PREREQUISITES:			CATEGORY	PC	Credit		3
			Hours/Week	L	T	P	T
				3	0	0	3
1.	Signals and Systems						
Course Objectives:							
1.	To analyse the Discrete Fourier Transform, Fast Fourier Transform algorithms.						
2.	To design and realize IIR FIR filters to understand finite word length effects on digital filters.						
3.	To gain knowledge of DSP architecture, Programming and concepts of Multi rate signal processing.						
Unit I	**DISCRETE FOURIER TRANSFORM**			**9**	**0**	**0**	**9**
Introduction to DFT–Properties of DFT-Circular convolution -FFT algorithms–Radix-2 FFT algorithms Decimation in Time and Decimation in Frequency algorithms.							
Unit II	**INFINITE IMPULSE RESPONSE FILTER DESIGN**			**9**	**0**	**0**	**9**
Characteristics of Analog Butterworth filter-Chebyshev filter-Low pass filter, High pass filter, Band pass filter and Band stop filter-Transformation of analog filters in to equivalent digital filters using bilinear transformation method -Realization structure for IIR filters-Direct form-Cascade form-Parallel form.							
Unit III	**FINITE IMPULSE RESPONSE FILTER DESIGN**			**9**	**0**	**0**	**9**
Linear phase response of FIR filter - FIR design using window method: Rectangular, Hamming, Hanning and Blackman Windows - Realization structures for FIR filters - Linear phase structures and Direct form structure-Comparison of FIR and IIR filters.							
Unit IV	**FINITE WORD LENGTH EFFECTS**			**9**	**0**	**0**	**9**
Representation of numbers-Quantization by truncation and rounding– Derivation for quantization noise power–co-efficient quantization error – Product quantization error – Round off noise power - Limit cycle oscillations due to product round off and over flow errors –scaling to prevent overflow.							
Unit V	**DSP APPLICATIONS AND DIGITAL SIGNAL PROCESSOR**			**9**	**0**	**0**	**9**
Introduction to MultiRate signal processing: Decimation, Interpolation-Introduction to DSP TMS320C54X processor: Architecture- Instruction set-Addressing modes – programming .							
							Total (45L)= 45 periods

Text Books:	
1.	S.K.Mitra, “Digital Signal Processing, A Computer Based approach”,4th Edition,McGraw-Hill,2013.
2.	John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, 5th Edition,Pearson Education, 2022.
Reference Books:	
1.	Emmanuel C. I feacher, Barry W.Jervis,“Digital Signal Processing :A Practical Approach ”,2ndEdition, Pearson Education, 2004.
2.	A.V. Oppenheim, R.W.Schaferand J.R. Buck,“Discrete-TimeSignalProcessing”,3rdEditionPrenticeHall,
3.	L.R.Rabinerand B. Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall, 1992.
4.	J.R.Johnson, “Introduction to Digital Signal Processing”, Prentice Hall,1992.
E-References:	
1.	https://www.coursera.org/learn/dsp
2.	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/
3.	www.nptelvideos.in/2012/12/digital-signal-processing.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse the need for Discrete Fourier Transform, Fast Fourier Transform algorithms in digital signals & systems.	Analysing
CO2	Design and realize IIR filters	Creating
CO3	Design and realize FIR filters	Creating
CO4	Analyse finite Word length effect on filters.	Analysing
CO5	Apply the concepts of Multirate signal processing and gain the knowledge on DSP architecture and programming	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	1	-	-	-	-	-	-	-	1	1	1
CO2	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO3	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO4	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO5	1	1	1	1	1	-		-	-	-	-	-	2	2	1
Avg	2.6	2	1.6	1.6	1	-	1	-	-	-	-	-	1.2	1.2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC503	EMBEDDED SYSTEMS			SEMESTER		V
PREREQUISITES:		CATEGORY	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

1.	Microcontrollers

Course Objectives:

1.	To impart knowledge on embedded system architecture and embedded development strategies.
2.	To understand the bus communication in processors and peripheral interfacing.
3.	To understand basics of Real Time Operating Systems.

Unit I	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9**	**0**	**0**	**9**

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor and memory devices-DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

Unit II	**EMBEDDED NETWORKING**	**9**	**0**	**0**	**9**

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.

Unit III	**EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT**	**9**	**0**	**0**	**9**

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

Unit IV	**RTOS BASED EMBEDDED SYSTEM DESIGN**	**9**	**0**	**0**	**9**

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

Unit V	**EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT**	**9**	**0**	**0**	**9**

RFID Systems - GPS Navigation System - Automotive Application - Smart card System Application-ATM machine – Digital camera.

Total (45L)= 45 periods

Text Books:

1.	Peckol, "Embedded system Design", John Wiley & Sons,2010
2.	Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013

Reference Books:

1.	Shibu. K.V, "Introduction to Embedded Systems", 2e, Mcgraw Hill, 2017.
2.	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013
3.	Tammy Noergaard, ―Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4.	Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007.

E-References:

1.	https://lecturenotes.in/subject/225/embedded-system-es
2.	https://nptel.ac.in/courses/108102045/19
3.	https://www.coursera.org/learn/introduction-embedded-systems

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basics of embedded systems	Understanding
CO2	Study about the bus communication and peripheral interfacing	Remembering
CO3	Know about the embedded product development and modeling	Understanding
CO4	Acquire knowledge on Real time operating system	Understanding
CO5	Design and Analyze the real-time applications of embedded-systems	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	2	2	-	-	-	-	-	-	-	1	-	-
CO2	2	-	2	2	2	-	-	-	-	-	-	-	2	-	2
CO3	2	1	3	3	2	-	-	-	2	-	-	-	2	1	2
CO4	2	-	3	2	3	-	-	-	-	-	-	-	1	1	1
CO5	2	2	3	3	3	2	2	-	2	-	-	-	2	2	2
Avg	2	1.5	2.4	2.4	2.4	2	2	-	2	-	-	-	1.6	1.3	1.75
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECMG501	PRINCIPLES OF MANAGEMENT			SEMESTER V				
PREREQUISITES				**CATEGORY**	**HS**	**Credit**		**3**
				Hours/Week	**L**	**T**	**P**	**TH**
					3	**0**	**0**	**3**
Course Objectives:								
1.	To enable the students to study the evolution of Management							
2.	To study the functions and principles of management							
3.	To learn the application of the principles in an organization.							
4.	To emphasize the need for Data display recording and systems							
Unit I	**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**				**9**	**0**	**0**	**9**
Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.								
Unit II	**PLANNING**				**9**	**0**	**0**	**9**
Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.								
Unit III	**ORGANISING**				**9**	**0**	**0**	**9**
Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.								
Unit IV	**DIRECTING**				**9**	**0**	**0**	**9**
Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.								
Unit V	**CONTROLLING**				**9**	**0**	**0**	**9**
System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.								
								Total (45L)= 45 Periods

Text Books:	
1.	JAF Stoner, Freeman R.E and Daniel R Gilbert “Management”, 6th Edition, Pearson Education, 2004.
2.	Stephen P. Robbins & Mary Coulter, “Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.
Reference Books:	
1.	Harold Koontz & Heinz Weihrich, “Essentials of Management”, Tata McGraw Hill, 1998.
2.	Robert Kreitner & Mamata Mohapatra, “Management”, Biztantra, 2008.
3.	Stephen A. Robbins & David A. Decenzo& Mary Coulter, “Fundamentals of Management”, 7th Edition, Pearson Education, 2011.
4.	Tripathy PC & Reddy PN, “Principles of Management”, Tata Mcgraw Hill, 1999
E-References:	
1.	https://nptel.ac.in/courses/122108038/
2.	https://www.coursera.org/learn/fundamentals-of-management
3.	https://www.digimat.in/nptel/courses/video/110107150/L01.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling and have same basic knowledge on international aspect of management	Understanding
CO2	To have same basic knowledge on international aspect of management.	Remembering
CO3	To Gain Basic knowledge on international aspect of management.	Remembering
CO4	To help the students to develop cognizance of the importance of management principles.	Understanding
CO5	To enable them to analyze and understand the environment of the organization.	Analysing

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	-	-	-	-	-	-	-	1	2	3
CO2	3	3	3	3	3	-	-	-	-	-	-	-	2	2	3
CO3	3	2	3	2	3	-	-	-	-	-	-	-	1	2	3
CO4	3	1	2	1	3	-	-	-	-	-	-	-	1	3	2
CO5	3	1	2	1	2	-	-	-	-	-	-	-	1	3	3
Avg	3	2	2.6	2	2.8	-	-	-	-	-	-	-	1.2	2.4	2.8

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22MCIN04	IDEATION SPRINTS				SEMESTER V		
PRE-REQUISITE:		Category	EE	Credit			1
		Hours/Week	L	T	P	TH	
			0	0	2	2	

Course Objectives:	
1.	To offer a systematic and structured process to hack a solution using available tools & resources
2.	To identify the challenge/opportunity, derive insights from the customer/user interviews, & build a solution and validate the technical feasibility of the solution
3.	To build the PoC for proposed solution & pitch to user/customer for validation.

UNIT	TITLE	L	T	P	TH
UNIT I	**INNOVATION 101**	**0**	**0**	**6**	**6**
Difference between a startup and a small business enterprise - Idea worth prototyping -Risk of innovations - Defining &validating hypothesis through Product Innovation Hypothesis (PIH) & Forge Innovation Rubric (FIR)					
UNIT II	**PROBLEM VALIDATION & CUSTOMER DISCOVERY**	**0**	**0**	**6**	**6**
Tools and techniques of the managed innovation process (iTOOLS - innovation toolkit) -Customer-Centric Innovation: Customer-centric design thinking and validate the problem scenario, its significance, severity, and incidence - Discover & identify the right buyer beneficiary/Customer - rigorous Gap analysis of the existing solution - Adoption barriers of the solutions.					
UNIT III	**DESIGNING & CRAFTING VALUE PROPOSITION**	**0**	**0**	**6**	**6**
Understand Customer Jobs, Pains & gains - Design Product/Service - Define & quantify Value Proposition -Build a compelling value proposition.					
UNIT IV	**MUP SOLUTION CONCEPT EXPLORATION & DESIGN GENERATION**	**0**	**0**	**6**	**6**
Solution: Concept Generation, Concept Assessment, Solution, Capability, Usability, and Feasibility- MUP Design and Technology Block Diagrams- Bill of Materials Generation - BoM Optimization					
UNIT V	**PROOF OF CONCEPT DEVELOPMENT & DEMONSTRATION**	**0**	**0**	**6**	**6**
Proof-of-Concept design - hack to build PoC with critical features -Test PoC for technical feasibility test deliver of Value proposition - Innovation Brief documentation (Proposal) - Demonstrate a PoC;					
					Total (30P) = 30 Periods

Text Books:	
1.	Tim Brown, Change by Design:How design thinking transforms organizations and inspires innovation – HarperCollins e-books, 2009
2.	Alexander Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want (Strategyzer) - John Wiley & Sons, 2014
3.	Ulrich Karl and Eppinger Steven D, Product Design and Development - McGraw Hill, 5th edition, 2020
4.	Blank Steve, Four Steps to Epiphany: Successful strategies for products that win, KS Ranch, 5th edition, 2013
Reference Books:	
1.	Everything you need about value proposition: https://blog.forgeforward.in/everything-you-need-to-know-about-value-proposition-7247493c940c
2.	Test your Value Proposition:http://businessmodelalchemist.com/2012/09/test-your-value-proposition-supercharge-lean-startup-and-custdev-principles.html

3.	Valuation Risk versus Validation Risk in Product Innovations:https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624
4.	User Guide for Product Innovation Rubric:https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd
5.	Innovation Risk Diagnostic - Product Innovation Rubric:https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356
6.	Evaluating Product Innovations - proof, potential, & progress:https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Apply a scientific method to understand the inherent risks of product innovation	Applying
CO2	Apply innovation tools & techniques to validate the problem scenario and to assess the market potential of product innovation;	Applying
CO3	Design solution concept based on the proposed value by exploring various alternate solutions to achieve value-price fit;	Creating
CO4	Demonstrate technical skills by applying technology to build and demonstrate proof of concept for the solution proposed;	Creating
CO5	Develop skills to articulate the solution concept into a proposal for grants.	Creating

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	1	-	-	-	-	-	-	-	2	2	3
CO2	2	3	3	2	2	-	-	-	-	-	-	-	3	3	3
CO3	2	2	3	1	1	1	-	-	1	1	-	-	3	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
Avg	**2.4**	**2.8**	**2.8**	**1.8**	**1.8**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**2.8**	**2.6**	**2.8**
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC505	COMMUNICATION SYSTEMS LABORATORY	SEMESTER V				
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**4**	**4**

Course objectives:

1.	To make the students to understand the basics of analog and digital modulation techniques
2.	To deal with the different pulse modulation schemes.
3.	To simulate different modulation scheme using suitable tool.

EXPERIMENTS

1.	Generation and detection of AM signal
2.	Generation and detection of FM signal
3.	Pulse Amplitude Modulation
4.	Pulse Width Modulation
5.	Pulse Position Modulation
6.	Sampling and reconstruction of signals
7.	Digital Modulation Techniques: ASK, PSK, FSK, QPSK
8.	Delta and Adaptive Delta modulation
9.	Pulse Code Modulation
10.	Time Division Multiplexing and De multiplexing
11.	Simulation to generate various line codes
12.	Simulation and performance analysis of analog and digital modulation techniques .
	Total (60P)= 60 Periods

Text Books:

1.	S.Poorna Chandra, B.Sasikala, “Electronics Laboratory Primer”, S.Chand& Company Ltd, 2010.
2.	L.K. Maheshwari, M.M.S. Anand, “Laboratory Manual for Introductory Electronics Experiments”, New age International (P) Limited Publishers, 2010.
3.	Simon Haykin S., "Digital Communications Systems", 3rd Edition, John Wiley and Sons, 2013.

Reference Books:

1.	Simon Haykins, “Digital Communications” John Wiley, 2017.
2.	Taub & Schilling, “Principles of Digital Communication”, 28threprint , Tata McGraw-Hill, 2014.
3.	R.N.Mutagi,”Digital Communication”, 2nd Edition, Oxford University Press, 2013
4.	Dennis Roddy, John Coolen,”Electronic Communications”, 10th impression, Pearson Prentice Hall, 2013.

E-References:

1.	https://umairbfrend.files.wordpress.com/2015/01/analogue-digital-communication-manual_august-2015.pdf
2.	https://stannescet.ac.in/cms/staff/qbank/ECE/Lab_Manual/EC8561- COMMUNICATION% 20 SYSTEM %20 LABORATORY – 2062944779 – EC %20 8461 %20 communication %20 systems %20 manual.pdf
3.	www.vlab.co.in/ba-nptel-labs-electronics-and-communications

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Generate and analyse analog modulated signals.	Analysing
CO2	:	Generate and analyse pulse modulated signals.	Analysing
CO3	:	Understand the concept of sampling of signals and can generate and reconstruct various digital modulated signals.	Applying
CO4	:	Generate delta modulated waveforms and can Multiplex and de multiplex digital signals .	Applying
CO5	:	Write codes for generating line codes and to generate various analog and digital modulation schemes.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	2	1	2	-	-	-	-	-	-	1	2	2	2
CO2	1	2	2	1	2	-	-	-	-	-	-	1	1	2	2
CO3	1	2	2	1	2	-	-	-	-	-	-	1	2	2	2
CO4	1	2	2	1	2	-	-	-	-	-	-	1	1	2	2
CO5	2	2	2	1	2	-	-	-	-	-	-	1	2	2	2
Avg	1.2	2	2	1	2	-	-	-	-	-	-	1	1.6	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC506	DIGITAL SIGNAL PROCESSING LABORATORY	SEMESTER V			
PREREQUISITES		**CATEGORY**	**PC**	**Credit**	**2**
		Hours/Week	**L**	**T** / **P**	**TH**
1.Signals and Systems			**0**	**0** / **4**	**4**

Course objectives:	
1.	To implement basic signals operations using a software tool.
2.	To design FFT algorithms, IIR and FIR filters.
3.	To verify the various basic signal processing technique.
EXPERIMENTS	
1.	Generation of Signals
2.	Discrete-time convolution
3.	Circular convolution of two sequences
4.	Sampling and effect of aliasing
5.	Spectrum analysis using Discrete Fourier Transform
6.	Calculation of FFT of a signal using a) Decimation in time algorithm b) Decimation in frequency algorithm
7.	Design of FIR filters using a)Windowing technique b)Frequency sampling method
8.	Design of IIR digital filter using Bilinear transformation
9.	Design of IIR digital filter using Impulse invariant method
10.	Verification of BIBO stability of a system.
	Total (60P)= 60 Periods

Text Books:	
1.	Digital Signal Processing Using MATLAB, Vinay K.Ingle, John G.Proakis,Cent age learning, 3rd Edition,2012
2.	Sanjit K. Mitra,"Digital Signal Processing",3rd Edition, McGraw Hill Higher Education,2007.
Reference Books:	
1.	Simon Haykins, "Digital Communications" John Wiley, 2017.
2.	Taub & Schilling, "Principles of Digital Communication", 28threprint , Tata McGraw-Hill, 2014.
3.	R.N.Mutagi,"Digital Communication", 2nd Edition, Oxford University Press, 2013
4.	Dennis Roddy , John Coolen , "Electronic Communications", 10th impression, Pearson Prentice Hall, 2013.

E-References:	
1.	https://nptel.ac.in/courses/117102060/
2.	Studentsfocus.com/notes/anna_university/ECE/5SEM/EC6511%20%20DSP%20Lab/EC%206511%20DIGITAL%20SIGNAL%20PROCESSING%20LAB%20MANUAL_2013_regulation.pdf
3.	vlab.co.in/ba_nptel_labs.ph p? id =1

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Generate and analyse various signal processing algorithms.	Analysing
CO2	Implement FFT algorithms, Linear/Circular convolution.	Analysing
CO3	Design FIR filters.	Creating
CO4	Design IIR filters.	Creating
CO5	Verify and understand system stability.	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	3	-	-	1	-	1	-	-	1	1	1
CO2	3	3	1	1	3	-	-	1	-	1	-	-	1	1	1
CO3	3	3	2	2	3	-	-	1	-	1	-	-	1	1	1
CO4	3	3	2	2	3	-	-	1	-	1	-	-	1	1	1
CO5	3	3	2	2	3	-	-	1	-	1	-	-	1	1	1
Avg	3	3	1.6	1.6	3	-	-	1	-	1	-	-	1	1	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

PROTOSEM COURSES SYLLABUS

<table>
<tr><td>22PSPE01</td><td colspan="2">COMPUTATIONAL HARDWARE</td><td colspan="3">Semester</td><td>VI</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2"></td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To learn basic concepts of Embedded Systems by familiarizing the functionalities of embedded platforms with development boards.</td></tr>
<tr><td>2</td><td colspan="6">To understand the core concepts of GPIO Pins, Functionality of peripherals, Selection of I/O devices , Usage of Internal functions, and Communication protocols.</td></tr>
<tr><td>3</td><td colspan="6">To familiarize the current technologies and protocols used in the Internet of Things (IoT) and to learn the Cloud services.</td></tr>
<tr><td>Unit I</td><td colspan="2">BASICS OF EMBEDDED SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Embedded Platform: Architecture and working - Factors for Microcontroller/Microprocessor selection. Arduino - Boards and schematics – Toolchain - Setup and Configuration - Input/Output Configurations and Access - Libraries - Digital I/O - ADC - Analog I/O - Timers, Interrupts - Pulse Width Modulation - Display: 7-segment , LCD , OLED.</td></tr>
<tr><td>Unit II</td><td colspan="2">BASICS OF RASPBERRY PI</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Raspberry Pi: Raspberry pi Board - Processor - Setup and Configuration - Installing Python IDLE using Command Terminal - General Purpose I/O Pins - Protocol Pins - GPIO Access - Pulse Width Modulation - Network Libraries - Web services - Twitter APIs - Twitter Bot - Interfacing pi with camera modules.</td></tr>
<tr><td>Unit III</td><td colspan="2">SENSORS AND ACTUATORS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Interfacing of Sensors and Actuators - Sensors: Introduction, Characteristics: Analog - Potentiometer, Temperature Sensor, Soil Moisture Sensor, LDR - Digital - PIR Sensor, Smoke Sensor, Infrared - Sensor, Ultra- Sonic Sensor. Actuators - Introduction, Characteristics and working with relay, DC motors, Servo motor, Stepper motor and its drivers.</td></tr>
<tr><td>Unit IV</td><td colspan="2">COMMUNICATION PROTOCOLS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Protocols - Wired: RS232 Standard - UART, SPI, I2C - Comparative study of wired protocols - Implementation of wired Serial Communication protocols Wireless: Standards - Bluetooth, RF - Comparative study of wireless protocols - Implementation of wireless Serial Communication protocols.</td></tr>
<tr><td>Unit V</td><td colspan="2">INTERNET OF THINGS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Definition and Architecture of IoT, Building blocks of IoT, Programming with IoT protocols - MQTT, CoAP - Connecting embedded target board to Web, Basics networking in IoT: creating a web page - Creating a server on target board - Controlling I/O peripherals from the webpage, Embedded Application Development, Creating communication between different nodes - Cloud platforms for IoT, Cloud data logging and monitoring, Interfacing with web services.</td></tr>
<tr><td colspan="7" align="right">Total = 45 Periods</td></tr>
</table>

Text Books:	
1	Raj Kamal, “ Embedded Systems - SoC, IoT, AI and Real-Time Systems”, 4th Edition, McGraw Hill, 2020.
2	Mohit Arora, “Embedded System Design”, 1st Edition, Learning Bytes Publishing, 2016.
3	Elecia White, “Making Embedded Systems”, 1st Edition, Shroff/ O’ Reilly, 2012.
4	Jack Ganssle, “ The Firmware Handbook”, 1st Edition, Newnes, 2004.

Reference Books:	
1	https://juniorfall.files.wordpress.com/2011/11/arduino-cookbook.pdf
2	https://drive.google.com/file/d/13s0m3lHPEFP2f2aCuVNRWeBZNKXWKTW5/view?ts=6231cab 3
3	https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia_DigitalV2_2.pdf 4.
4	https://www.riverpublishers.com/pdf/ebook/RP9788793519046.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand and implement the functions & Capabilities of embedded platforms for easy prototyping.	L2: Understanding
CO2	Identify the type of sensors and actuators for required applications.	L3: Applying
CO3	Develop communication between devices using different protocols.	L3: Applying
CO4	Develop IoT based systems with wireless network connections and accessing devices over cloud.	L3: Applying

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3								3	2	2
CO2	3	3	2	2	2								3	2	2
CO3	3	2	3	2	3								3	3	3
CO4	3	2	3	2	3								3	3	3
AVG	**3**	**2.25**	**2.75**	**2**	**2.75**								**3**	**2.5**	**2.5**

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22PSPE02	CODING FOR INNOVATORS			Semester		VI
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To learn and express creativity using coding skills.
2	To gain knowledge of Python programming with hands-on experience.
3	To demonstrate a problem solving using OOPs concepts.
4	To learn basics of Linux by familiarizing the concepts of management and file structure.
5	To practise full stack development using cloud platform.

Unit I	**PROGRAMMING PARADIGMS**	**9**	**0**	**0**	**9**
Need for programming - Outside box thinking to solve problems - Need for algorithms and data structures - Flowcharts & Algorithms - Memory Allocation - Conditions and loops - Creating effective functions - Case studies - Visual Programming - Types of programming languages & paradigms - Getting started with development - Build & test an algorithm - best practices					
Unit II	**BASIC OF PROGRAMMING**	**9**	**0**	**0**	**9**
Introduction to Python: statements, variables, functions, operators, modules, conditional statements, loop statements, Lists: list operations, traversing a list, slicing a list - Text Handling: Strings, string functions, conversion functions, Dictionaries - File Operations: File open, close, read, copy, word frequency, creating word histograms from text file.					
Unit III	**OOPS 5**	**9**	**0**	**0**	**9**
OOPS- Why OOPS- verticals- implementation in python - Classes and Objects, Methods, Constructors and Destructors, Inheritance, Polymorphism, Abstraction, Encapsulation.					
Unit IV	**SOFTWARE DEVELOPMENT TO DELIVERY**	**9**	**0**	**0**	**9**
Software Engineering - Life Cycle (Tools), Agile Methodologies - Framework - Why Frameworks - Software Testing(Tool Based) - Data Structures - Database Management System - A case study to experiment from Development to Deployment(D2D) - Source code management and version control - GitHub - GitHub Actions - GitBash - Continuous Integration - Platform as service - Heroku - Build Packs AWS- Anaconda					
Unit V	**OPERATING SYSTEMS**	**9**	**0**	**0**	**9**
Introduction to Linux - Process Management - Process Scheduling - Memory Management - Storage Management - System calls - File System Structure - Multithreading - Multicore Programming - Deadlock Handling - Disk Structure - Disk Management - Dockers - Kubernetes					
					Total = 45 Periods

Text Books:	
1	Zed A. Shaw, “Learn Python 3 the Hard Way”, 3rd edition, Addison-Wesley Professional, 2013.
2	Silberschatz Abraham, “Operating System Concepts”, 9th edition, John Wiley & Sons Inc (Sea)Pte Ltd, 2016.
3	Paul Barry, "Head-First Python", 2nd edition, O'Reilly Media, Inc, 2016.
4	Anton Spraul, “Think Like a Programmer”, 1st edition, No Starch Press, 2012.

E-References :	
1	https://www.geeksforgeeks.org/python-programming-language/
2	https://www.guru99.com/python-tutorials.html
3	https://www.tutorialspoint.com/python/python_tutorial.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the aspects of programming protocols	L2: Understanding
CO2	Develop optimized code for real-world problems	L3: Applying
CO3	Build full-stack development to deployment	L3: Applying
CO4	Demonstrate problem solving and continuous development	L2: Understanding

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
CO1	2	2	2	1	3								2	1	1
CO2	3	3	3	2	3								3	2	2
CO3	3	2	3	1	3								3	2	2
CO4	2	3	2	1	2							3	2	1	1
AVG	**2.5**	**2.5**	**2.5**	**1.25**	**2.75**							**3**	**2.5**	**1.5**	**1.5**

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22PSPE03	INDUSTRIAL AUTOMATION				Semester		VI
PREREQUISITES			Category	PE	Credit		3
			Hours/Week	L	T	P	TH
				3	0	0	3

Course Learning Objectives

1	Acquire conceptual knowledge in Industrial Controllers by scaling of on-board devices and embedded board interfacing with various I/O peripherals.
2	Learn PLC by working on internal features and also interfacing with Sensors and actuators along HMI concept using SCADA and standard communication protocols.
3	To work with FPGA boards and RT controllers for reprogrammable embedded applications using LabVIEW
4	Understand the concepts and design electronics circuits

Unit I	INDUSTRIAL CONTROLLERS - I	9	0	0	9

Industrial Controllers - Introduction to RIO Controllers - Platform - Connection and Configuring controllers - Accessing onboard devices - Module SOM - Interfacing with Input and Output devices - Interfacing protocol based Analog and Digital sensors - Acquiring and Data Logging from sensors - Interfacing Actuators: Relay, DC Motor, Servo Motor - Creating standalone applications

Unit II	INDUSTRIAL CONTROLLERS - II	9	0	0	9

Industrial Controllers - II - PLC - Introduction - Mode of Operation - IEC 61131 Programming languages for PLC - Programming & sequence control - Instruction set - Scan Time - Timers - Counters - Interfacing with Input/Output devices - Interfacing with Sensors - Interfacing with Actuators - Interfacing with Human Machine Interface - Commissioning and operational safety of PLC - SCADA

Unit III	INDUSTRIAL COMMUNICATION PROTOCOLS	9	0	0	9

Serial Communication Protocols - I2C, SPI - Serial Field bus protocols CAN, PROFIBUS - Ethernet, HTTP, TCP/UDI, WiF, Cloud data logging. Multi-sensor communication, Data parsing between Embedded platforms. Comparative study of Industrial communication protocols - Implementation of Industrial Communication protocols.

Unit IV	FPGA AND RT CONTROLLER PROGRAMMING	9	0	0	9

Introduction to FPGA - Architecture - Operations in FPGA programming - FPGA Programming in LabVIEWand implementation in myRIO - Introduction to RT controllers - Architecture - Programming RT Controllers - Creating standalone applications.

Unit V	INDUSTRIAL CIRCUIT BOARD DESIGN	9	0	0	9

Designing basics circuits and to simulate in environment setup - Component selection - Creating libraries- Schematic design - Design rules, supply & communication track rules - Component and footprint editor -Understanding component package types - Test point creation for measurement - PCB Layout,placement rules - Footprint, 3D models, BoMs - Generating GERBER and output documentation

Total = 45 Periods

Text Books:	
1	Ed Doering, NI myRIO Project Essential Guide, National Instruments, 2016.
2	Willian Bolton, Programmable Logic Controllers, 6th edition, Newnes Publications, 2015
3	Richard Zurawski, Industrial Communication Technology Handbook, Second edition, CRC Press, 2014
4	Simon Monk, Make Your Own PCBs with EAGLE, McGraw Hill Education, 2014.
References Books:	
1	Jeffrey Travis, Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun,3rd edition, Prentice Hall
2	Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing,Fourth edition, Pearson Education, 2016
3	Michael J. Hamill, Industrial Communications and Control Protocols, PDH centre, 2016
4	Ema Design Automation, The Hitchhiker's Guide to PCB Design, First edition, Blurb Publishers,December 2021

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the usage of controllers in an industrial environment	L2: Understanding
CO2	Build Real-Time systems for Industrial embedded monitoring and controlling deterministic applications	L3: Applying
CO3	Communicate between devices at different levels using industrial protocols	L3: Applying
CO4	Understand the process involved in PCB design using EDA tools and fabricate it	L2: Understanding

COURSE ARTICULATION MATRIX

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	3								3	2	2
CO2	3	3	3	2	3								3	3	3
CO3	3	2	3	2	3								3	3	3
CO4	3	2	3	2	3								3	3	2
AVG	3	2.25	2.75	1.75	3								3	2.75	2.5

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22PSOE01	APPLIED DESIGN THINKING			Semester		VI
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	The course enables product innovators and early-stage startup founders to learn the customer development process
2	To familiarize with the tools & techniques & validate the inherent risks by linking their progress to customer-motivation, customer-commitment & customer-acceptance.
3	To learn the system thinking concepts by reverse engineering technique.

Unit I	**DESIGN THINKING PRINCIPLES**	**9**	**0**	**0**	**9**

Exploring Human – Centered Design – Understanding the innovation process, discovering areas of opportunity, interviewing &empathy –building techniques, Mitigate validate risk with FIR(Forge Innovation Rubric) – Case Studies.

Unit II	**CUSTOMER-CENTRIC INNOVATION**	**9**	**0**	**0**	**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**	**0**	**0**	**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**	**0**	**0**	**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 technology alternatives and the solution concepts.

Unit V	**SYSTEM THINKING & REVERSE ENGINEERING**	**9**	**0**	**0**	**9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems, Reverse Engineering Methodology, Identify building blocks/Components – Re-Engineering a complex system.

Total = 45 Periods

Text Books:

1	Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2	Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3	Proposition Design: How to Create Products and Services Customers Want, Wiley
4	Donella H. Meadows, (2015), “Thinking in Systems -A Primer”, Sustainability Institute.
5	Tim Brown,(2012) “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Business.

Reference Books:	
1	https://www.ideou.com/pages/design-thinking#process
2	https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624
3	https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356
4	https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e
5	https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd6
6	https://blog.forgeforward.in/startup-failure-is-like-true-lie-7812cdfe9b85

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Define & treat various hypotheses to mitigate the inherent risks in product innovations	L1: Remembering
CO2	Design the solution concept based on the proposed value by exploring various alternate solutions to achieve value-price fit.	L6: Creating
CO3	Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching.	L3: Applying
CO4	Apply system thinking to reverse engineer a product/prototype and understand its internal correlations.	L3: Applying

COURSE ARTICULATION MATRIX

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	2	3	2	1	1	1	1	1	1	1	2	2	3
CO2	2	2	3	2	2	1	1	1	1	1	1	1	3	3	2
CO3	1	2	2	1	1	3	1	1	3	3	1	1	1	1	1
CO4	2	3	3	3	3	2	2	1	2	2	1	1	3	3	3
AVG	**1.75**	**2.5**	**2.5**	**2.25**	**2**	**1.75**	**1.25**	**1**	**1.75**	**1.75**	**1**	**1**	**2.25**	**2.25**	**2.25**

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22PSOE02	STARTUP FUNDAMENTALS				Semester		VI
PREREQUISITES		Category	OE	Credit			3
		Hours/Week	L	T	P		TH
			3	0	0		3

Course Learning Objectives

1	Learn the science of to transforming an innovative idea into high-growth enterprises.
2	To understand the basic concepts of IPR, and develop a patent draft for a potential IP

Unit I	ENTREPRENEURIAL MINDSET & METHOD	9	0	0	9
Introduction to Innovation-led, tech-powered entrepreneurship - Understand from research the attributes of an expert entrepreneur - Effectuation principles - Dealing with the unknowns - Case studies of startup failures.					
Unit II	**IDEA TO ENTERPRISE**	**9**	**0**	**0**	**9**
Design and Planning of Product Concept - Business Model - Business Planning - Building Proof of Product and Value Testing - Target Market and Revenue Planning					
Unit III	**MINIMUM VIABLE BUSINESS**	**9**	**0**	**0**	**9**
Framework for Minimum Viable Business - Disruptive Innovation - Theory of Disruption - Competitive advantage - Building proof of viable business model - Demystifying Scalability - Funding Opportunities					
Unit IV	**INTELLECTUAL PROPERTY**	**9**	**0**	**0**	**9**
Introduction and the need for Intellectual Property Rights - IPR Genesis and Development - Copyright - Trademark - Trade Secret - Geographical Indicators - Industrial Designs - Types of Patent – Sample Patent Application - IPR in INDIA; Global trends - Patent fees					
Unit V	**PRIOR ART SEARCH AND PATENT DRAFTING**	**9**	**0**	**0**	**9**
Prior Art Search - IP Licensing – IP Commercialization - IP Infringement- Case Study on Apple vsSamsung, Case study on basmati rice. The invention as a concept - Keywords formation - Structure of patent - Key attributes in patent drafting -Drafting provisional specifications - Drafting complete specifications - Draft claims - Case studies onpatent drafting					
					Total = 45 Periods

Text Books:

1	Steven Blank and Bob Dorf, (2012), The Startup Owner’s Manual: The Step-by-Step Guide for Building a Great Company, K&S Ranch
2	Dr Saras Sarasvathy, (2008), Effectuation: Elements of Entrepreneurial Expertise, New Horizons in Entrepreneurship series.
3	Elizabeth Verkey, (2005), Law of Patents, Eastern Book Company
4	Prabuddha Ganguli, (2017), Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education; 1st edition

Reference Books:	
1	WIPO Intellectual Property Handbook https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
2	https://assets.entrepreneur.com/static/20220301113822-Marketing.pdf
3	https://www.deluxe.com/blog/startup-fundamentals-guide/
4	https://www.forbes.com/sites/allbusiness/2018/07/15/35-step-guide-entrepreneurs-starting-a-business/?sh=69a6031e184b

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Develop an entrepreneurial mindset to identify, assess, shape & act on opportunities.	L3: Applying
CO2	Demonstrate the potential of an innovative idea to create economic value, as a startup	L2: Understanding
CO3	Understand the scientific process to explore a viable business model	L2: Understanding
CO4	Demonstrate knowledge on the fundamental concepts of Intellectual Property	L2: Understanding

COURSE ARTICULATION MATRIX

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	2	1	1	2	1	2	2	2	3	3	1	1	2
CO2	2	2	3	1	1	1	1	2	2	1	3	2	2	2	2
CO3	1	2	2	2	1	1	1	1	1	1	3	2	1	1	1
CO4	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
AVG	**1.25**	**1.75**	**2**	**1.25**	**1**	**1.25**	**1**	**2**	**1.5**	**1.25**	**2.5**	**2**	**1.25**	**1.25**	**1.5**

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22PSOE03	PROTOTYPE DEVELOPMENT			Semester		VI
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	Learn to design a UI/UX design and develop an android application.
2	Provide working CAD model for prototype development.
3	Knowledge in hardware, 3D Printers and Laser cutters.
4	Acquire basic knowledge in designing electrical circuits and fabrication of electronic devices.

Unit I	UI/UX	9	0	0	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 - Colour theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

Unit II	APP DEVELOPMENT	9	0	0	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	0	0	9

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation - Assembly - Product design and rendering basics - Dimensioning & Tolerancing

Unit IV	MECHANICAL RAPID PROTOTYPING	9	0	0	9

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - **Mechanical Prototyping:** 3DPrinting and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

Unit V	ELECTRICAL RAPID PROTOTYPING	9	0	0	9

Electronic Prototyping: 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, TASCHEN America Llc(2003)
2	Samar Malik, Autodesk Fusion 360 - The Master Guide.
3	Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition (2014)

E - References:

1	https://www.adobe.com/products/xd/learn/get-started.html
2	https://developer.android.com/guide
3	https://help.autodesk.com/view/fusion360/ENU/courses/
4	https://help.prusa3d.com/en/category/prusaslicer_204

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Level
CO1	Create quick UI/UX prototypes for customer needs	L6: Creating
CO2	Develop web application to test product traction / product feature	L3: Applying
CO3	Develop 3D models for prototyping various product ideas	L3: Applying
CO4	Built prototypes using Tools and Techniques in a quick iterative methodology	L3: Applying

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	3				1	1			2	1	1
CO2	3	3	3	2	3				1	1			3	2	2
CO3	3	2	3	2	3				1	1			3	2	2
CO4	3	2	3	2	3				1	1			3	2	2
AVG	**2.75**	**2.25**	**3**	**2**	**3**				**1**	**1**			**2.75**	**1.75**	**1.75**

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

22PSEE01	ROBOTICS				Semester		VI
PREREQUISITES			**Category**	**EE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				0	**0**	**6**	**3**

Course Learning Objectives

1	Learn the fundamentals of ROS
2	Understand the requirements and choose the right sensors and actuators for the application development
3	Create Bot in the virtual environment and simulate it to know the functionalities of the system developed
4	Learn the basics of Robotics Vision System
5	Integrate ROS and Computer Vision to build systems for various use cases

Unit I	**INTRODUCTION TO ROBOT KINEMATICS**	**9**	**0**	**0**	**9**

Introduction to Robotics - Transformations - Forward Kinematics - Kinematics equations - Link transformations - Inverse Kinematics - Kinematic analysis - Numerical Inverse Kinematic Solutions - Analytical Inverse Kinematic Solutions

Unit II	**SELECTION OF SENSORS AND ACTUATORS**	**9**	**0**	**0**	**9**

Introduction - Sensors & Actuators - Types - Selection criteria - Design considerations: Motor sizing - Selection of motors based on torque and speed characteristics - Hardware Interface & Assembly

Unit III	**INTRODUCTION TO ROBOT OPERATING SYSTEM**	**9**	**0**	**0**	**9**

Introduction to ROS framework and prerequisites - Understanding communications in ROS - ROS Ecosystem - Introduction to ROS programming - ROS nodes, topics, messages - ROS services - ROS Tools and Utilities - URDF , Rviz - Simulation - Gazebo - ROS Motion

Unit IV	**INTRODUCTION TO ROBOTICS VISION SYSTEM**	**9**	**0**	**0**	**9**

Image basics - Image Processing - Histograms - Gray scale, Color, Equalization - Smoothing andblurring/filtering - Averaging, Gaussian, Median, Bilateral - Thresholding - Simple, Adaptive, Otsu -Gradients and Edge detection - Laplacian, Sobel, Canny - Contours - Camera calibration

Unit V	**INTEGRATION OF ROS AND COMPUTER VISION**	**9**	**0**	**0**	**9**

Introduction - Installation - CV Bridge - Image publisher node - Image subscriber node - Nodes buildingand launching - Building real world applications

Total = 45 Periods

Text Books:

1	Introduction to Robotics: Mechanics and Control by John J Craig, Pearson Publishers.
2	Robot Operating System (ROS) for Absolute Beginners by Lentin Joseph, A press; Publishers (2018).
3	Learning OpenCV by Gary Bradski, Adrian Kaehler, O'Reilly Media, Inc.

Reference Books:

1	https://www.intechopen.com/chapters/379
2	https://www.plantengineering.com/articles/eight-selection-criteria-for-actuation-components/
3	https://www.controleng.com/articles/tips-on-sensor-selection/
4	https://www.toptal.com/robotics/introduction-to-robot-operating-system

5	https://www.thomasnet.com/articles/automation-electronics/machine-vision-systems/
6	https://automaticaddison.com/working-with-ros-and-opencv-in-ros-noetic/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand kinematics considerations of robot	L2: Understanding
CO2	Selection of sensors and actuators according to application	L3: Applying
CO3	Utilize the ROS environment to simulate and communicate between robot	L3: Applying
CO4	Develop algorithms to extract features and data from image	L3: Applying
CO5	Utilize the open CV for robotic applications	L3: Applying

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	2								3	3	2
CO2	3	3	2	1	2								3	3	3
CO3	3	2	3	2	3								3	3	3
CO4	3	3	3	2	3								3	3	2
AVG	**3**	**2.5**	**2.75**	**1.5**	**2.5**								**3**	**3**	**2.5**

3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**

SEMESTER VII

22EC701	VLSI DESIGN			SEMESTER VII			
PREREQUISITES:		CATEGOR	PC	Credit		3	
		Hours/Week	L	T	P	TH	
			3	0	0	3	

Course Objectives:	
1.	To understand the concepts of MOS transistors operations and their AC and DC characteristics.
2.	To understand the fabrication process of CMOS technology and its layout design rules.
3.	To design Data path systems and Subsystems using Verilog HDL and Learn FPGA architectures

Unit	Title	L	T	P	TH
Unit I	**MOS TRANSISTOR THEORY**	**9**	**0**	**0**	**9**
NMOS, PMOS Enhancement transistor - Threshold voltage - Body effect – MOS device: Basic DC equations - Channel length modulation - Mobility variation - MOS models - Small signal AC characteristics Complementary CMOS inverter: DC characteristics - Noise Margin - Rise time - Fall time – Power dissipation Transmission gate – Stick diagram – Layout diagram.					
Unit II	**CMOS TECHNOLOGY**	**9**	**0**	**0**	**9**
An overview of Silicon semiconductor technology - Basic CMOS technology: n-well - P well - Twin tub and SOI Process – CMOS process enhancements: Interconnects - Circuit elements: Resistors – Capacitors - Electrically Alterable ROMs - Bipolar transistors - Latch up and its prevention techniques.					
Unit III	**DATA PATH SYSTEMS AND ARRAY OF SUBSYSTEMS**	**9**	**0**	**0**	**9**
Data path Subsystems: Addition/Subtraction - One/Zero Detectors – Comparators – Counters - Multiplication - Array Subsystems: SRAM – DRAM - Read-Only Memory.					
Unit IV	**VERILOG HARDWARE DESCRIPTION LANGUAGE**	**9**	**0**	**0**	**9**
Basic Concepts: VLSI Design flow - Modules and ports - Switch level modelling - Gate level modelling – Data flow modelling – Behavioral modelling - Structural gate level description of decoder - Equality detector – Comparator - Priority encoder - D-flip flop - Half adder - Full adder - Ripple Carry Adder.					
Unit V	**CMOS CHIP DESIGN**	**9**	**0**	**0**	**9**
ASIC design flow - CMOS chip design options: Full custom ASIC - Standard Cell based ASIC - Gate Array based ASIC - Channelled - Channel less and structured GA - Programmable logic structures; Programming of PALs - Programmable Interconnect - Reprogrammable GA - Need for CMOS testing.					
					Total (45L)= 45 periods

Text Books:	
1.	Neil H. E. Weste & David Money Harris, “CMOS VLSI Design Circuits and System perspective “, 2nd Edition, Pearson Education, 2016
2.	Samir Palnitkar: “Verilog HDL” A Guide to Digital Design and Synthesis”, 2nd Edition, Pearson Education, 2012.
Reference Books:	
1.	Douglas.A.Puchnell, Kamran Eshraghian, “’Basics VLSI Design and Circuits”, 3rd Edition, Prentice Hall India 2011.
2.	M.J.S .Smith, “Application - Specific Integrated Circuits”, Pearson Education, 2009.
3.	V.G.Kirankumar, H.R.Nagesh, ”Introduction to VLSI Design”, Pearson Education, 2011
4.	Wayne Wolf, “ Modern VLSI Design”, Pearson Education, 2003.
E-References:	
1.	https://freevideolectures.com/Subject/VLSI-and-ASIC-Design 2. 3.
2.	https://www.tutorialspoint.com/vlsi_design/vlsi_design_useful_resources.html

3.	https://nptel.ac.in/courses/117101058

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the concept of MOS transistors, use analytical methods and circuit analysis models in analysis of CMOS circuits.	Applying
CO2	Understand the CMOS process technology and design layout diagrams.	Understanding
CO3	Able to learn and design data path systems and array of subsystems.	Applying
CO4	Model the digital system using Verilog Hardware Description Language and	Applying
CO5	Learn FPGA architectures and need for CMOS testing.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO4	2	1	-	2	3	-	-	-	-	-	-	-	1	2	1
CO5	-	-	2	2	-	-	-	-	-	-	-	-	-	2	1
Avg	1.75	1	2	2	3	-	-	-	-	-	-	-	1	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC702	WIRELESS AND MOBILE COMMUNICATION					SEMESTER VII		
PREREQUISITES			CATEGORY	PC	Credit		3
			Hours/Week	L	T	P	T
1.	Digital Communication			3	0	0	3

Course Objectives:	
1.	To make the students understand the basics of wireless and mobile communication
2.	To understand the basics and design if cellular system.
3.	To have an insight into the various propagation models and the speech coders used in mobile communication

Unit I	**INTRODUCTION AND MODERN WIRELESS COMMUNICATION SYSTEMS**	**9**	**0**	**0**	**9**
Introduction to wireless communications - History and evolution – Mobile radio system around the world – Examples of common wireless communication systems - Trends in cellular radio and personal communications - Modern wireless communication systems: 2G Cellular networks – 3G wireless networks - 4G mobile web access - 5G faster wireless network - Wireless network standards.					
Unit II	**THE CELLULAR CONCEPT: SYSTEM DESIGN FUNDAMENTALS AND MODULATION TECHNIQUES FOR MOBILE RADIO**	**9**	**0**	**0**	**9**
Frequency reuse - Channel Assignment strategies - Handoff strategies - Interference and system capacity -Trunking and grade of service - Improving coverage and capacity in cellular systems - Modulation: Combined linear and Constant envelope modulation techniques: Mary PSK, M_ ary QAM, M _ ary FSK and OFDM.					
Unit III	**MOBILE RADIO PROPAGATION:LARGE SCALE PATH LOSS**	**9**	**0**	**0**	**9**
Introduction to Radio wave propagation - Free-space propagation model - 3 basic propagation mechanisms and models: reflection - Ground reflection model – Diffraction - Knife-edge diffraction model -Scattering – radar cross section model - Practical Link budget design using path loss models - Outdoor propagation models - Indoor propagation models					
Unit IV	**MOBILE RADIO PROPAGATION:SMALL-SCALE FADING AND MULTIPATH FADING**	**9**	**0**	**0**	**9**
Small-Scale fading: Small scale multipath propagation - Impulse response model of a multipath channel - Small-scale multipath measurements - Parameters of mobile multipath channels – Types of small-scale fading- Introduction to shape factors: Angular spread - Angular constriction - Azimuthal Direction of maximum fading.					
Unit V	**EQUALISATION,DIVERSITY AND CHANNEL CODING**	**9**	**0**	**0**	**9**
Equalisation: Fundamentals – Training a generic adaptive equalizer – Equalizers in a communication receiver -Survey of equalization - Linear equalizers - Nonlinear equalization - Algorithms for adaptive equalization – Diversity: Practical Space Diversity Considerations - Polarization diversity -Frequency diversity -Time diversity - RAKE receiver – coding: Speech coding – Vocoders - LPC-Choosing Speech Codecs for Mobile communication - GSM codec - USDC codec.					
					Total (45L) = 45 periods

Text Books:	
1.	Theodore S.Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition", Person, 2012.
2.	Simon Haykin, "Digital Communications" Student Edition, John Wiley & sons, 2008.
Reference Books:	
1.	A.Molisch, wiley, "Wireless Communications", 2nd Edition, 2010.
2.	V.K.Garg, "Principles and Applications of GSM", Person Edtion.

3.	V.K. Garg, "IS-95 CDMA and CDMA 2000", Person Edition.
4.	S.Haykins, "Communication Systems", 5th Edition , John wiley, 2008.

E-References:

1.	https://www.pdfsdownload.com/download-pdf-for-free/wireless+communication+rappaport
2.	https://www.oreilly.com/library/view/wireless-communications-principles/0130422320/
3.	https://en.wikipedia.org/wiki/Adaptive_equalizer

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Characterize a wireless channel and evolve the system design specifications and understand the difference between wireless compared to wired counterpart.	Understanding
CO2	:	Design a cellular system, with improved coverage and capacity with the cell structure based on the resource availability and traffic demands and able to calculate interference.	Applying
CO3	:	Identify various propagation effects and calculate large scale path loss.	Applying
CO4	:	Analyze small scale and multipath fading in mobile environment.	Understanding
CO5	:	Exploit multiple antenna techniques for capacity / performance gains and design equalizer.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	1	2	1	-	-	-	-	-	-	-	1	2	1
CO2	2	1	2	2	1	-	-	-	-	-	-	-	1	2	2
CO3	1	1	1	1	1	-	-	-	-	-	-	-	1	2	1
CO4	1	1	2	1	1	-	-	-	-	-	-	-	1	2	1
CO5	1	1	1	1	1	-	-	-	-	-	-	-	1	2	1
Avg	1.25	1	1.4	1.4	1	-	-	-	-	-	-	-	1	2	1.2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC703	OPTICAL COMMUNICATION					SEMESTER VII	
PREREQUISITES		CATEGORY	PC	Credit			3
		Hours/Week	L	T	P		TH
1.	Digital Communication		3	0	0		3

Course Objectives:

1.	To learn the basic elements of optical fiber transmission link, fiber modes, configurations, and the structures.
2.	To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation
3.	To know about the various optical source materials, LED structures, Quantum efficiency, LASER diodes and fiber joining devices.

Unit I	INTRODUCTION TO OPTICAL FIBERS	9	0	0	9

Introduction - The General Systems - Advantages of Optical Fiber Communication- Ray Theory Transmission: Total Internal Reflection, Acceptance Angle, Numerical Aperture, Skew Rays - Electromagnetic Mode Theory for Optical Propagation: Modes in a Planar Guide, Phase and group velocity - Cylindrical Fiber: Step index fibers, Graded index fibers - Single mode fibers: Cutoff wavelength.

Unit II	SIGNAL DEGRADATION IN OPTICAL FIBERS	9	0	0	9

Attenuation: Absorption losses - Scattering losses - Bending Losses - Core and Cladding losses. Signal Distortion in Fibers: Intermodal delay- intramodal dispersion-Factors contributing to dispersion- Group Delay - Material Dispersion - Wave guide Dispersion – Signal distortion in single mode fiber-Bending loss.

Unit III	FIBER OPTICAL SOURCES AND COUPLING	9	0	0	9

Basics of semiconductor physics—LED: structures-light source materials-Quantum efficiency and LED power-LASER diodes: modes and threshold conditions-rate equations—external quantum efficiency-resonant frequencies-structures and radiation patterns - temperature effects. Coupling: Laser diode to fiber coupling-fiber to fiber joints-Fiber related losses-end face preparation—LED coupling to single mode fibers-fiber splicing-optical fiber connectors.

Unit IV	FIBER OPTICAL RECEIVERS AND DIGITAL TRANSMISSION SYSTEM	9	0	0	9

Physical principles of photodiodes-: PIN photo diode-Avalanche photo diodes-Photodetector noise-SNR-Detector response time-Double heterostructure photodiodes-structure for InGaAS APDs-Temperature effect on avalanche gain. Comparison of photo diodes. Fundamental receiver operation: digital signal transmission-error sources-front end amplifier-Digital receiver performance: Receiver sensitivity. Optical Amplifiers: Types- Erbium Doped fiber amplifier.

Unit V	OPTICAL FIBER NETWORK AND MEASUREMENT AND MONITORING	9	0	0	9

Network application :SONET/SDH-WDM- Basic test equipment-Optical power measurements Telecommunication application: Introduction-Generations of optical fiber link-Optical fiber LAN link-Optical networking technology in enterprise –Applications of optical fiber sensors and systems: Types of optical fiber sensors.

Total (45L) = 45 periods

Text Books:

1.	John M. Senior, “Optical fiber communications: Principles and Practice”, 2nd Edition.”, Pearson,2012.
2.	Gerd Keiser, “Optical Fiber Communication” McGraw –Hill International, 3 rd & 4 th ed., 2012

Reference Books:

1.	S.C.Gupta, “Textbook on Optical Fiber Communication and its applications”, PHI, 2 nd edition, 2012.
2.	J.Gower, “Optical Communication System”, Prentice Hall of India, 2001.
3.	Govind P.Agrawal, ‘Fiber-Optic Communication Systems’, 4 th Ed., Wiley, 2010.
4.	Djafar K.Mynbaev, Lowell L.Scheiner, ‘Fiber-Optic Communications Technology’, Pearson, 2001.

E-References:	
1.	https://mrcet.com/downloads/digital_notes/ECE/III%20Year/FIBER % 20 OPTICAL % 20 COMMUNICATIONS
2.	https://www.stannescet.ac.in/cms/staff/qbank/ECE/Notes/EC8751- OPTICAL COMMUNICATION -49686676 -EC 8751 – OPTICAL %20 COMMUNICATION.pdf
3.	https://electrobian.files.wordpress.com/2016/07/ece- vii - optical - fiber – communication – 10 ec 72 -notes_1449128210314_1449181382135_1449205363661.pdf

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Discuss the various optical fiber modes, configurations, structure of the cable, manufacturing methods and the properties.	Understanding
CO2	:	Calculate the degradation in the signal due to losses and dispersion.	Applying
CO3	:	Explain the various optical sources and optical detectors and their use in the optical communication system.	Applying
CO4	:	Analyze the digital transmission and its associated parameters on system Performance.	Understanding
CO5	:	Have the idea of various applications of optical fiber.	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	-	2	-	2	-	1	-	-	-	2	1
CO2	2	2	-	2	-	2	2	1	-	-	-	-	-	2	1
CO3	2	1	2	-	3	-	-	-	-	-	-	1		2	2
CO4	1	-	2	2	-	-	3	-	-	-	-	-	-	2	2
CO5	2	1	-	2	-	2		2	-	-	-	-	-	2	1
Avg	1.8	1.5	2.3	2	3	2	2.5	1.7	-	1	-	1	-	2	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC704	MICROWAVE ENGINEERING					SEMESTER VII
PREREQUISITES:		CATEGORY	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3
1.	Transmission Lines and Waveguides					

Course Objectives:	
1.	To understand and gain knowledge about various microwave components.
2.	To study the microwave generation and amplification using microwave solid-state devices.
3.	To study the microwave generation and amplification using microwave tubes.
4.	To enable the student to understand the working concepts of RF passive and active components
5.	To understand the working of RF amplifiers.

Unit I	MICROWAVE COMPONENTS	9	0	0	9
Review of low frequency parameters: Z, Y and ABCD Parameters - Introduction to S parameters -properties of S Matrix-Hybrid Circuits - Waveguide Tees - Magic Tees (Hybrid Tees) - Hybrid Rings (Rat-Race Circuits) -Waveguide Corners - Bends and Twists - Directional Couplers - Two-Hole Directional Couplers -S Matrix of a Directional Coupler - Hybrid Couplers - Circulators and Isolators.					
Unit II	SOLID STATE MICROWAVE DEVICES	9	0	0	9
Introduction- Gunn Effect Diodes - GaAs Diode - Ridley-Watkins - Hilsum (RWH) Theory - Modes of Operation - Microwave Generation and Amplification - Avalanche transit - Time devices – Introduction - Read Diode -IMPATT Diodes - TRAPATT Diodes -BARITT Diodes - Parametric Devices.					
Unit III	MICROWAVE TUBES	9	0	0	9
Klystrons - Two cavity Klystron Amplifiers - Reflex Klystrons - Velocity Modulation - Power Output and Efficiency - Electronic Admittance - Helix Traveling Wave Tubes (TWTs) – Slow Wave structures - Amplification Process - Convection Current - Axial Electric Field - Wave Modes - Gain Consideration - Magnetron Oscillators - Cylindrical Magnetron - Coaxial Magnetron.					
Unit IV	RF PASSIVE& ACTIVE COMPONENTS	9	0	0	9
RF Behaviour of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, Semiconductor properties, RF diodes- PIN, Schotky, Varactor, Gunn diode, applications of diodes- switch, modulator, attenuator, phase shifter, detector BJTs, FET,s, MOSFETS, MESFETS.					
Unit V	RF AMPLIFIERS	9	0	0	9
BJT and FET Biasing, Impedance matching, Small Signal Amplifier Design, Large signal amplifier design, Multistage amplifier design.					
					Total (45L)= 45 periods

Text Books:	
1.	Samuel Y.Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson education, 2008.
2.	Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second

Reference Books:	
1.	R.E. Collin, "Foundations for Microwave Engineering", 2nd Edition, IEEE Press, 2002.
2.	David M.Pozar, "Microwave Engineering", 2nd Edition, John Wiley & Sons, 2003
3.	Reinhold Ludwig and Powel Bretchko," RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition.
4.	Devendra K. Misra, "Radio Frequency and Microwave Communication Circuits – Analysis and Design", Wiley Student Edition, John Wiley & Sons, 2nd edition, July 2004.

E-References:	
1.	https://nptel.ac.in/courses/108101112/
2.	http://www.seas.ucla.edu/brweb/teaching.html
3.	http://www.qsl.net/va3iul/Files/RF_courses_lectures.htm

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the active and passive microwave components used in microwave communication.	Remembering
CO2	Have an in-depth knowledge of microwave generation and amplification.	Understanding
CO3	Explain the performance of passive components at very high frequency.	Understanding
CO4	Examine the behaviour of active components at very high frequency.	Analysing
CO5	Analyze the performance parameters of RF amplifiers.	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	-	-	-	-	-	-	1	-	1	2	1
CO2	2	3	2	3	-	-	-	-	-	-	2	-	1	2	1
CO3	2	2	2	2	-	-	-	-	-	-	-	-	2	1	2
CO4	2	2	2	2	-	-	-	-	-	-	2	-	2	1	2
CO5	2	1	2	2	-	-	-	-	-	-	1	-	1	2	1
Avg	2	2	2	2.2	-	-	-	-	-	-	1.5	-	1.4	1.6	1.4

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22EC705	OPTICAL AND MICROWAVE ENGINEERING LABORATORY				SEMESTER VII		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**	
		Hours/Week	**L**	**T**	**P**	**TH**	
1.	Communication systems Lab		**0**	**0**	**4**	**4**	

Course Objectives:	
1.	To Understand the working principle of microwave components.
2.	To Practice microwave measurement procedures.
3.	To Understand the working principle of optical sources, detector, fibres and microwave components.
4.	To Develop and understand simple optical communication link.
5.	To Learn about the characteristics and measurements in optical fibre.
EXPERIMENTS:	
	OPTICAL COMMUNICATION
1.	Determination of Numerical aperture for Fibers and Measurement of Attenuation in fibers.
2.	Mode Characteristics of Fibers – SM Fibers.
3.	Coupling Fibers to Semi-Conductor Sources – Connectors & Splices.
4.	Establish Fiber optic analog and digital communication links.
5.	LED & Photo Diode Characteristics.
	MICROWAVE ENGINEERING
6.	VSWR Measurements.
7.	Determination of terminated impedance.
8.	Determination of guide wavelength and frequency.
9.	Radiation Pattern of Horn antenna.
10.	Microwave Power Measurement.
11.	Characteristics of Gunn diode Oscillator.
12.	Mode Characteristics Reflex Klystron.
13.	Dielectric constant measurements.
14.	Study of Isolator, circulator and Hybrid Tee.
	Total (60P)=60 Periods

References:	
1	Samuel Y.Liao, ―Microwave Devices and Circuits‖, Pearson education, 3rd Edition, 2008.
2	Gerd Keiser, ―Optical Fiber Communication‖ McGraw –Hill International, 3rd& 4th ed., 2012
E-References:	
1	http://nptel.ac.in/courses/113104012/
2	http://nptel.ac.in/courses/115102026/
3	http://nptel.ac.in/courses/113106062/21

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze the performance of simple optical link.	Analysing
CO2	Gain knowledge on working of LED and photo detector.	Understanding
CO3	Gain knowledge on testing microwave components.	Applying
CO4	Analyze the radiation of pattern of antenna,	Applying

CO5	Measure a microwave link's impedance, VSWR, and frequency.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	3	3	3	-	-	2	-	-	-	2	-	3	2	2
CO2	2	3	3	3	-	-	2	-	-	-	2	-	3	2	2
CO3	2	3	3	3	-	-	2	-	-	-	2	-	3	2	2
CO4	1	3	3	3	-	-	2	-	-	-	2	-	3	2	2
CO5	1	3	3	3	-	-	2	-	-	-	2	-	2	2	2
Avg	1.4	3	3	3	-	-	2	-	-	-	2	-	2.8	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC706	VLSI DESIGN AND EMBEDDED SYSTEMS LABORATORY			SEMESTER VII			
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**	
		Hours/Week	**L**	**T**	**P**	**TH**	
1.	VLSI Design & Embedded Systems		**0**	**0**	**4**	**4**	

COURSE OBJECTIVES:	
1.	To design Digital system using Hardware Description Language.
2.	To practically train the programming concepts using Verilog HDL and implement in FPGA.
3.	Design the Building Blocks of Embedded Systems and simulation tools.
EXPERIMENTS:	
	VLSI DESIGN
1.	Design and simulate Combinational circuits using Verilog HDL.
2.	Design and simulate Sequential circuits using Verilog HDL.
3.	Design Traffic light controller using Verilog HDL.
4.	Design Pipelined parallel adder to add 8 number of size 12 bits each in 2's complement.
5.	Design 8 bit signed multiplication algorithm.
6.	Study of FPGA Board.
7.	Implementation of ALU/MAC unit in FPGA.
8.	Implementation of Flip-Flops in FPGA.
	EMBEDDED SYSTEMS
9.	Embedded program for I/O interfacing using PIC controller.
10.	Design a stepper motor controller using LCD and keys in PIC controller.
11.	Generate 3-phase PWM signals and demonstrate the utility of PWM with high bright LED lights using RL 78.
12.	Measure room temperature and display the same in a LCD with keyboard interaction using RL 78
13.	Design an embedded system to measure the unknown signal frequency using timer/counter of RL78.
14.	Demonstrate the usage of watchdog timers and voltage detection facilities of RL78 in an application.
15.	Interface ADC with embedded system trainer kit.
16.	Interfacing 3 axis motion & vibration sensor with STM32 Nucleo board.
	Total (60P)=60 Periods

References:	
1	J.Bhaskar, “Verilog HDL Primer” 2nd Edition, 2004.
2	Alexander G. Dean, “Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach”.
E-References:	
1	https://freevideolectures.com/Subject/VLSI-and-ASIC-Design 2. 3.
2	https://www.tutorialspoint.com/vlsi_design/vlsi_design_useful_resources.html.
3	https://nptel.ac.in/courses/117101058.

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To demonstrate a clear understanding in VeriLog HDL	Creating
CO2	Model a combinational circuit and sequential circuit using Verilog HDL.	Creating
CO3	Import the logic modules into FPGA boards.	Evaluating
CO4	Write, debug and compile embedded processors programs for a given Application.	Creating
CO5	Implement interrupt control for a given embedded System.	Evaluating

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	-	3	1	-	-	-	1	-	-	2	3	1
CO2	1	2	1	-	3	1	-	-	-	1	-	-	2	3	1
CO3	1	2	1	-	3	1	-	-	-	1	-	-	2	3	1
CO4	1	2	1	-	3	1	-	-	-	1	-	-	2	3	1
CO5	1	2	1	-	3	1	-	-	-	1	-	-	2	3	1
Avg	1	2	1	-	3	1	-	-	-	1	-	-	2	3	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

PROFESSIONAL ELECTIVE COURSES

PROFESSIONAL ELECTIES

22ECPE61	ELECTRONIC MEASUREMENTS			SEMESTER VI			
PREREQUISITES		**CATEGORY**		**PE**	**Credit**		**3**
1.	Electronic Devices	**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Objectives:							
1.	To Know the basic measurement concepts, units, standards, various types of meters and errors.						
2.	Learn to measure unknown value of components using bridges and understand the concept of various signal generator and analyzers.						
3.	To gain knowledge on Different types transducers and their usage in the Data Acquisition system						
4.	To emphasize the need for Data display recording and systems						
Unit I	**BASIC MEASUREMENTS**			**9**	**0**	**0**	**9**
Introduction – Characteristics of measurement systems – Static and Dynamic – Errors in Measurements – Calibration and Standards - DC Ammeters and Voltmeters - AC Ammeters and Voltmeters – Multi range – Ohm meter: series Type, Shunt Type - Electronic Multi meter.							
Unit II	**BRIDGE MEASUREMENT**			**9**	**0**	**0**	**9**
Introduction - DC Bridges and their Applications - Wheatstone Bridge - Kelvin Bridge - AC Bridges and their Applications - Maxwell's Bridge - Hay Bridge - Schering Bridge – We in Bridge - Wagner ground Connection.							
Unit III	**SIGNAL GENERATOR & ANALYZERS**			**9**	**0**	**0**	**9**
Signal Generators: Sine wave generator, Frequency Synthesized Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators. - Sweep Frequency Generator - Pulse and square wave generator - Function Generators - Signal Analyzers: Wave Analyzers - Harmonic Distortion Analyzers - Spectrum Analyzers.							
Unit IV	**TRANSDUCER & DATA ACQUISITION SYSTEMS**			**9**	**0**	**0**	**9**
Classification of Transducers – Variable Resistive transducers – Strain gauges, Thermistor, RTD - Variable Inductive transducers - LVDT, RVDT - Variable Capacitive Transducers - Photo electric transducers, Piezo electric transducers – Thermocouples - Thermistors – Smart / intelligent sensors, Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System.							
Unit V	**DATA DISPLAY RECORDING AND SYSTEMS**			**9**	**0**	**0**	**9**
Dual trace CRO – Digital storage and Analog storage oscilloscope. Analog and Digital Recorders and printers. Virtual Instrumentation - Block diagram and architecture – Applications in various fields. Measurement systems applied to Micro and Nanotechnology							
							Total (45L)= 45 Periods

Text Books:	
1.	Albert D.Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 5th Edition, PHI, 2011.
2.	A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2010.
Reference Books:	
1.	John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", CRC Press. 2014
2.	RobertA.Witte,"ElectronicTestInstruments,AnalogandDigitalMeasurements",2ndEdition,PearsonEducation,2004.
3.	K.LalKishore,"Electronic MeasurementsandInstrumentations",PearsonEducation,2005.
4.	Deoblin E.O. "Measurement Systems - Application and Design", McGraw Hill, 4th Edition, 2005

E-References:	
1.	https://nptel.ac.in/courses/108105153
2.	http://bcas.du.ac.in/wp-content/uploads/2020/04/Study-Material-Dr.-Avneesh-Mittal.pdf
3.	http://www.academia.edu/8140873/A_K.Sawhney-

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Discuss about the principles of various measurement techniques and identify its errors	Understanding
CO2	Have knowledge on designing and to find the unknown elements in the measuring bridges.	Applying
CO3	To categorize different instruments used for signal generation and analysis.	Understanding
CO4	Analyze the transducers and its impact and to understand the function of Data acquisition systems.	Understanding
CO5	To have knowledge on Data display and recording Systems.	Remembering

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	1	-	-	-	-	-	-	-	1	-	2
CO2	3	-	2	2	1	-	-	-	-	-	-	-	1	1	2
CO3	3	1	-	1	2	-	-	-	-	-	-	-	1	1	2
CO4	3	-	1	2	-	-	-	-	-	-	-	-	1	-	1
CO5	3	2	1	-	1	-	-	-	-	-	-	-	1	2	2
Avg	3	1.7	1.25	1.7	1.25	-	-	-	-	-	-	-	1	1.3	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE62	COMPUTER ARCHITECTURE		SEMESTER VI			
PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1	To describe computer architecture concepts and mechanisms related to the design of modern processors, memories, and networks.
2	To understand various design alternatives and make a compelling quantitative and/or qualitative argument for why one design is superior to the other approaches.
3	To illustrate the fixed point and floating-point arithmetic of ALU operations.

Unit I	FUNDAMENTALS OF QUANTITATIVE DESIGN AND ANALYSIS	9	0	0	9

Introduction-Classes of Computers- Defining Computer Architecture- Trends in Technology- Trends in Power and Energy in Integrated Circuits-Trends in Cost - Dependability - Measuring, Reporting, and Summarizing Performance - Quantitative Principles of Computer Design - Putting It All Together: Performance, Price, and Power - Fallacies and Pitfalls.

Unit II	COMPUTER ARITHMETIC	9	0	0	9

Addition and subtraction of signed numbers - Design of fast adders - multiplication of positive numbers - signed operand multiplication, Booth algorithm - Fast multiplication - Bit pair recoding of the multiplier - Carry save addition - Integer division - Floating point numbers - Arithmetic operations on floating point numbers - Guard bits and truncation.

Unit III	PROCESSING UNITS	9	0	0	9

Fundamental concepts – Execution of a complete Instruction – Multiple bus organization – Hardwired control – Micro programmed control - Pipelining – Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration – Superscalar operation – Performance considerations.

Unit IV	MEMORY SYSTEM	9	0	0	9

Basic concepts – semiconductor RAMs, ROMs – Speed, size and cost – Cache memories - Memory Hierarchy Design-Ten Advanced Optimizations of Cache Performance - Performance consideration – Virtual memory-Memory Management requirements – Secondary storage - CD-ROM - DVD_ROM - DVD drive - Hard drive.

Unit V	DOMAIN-SPECIFIC ARCHITECTURES	9	0	0	9

Introduction - Guidelines for DSAs - Example Domain: Deep Neural Networks - The Neurons of DNNs-Training Versus Inference-Multilayer Perceptron - Convolutional Neural Network -Recurrent Neural Network – Batches – Quantization-Google's Tensor Processing Unit, an Inference Data Center Accelerator -TPU Architecture - TPU Instruction Set Architecture -TPU Micro architecture.

Total(45L) =45 Periods

Text Books:

1.	John Hennessy, David Patterson ,"Computer Architecture A Quantitative Approach",6th Ed, Morgan Kaufmann Publishers,2019.
2.	Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization" 5th Ed, McGraw Hill, 2001.

Reference Books:

1.	William Stallings, "Computer Organization and Architecture – Designing for Performance", 10th Edition, Pearson, 2016.
2.	David A. Patterson and John L.Hennessy, "Computer Organization and Design, the hardware / software interface", 5th edition, Morgan Kaufmann, Elsevier, 2014.
3.	Caxton C. Foster, "Computer Architecture", 6th Edition, Van Nostrand Reinhold Company.
4.	Andrews .Tanenbaum , T odd Austin," Structured Computer Organization", 6th Edition, Pearson, 2013.

E-References:

1.	http://nptel.ac.in/courses/106102062/
2.	https://www.coursera.org/learn/comparch/home/week/1
3.	https://nptel.ac.in/courses/106106134

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize the trends followed in designing architecture.	Understanding
CO2	Illustrate the fixed point and floating-point arithmetic for ALU operation.	Remembering
CO3	Analyse the pipeline performance considering the hazards by computing clock cycles.	Analysing
CO4	Differentiate the types of memory and use suitable type for architecture development	Applying
CO5	Understand domain-specific architectures like DNN and TPU for a new application	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	2	-	-	-	-	-	-	-	-	2	1	2
CO2	2	-	3	2	-	-	-	-	-	-	-	-	1	-	-
CO3	1	-	2	-	-	-	-	-	-	-	-	-	2	-	2
CO4	2	2	2	2	2	-	-	-	-	-	-	-	2	-	3
CO5	-	2	2	-	2	-	-	-	-	-	-	-	2	1	3
Avg	1.7	2	2.25	2	2	-	-	-	-	-	-	-	1.8	1	2.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE63	DIGITAL IMAGE PROCESSING					SEMESTER VI		
PREREQUISITES			**CATEGORY**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
1	Signals and Systems			**3**	**0**	**0**	**3**

Course Objectives:	
1	To become familiar with digital image fundamentals
2	To get exposed to simple image enhancement techniques in Spatial and Frequency domain
3	To learn concepts of degradation function and restoration techniques
4	To study the image segmentation and representation techniques.
5	To become familiar with image compression and recognition methods

Unit I	**DIGITAL IMAGE FUNDAMENTALS**	**9**	**0**	**0**	**9**
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, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.					
Unit II	**IMAGE ENHANCEMENT**	**9**	**0**	**0**	**9**
Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.					
Unit III	**IMAGE RESTORATION**	**9**	**0**	**0**	**9**
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**	**9**	**0**	**0**	**9**
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**	**9**	**0**	**0**	**9**
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.					
					Total(45L) =45 Periods

Text Books:	
1.	Rafael C. Gonzalez, Richard E. Woods, _Digital Image Processing‘, Pearson, Third Edition, 2010.Anil K. Jain, _Fundamentals of Digital Image Processing‘, Pearson, 2002.
2.	Anil K. Jain, _Fundamentals of Digital Image Processing‘, Pearson, 2002.
Reference Books:	
1.	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, _Digital Image Processing using MATLAB‘, Pearson Education, Inc., 2011.
2.	Kenneth R. Castle man, _Digital Image Processing‘, Pearson, 2006.
3.	William K. Pratt, _Digital Image Processing‘, John Wiley, New York, 2002
4.	Milan Sonka et al _Image processing, analysis and machine vision‘, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
E-References:	
1.	https://www.tutorialspoint.com/dip/index.html
2.	https://www.youtube.com/watch?v=zDuJZDBsfto
3.	https://www.udemy.com/topic/image-processing/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.	Understanding
CO2	Operate on images using the techniques of smoothing, sharpening and enhancement.	Applying
CO3	Understand the restoration concepts and filtering techniques.	Understanding
CO4	Learn the basics of segmentation and features extraction	Understanding
CO5	Apply compression and recognition methods for color models.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE64	MACHINE LEARNING				SEMESTER VI	
PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1	To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
2	To explore the different supervised learning techniques including ensemble methods
3	To learn different aspects of unsupervised learning and reinforcement learning
4	To learn the role of probabilistic methods for machine learning
5	To understand the basic concepts of neural networks and deep learning.

Unit I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS	9	0	0	9

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory .

Unit II	SUPERVISED LEARNING	9	0	0	9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Over fitting - Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

Unit III	UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING	9	0	0	9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

Unit IV	PROBABILISTIC METHODS FOR LEARNING	9	0	0	9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

Unit V	NEURAL NETWORK AND DEEP LEARNING	9	0	0	9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases .

Total(45L) =45 Periods

Text Books:

1.	Stephen Mars land, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2.	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Reference Books:

1.	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.
2.	Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008
3.	Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4.	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
5.	Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012

E-References:

1.	https://machinelearningmastery.com/

2.	https://ai.google/education/
3.	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the mathematical foundation for solving ML problems.	Understanding
CO2	Apply various supervised learning technique to solve ML problem	Applying
CO3	Apply various unsupervised and reinforcement learning technique to solve ML problems	Applying
CO4	Understand various probabilistic methods of learning.	Applying
CO5	Understand basic idea behind neural network and deep learning.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	3	2	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE65	MODERN SENSORS AND ITS APPLICATIONS				SEMESTER VI		
PREREQUISITES		CATEGORY	PE	Credit		3	
		Hours/Week	L	T	P	TH	
			3	0	0	3	

Course Objectives:

1	To know the various stimuli that are to be measured in real life instrumentation.
2	To select the right process or phenomena on which the sensor should depend on
3	Toa ware of the various sensors available for measurement and control applications.

Unit I	INTRODUCTION TO SENSORS	9	0	0	9

Introduction to sensors and transducers. Need for sensors in the modern world. Different fields of sensors based on the stimuli - various schematics for active and passive sensors. Static and dynamic characteristics of sensors - zero, I and II order sensors – Response to impulse, step, ramp and sinusoidal inputs. Environmental factors and reliability of sensors.

Unit II	SENSORS FOR MECHANICAL SYSTEMS	9	0	0	9

Sensors for mechanical systems or mechanical sensors - Displacement - acceleration and force - flow of fluids - level indicators - pressure in fluids - stress in solids. Typical sensors - wire and film strain gauges, anemometers, piezo electric and magneto strictive accelerometers, potentio metric sensors, LVDT

Unit III	THERMAL AND OPTICAL SENSORS	9	0	0	9

Thermal sensors: temperature – temperature difference – heat quantity. Thermometers for different situation – thermocouples thermistors – color pyrometry. Optical sensors: light intensity – wavelength and color – light dependent resistors, photodiode, photo transistor, CCD, CMOS sensors. Radiation detectors: radiation intensity, particle counter – Gieger Muller courter (gas based), Hallide radiation detectors.

Unit IV	MAGNETIC AND ACOUSTIC SENSORS	9	0	0	9

Magnetic sensors: magnetic field, magnetic flux density – magneto resistors, Hall sensors, super conduction squids. Acoustic or sonic sensors: Intensity of sound, frequency of sound in various media, various forms of microphones, piezo electric sensors.

Unit V	ELECTRICAL AND HIGH FREQUENCY SENSORS	9	0	0	9

Electrical sensors: conventional volt and ammeters, high current sensors, (current transformers), high voltage sensors, High power sensors. High frequency sensors like microwave frequency sensors, wavelength measuring sensors. MEMs and MEM based sensors.

Total(45L) =45 Periods

Text Books:

1.	Doebelin, “Measurement Systems: Application and Design”, McGraw Hill Kogakusha Ltd,1983.
2.	Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim “Microsensors, MEMS and Smart Devices”, New York: Wiley, 2001.

Reference Books:

1.	Henry Bolte, “Sensors – A Comprehensive Sensors”, John Wiley.
2.	Jocob Fraden,” Handbook of Modern Sensors, Physics, Designs, and Applications”, Springer,2014
3.	Manabendra Bhuyan,” Intelligent Instrumentation Principles and Applications”, CRC Press,2017
4.	Randy Frank,” Understanding Smart Sensors”, Second edition, Artech House,2000.

E-References:

1.	https://onlinecourses.nptel.ac.in/noc22_ee50/preview
2.	https://www.youtube.com/watch?v=1uPTyjxZzyo
3.	https://nptel.ac.in/courses/115107122

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Appreciate the operation of various sensors and its characteristics, which they encounter in their respective fields.	Understanding
CO2	Understand various mechanical sensors, which they encounter in their career.	Analysing
CO3	Understand the principles of thermal and magnetic sensors.	Understanding
CO4	Learn the various types of optical and acoustic sensors.	Understanding
CO5	Know and understand the various electrical and high frequency sensors.	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	2	2	1	1	-	2	1	-	-	-	3	1	3	2	-
CO3	2	2	2	1	-	-	3	-	-	-	2	-	2	-	-
CO4	3	2	3	2	3	-		-	-	-	1	-	1	2	-
CO5	3	2	3	-	2	2	1	-	-	-	2	2	2	-	1
Avg	2.2	2	2.25	1.3	2.5	2	1	-	-	-	2	1.5	2	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE66	RADAR COMMUNICATION			SEMESTER VI			
PREREQUISITES		**CATEGORY**		**PE**	**Credit**		**3**
		Hours/Week		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1	To introduce the students about various types of radar and its applications.
2	To enhance the knowledge on Doppler RADAR
3	To enhance the knowledge on detection of RADAR signals.
4	To enhance the knowledge on CFAR.
5	Develop an ability to gain knowledge on radar transmitters and receivers

Unit I	RADAR AND RADAR EQUATION	9	0	0	9

Introduction to Radar: Basic Radar –The simple form of the Radar Equation- Radar Block Diagram- Radar Frequencies –Applications of Radar – The Origins of Radar -The Radar Equation: Introduction- Detection of Signals in Noise- Receiver Noise and the Signal-to-Noise Ratio-Probability Density Functions- Probabilities of Detection and False Alarm.

Unit II	MTI AND PULSE DOPPLER RADAR	9	0	0	9

Introduction to 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 – Tracking with Radar –Mono pulse Tracking –Conical Scan and Sequential Lobing - Limitations to Tracking Accuracy - Low-Angle Tracking - Tracking in Range - Automatic Tracking with Surveillance Radars (ADT).

Unit III	THRESHOLD DETECTION OF RADAR TARGETS	9	0	0	9

Detection strategies for multiple measurements, Introduction to optimal detection: Hypothesis testing and Ney man-Pearson criterion, statistical models for noise and target RCS in radar, threshold detection of radar signals.

Unit IV	CONSTANT FALSE ALARM RATE DETECTORS	9	0	0	9

Overview of detection theory, false alarm impact and sensitivity, CFAR detectors, Cell averaging CFAR, robust CFARs, adaptive CFARs.

Unit V	RADAR TRANSMITTERS AND RECEIVERS	9	0	0	9

Introduction –Linear Beam Power Tubes - Solid State RF Power Sources - Magnetron - Crossed Field Amplifiers - Radar Receivers: The Radar Receiver - Receiver noise Figure - Super heterodyne Receiver - Duplexers and Receiver Protectors- Radar Displays.

Total(45L) =45 Periods

Text Books:

1.	Mark A.Richards, “Fundamentals of Radar Signal Processing”, Tata McGraw Hill, 1st Edition, 2005.
2.	Merrill I. Skolnik ," Introduction to Radar Systems", Tata McGraw-Hill (3rd Edition) 2008.

Reference Books:

1.	Mark A.Richards, James A.Scheer, William A.Holm,” Principles of Modern RADAR”, Yes dee Publishing Pvt Ltd, 1st Edition, 2012.
2.	Nathan son, F.E, “Radar Design Principles, second edition, McGraw-Hill, New York,1991.
3.	Steven M.Kay, “Fundamentals of Statistical Signal Processing”, Vol II Detection Theory, Prentice Hall Inc, 1998.
4.	Peyton Z. Peebles:, "Radar Principles", John wiley, 2004.

E-References:

1.	http://www.radioelectronics.com/info/data/semicond/semiconductor/semiconductor-materials-types-list.php
2.	http://911electronic.com/
3.	https://nptel.ac.in/courses/108105154

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the concepts of radar measurements, radar functions and range equation.	Understanding
CO2	Familiarize about MTI and pulse Doppler radar and detection of RADAR signals.	Understanding
CO3	Analyze the principle behind, detecting the signals of radar communication.	Analysing
CO4	Apply CFAR detector to improve the detection performance of Radar.	Applying
CO5	Knowledge in RADAR systems and analyze the signal to noise ratio in the radar system.	Evaluating

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	3	3	2	-	-	-	-	-	2	-	2	2	2
CO2	-	2	3	3	2	-	-	-	-	-	2	-	2	2	2
CO3	-	2	2	3	2	-	-	-	-	-	2	-	2	2	2
CO4	-	2	3	2	2	-	-	-	-	-	2	-	2	2	2
CO5	-	2	3	3	2	-	-	-	-	-	2	-	2	2	2
Avg	-	2	2.8	2.8	2	-	-	-	-	-	2	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECPE67	INTERNET OF THINGS			SEMESTER VI			
PREREQUISITE		**CATEGORY**	**PE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1	To understand the vision of M2M to IOT.
2	To gain an understanding of IOT market perspective.
3	To acquire knowledge on IOT Technology Fundamentals and applications
4	To build small system using Raspberry Pi.

Unit I	**M2M TO IOT – THE VISION**	**9**	**0**	**0**	**9**
Introduction - From M2M to IOT- M2M towards IOT: M2M Communication - The global context - A use case example – Differing Characteristics.					
Unit II	**M2M TO IOT – A MARKET PERSPECTIVE**	**9**	**0**	**0**	**9**
Introduction - Some Definitions - M2M Value Chains - IOT Value Chains - An emerging industrial structure for IOT- International driven global value chain and global information monopolies - M2M to IOT-An Architectural Overview – Building an architecture - Main design principles and needed capabilities - An IOT architecture outline - Standards considerations.					
Unit III	**IOT TECHNOLOGY FUNDAMENTALS**	**9**	**0**	**0**	**9**
IOT Enabling technologies – IOT levels and deployment templates - Devices and gateways - Data management - Business processes in IOT - Everything as a Service (XaaS) - M2M and IOT Analytics.					
Unit IV	**BUILDING IOT WITH HARDWARE PLATFORMS**	**9**	**0**	**0**	**9**
IOT Systems-Logical Design using Python –IOT Physical Devices and End Points- IOT Device - Raspberry Pi - Interfaces – Programming – Other IOT devices - IOT Reference Model - Real World Design Constraints.					
Unit V	**IOT USE CASES AND APPLICATIONS**	**9**	**0**	**0**	**9**
Home automation-Automatic lighting-Home intrusion detection- Cities-Smart parking – Environment – We other monitoring system-Air pollution Monitoring-Forest Fire Detection- Agriculture- Smart irrigation. Commercial Building Automation – Introduction - Case study (Phase one) : Commercial building automation today - Case study (Phase two) - Commercial building automation in the future.					
Total(45L) =45 Periods					

Text Books:

1.	Jan Holler, Vlasios T siatsis, Catherine Mulligan, Stefan Aves and, Stamat is Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2.	Arshdeep Bahga, Vijay Madisetti, “Internet of Things-A hands-on approach”, Universities Press, 2015

Reference Books:

1.	Olivier Hersent, davidBoswarthick, Omar Elloumi, ‘The Internet of Things Applications to the smart grid and building automation’, John Wiley & Sons, 2012.
2.	Francis da Costa, “Rethinking the Internet of Things : A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013
3.	HakimaChaouchi, ‘The Internet of Things Connecting Objects’, John Wiley & Sons, 2010.
4.	Fabrice Theoleyr, Ai-Chun Pang, ‘Internet of Things and M2M Communications’, River Publishers, 2013.

E-References:

1.	https://nptel.ac.in/courses/106105166
2.	https://onlineitguru.com/IoT-online-training.html
3.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the vision of IOT from a global context.	Understanding
CO2	Determine the Market perspective of IOT.	Remembering
CO3	Understand the IOT technology fundamentals.	Understanding
CO4	Build small system using Raspberry Pi.	Applying
CO5	Analyse applications of IOT and case studies	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2	2	2	-	-	-	-	-	-	1	1	-	-
CO3	2	2	2	2	2	-	-	-	-	-	-	1	1	-	-
CO4	2	2	2	2	2	-	-	-	-	-	2	2	2	-	-
CO5	2	2	2	2	2	-	-	-	-	-	2	-	2	-	2
Avg	2	1.8	2	2	2	-	-	-	-	-	2	1.3	1.5	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE68	VIRTUAL INSTRUMENTATION					SEMESTER VI
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
1. Analog Integrated Circuits.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:					
1.	To introduce graphical programming environment				
2.	To teach fundamentals of virtual instrumentation programming				
3.	To develop simple applications using VI				
Unit I	**GRAPHICAL PROGRAMMING ENVIRONMENT**	**9**	**0**	**0**	**9**
History of Virtual Instrumentation - Lab View and VI - Conventional and Graphical Programming - Future Perspective - Components of LabView - Owned and Free Labels - Tools and Other Palettes - Arranging Objects- Pop-up menus - Color Coding - Code Debugging - Context Sensitive Help - Types of VI's - Creating Sub-Vis - Concepts of graphical programming Lab-view software.					
Unit II	**FUNDAMENTALS OF VIRTUAL INSTRUMENTATION PROGRAMMING**	**9**	**0**	**0**	**9**
Modular programming - Controlling Program execution with structure - Composite data arrays and clusters - Visual displays types - Graphs and charts - Analog and digital - Shift registers and feedback nodes - Local and Global variables - Exploring string and File input and output operations.					
Unit III	**DATA ACQUISITION WITH LABVIEW**	**9**	**0**	**0**	**9**
Concept of Virtual Instrumentation - PC based data acquisition - Typical on board DAQ card Resolution and sampling frequency - Multiplexing of analog inputs – Single ended and differential inputs - Different strategies for sampling of multi-channel analog inputs - Concept of universal DAQ card - Use of timer - counter and analog outputs on the universal DAQ card - NI-DAQ mx Tasks					
Unit IV	**CLUSTER OF INSTRUMENTS IN SYSTEM**	**9**	**0**	**0**	**9**
Interfacing of external instruments to a PC RS232C - RS-422 - RS485 and USB standards - IEEE488 standard -ISO-OSI model for series bus-introduction to bus protocols of MOD bus and CAN bus.					
Unit V	**ANALYSIS TOOLS AND SIMPLE APPLICATION IN VI**	**9**	**0**	**0**	**9**
Signal Processing and manipulation - Anti-aliasing Filter - Frequency_ Domain Signal analysis (DFT and FFT) - Power Spectrum - Windowing - Practical Hints for Frequency Domain Analysis - Signal Processing Functions - Time Domain Analysis - Frequency Domain Analysis – Filters: Control design and simulation - Simulation of a simple second order system.					
					Total (45L)= 45 Periods

Text Books:	
1.	Jovitha Jerome "Virtual Instrumentation using LabVIEW", PHI publication, 2010
2.	Jeffrey Travis Jim Kring "LabVIEW for Everyone", 3rd Edition, Pearson education.
Reference Books:	
1.	Robert H. Bishop "Learning with Lab-View", PreticeeHall,2009
2.	Sanjay Gupta "Virtual Instrumentation, LABVIEW", , TMH,NewDelhi,2003
3.	Peter W Gofton,"Understanding Serial Communication", Sybes International, 2000
4.	S.Gupta and J P Gupta , "PC Interfacing for Data Acquisition and Process Control" , Instrument Society of America,1994.
E-References:	
1.	http://www.ni.com/white-paper/4752/en/
2.	http://sine.ni.com/tacs/app/fp/p/ap/ov/lang/en/pg/1/sn/n5:selfpacedonline/
3.	https://www.virtualinstruments.com/training/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply structured programming concepts in developing VI programs and employ various debugging techniques.	Applying
CO2	Create applications that uses plug in DAQ boards and built in analysis functions to process the data.	Applying
CO3	Define and Describe acquisition methodologies.	Understanding
CO4	Design and analyze various applications using signal Processing tool kit	Analysing
CO5	Design and analyze various applications using control and simulation tool kit.	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	-	-	-	-	-	-	-	1	2	1
CO2	3	2	2	3	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	2	3	-	-	-	-	-	-	-	1	2	2
CO4	3	1	2	1	2	-	-	-	-	-	-	-	1	3	2
CO5	3	2	2	1	2	-	-	-	-	-	-	-	1	3	3
Avg	3	2	2	2	2.4	-	-	-	-	-	-	-	1.2	2.4	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE69	SOFTWARE DEFINED RADIO	SEMESTER VI				
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Nil		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand the evolving software defined radio techniques and their essential functionalities.
2.	To study the basic architecture and standard for software defined radio.
3.	To understand the evolving cognitive radio techniques and their functionalities.
4.	To study the basic architecture and standard for cognitive radio.
5.	To expose the student to evolving applications and next generation wireless network.

Unit I	**INTRODUCTION TO SOFTWARE-DEFINED RADIO**	**9**	**0**	**0**	**9**
Evolution of Software Defined Radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.					
Unit II	**SDR ARCHITECTURE**	**9**	**0**	**0**	**9**
Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.					
Unit III	**INTRODUCTION TO COGNITIVE RADIOS**	**9**	**0**	**0**	**9**
Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.					
Unit IV	**COGNITIVE RADIO ARCHITECTURE**	**9**	**0**	**0**	**9**
Cognition cycle – orient, plan, decide and act phases, Organization, SDR as a platform for Cognitive Radio – Hardware and Software Architectures, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.					
Unit V	**NEXT GENERATION WIRELESS NETWORK**	**9**	**0**	**0**	**9**
The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.					
					Total (45L)= 45 Periods

Text Books:

1.	Joseph Mitola III,"Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000.
2.	Markus Dillinger, Kambiz Madani, Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003.

Reference Books:

1.	Kwang-Cheng Chen, Ramjee Prasad, ― Cognitive Radio Networks‖, John Wiley and Sons, 2009.
2.	Huseyin Arslan (Ed.), ―Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
3.	Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.
4.	Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006.

E-References:

1.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%201%20notes.pdf
2.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%201%20notes.pdf
3.	https://www.dsengg.ac.in/ece/EC6802%20Wireless%20Network.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Gain knowledge on the design principles on software defined radio and cognitive radio	Understanding
CO2	An ability to make system-level decisions for software-defined radio technology and products	Applying
CO3	Gain knowledge and understanding of software defined radio architecture.	Remembering
CO4	Apply the knowledge of advanced features of cognitive radio for real world applications	Applying
CO5	Knowledge and development methods for wireless Network	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	1	2	-	-	-	1	-	-	-	-	1	-	-
CO2	-	1	-	-	-	2	-	-	-	-	-	-	-	2	-
CO3	2	-	-	1	-	-	-	-	-	-	-	-	1	-	-
CO4	-	-	-	-	-	-	2		-	-	-	-	2	1	1
CO5	2	-	1	-	-	1		2	-	-	-	-	1	-	-
Avg	1.7	1	1	1.5	-	1.5	2	1.5	-	-	-	-	1.25	1.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE610	HIGH SPEED NETWORKS				SEMESTER VI		
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
1. Computer Networks		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the packet switching, ATM and Frame relay networks.
2.	To know the techniques involved to support real-time traffic and congestion control.
3.	To be familiar with different levels of quality of service to different applications.

Unit I	**INTRODUCTION TO HIGH SPEED NETWORKS**	**9**	**0**	**0**	**9**
The need for a protocol architecture – The TCP/IP protocol architecture – Internetworking – Packet switching networks – Frame Relay Networks – Asynchronous transfer mode: ATM Protocol Architecture, ATM logical Connections, ATM Cells, ATM Service Categories, AAL – High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fibre Channel – Wireless LANs: applications, requirements – Architecture of 802.11 .					
Unit II	**CONGESTION AND TRAFFIC MANAGEMENT**	**9**	**0**	**0**	**9**
Queuing Analysis – Queuing Models – Single Server Queues – Effects of Congestion –Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.					
Unit III	**TCP AND ATM CONGESTION CONTROL**	**9**	**0**	**0**	**9**
TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO back off – KARN's Algorithm – Window management – Performance of TCP over ATM – Traffic and Congestion control in ATM – Requirements – Attributes –Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.					
Unit IV	**INTEGRATED AND DIFFERENTIATED SERVICES**	**9**	**0**	**0**	**9**
Integrated Services Architecture – Approach, Components, Services – Queuing Discipline: FQ, PS, BRFQ, GPS, WFQ – Random Early Detection – Differentiated Services.					
Unit V	**PROTOCOLS FOR QOS SUPPORT**	**9**	**0**	**0**	**9**
RSVP – Goals and Characteristics, Data Flow, RSVP operations, Protocol Mechanisms – Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.					
					Total (45L)= 45 Periods

Text Books:	
1.	Warland, Pravin Varaiya, "High performance communication networks", Second Edition, Jean Harcourt Asia Pvt. Ltd, 2001.
2.	William Stallings, "High speed networks and internets", Pearson Education, Second Edition, 2002.
Reference Books:	
1.	James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Pearson Education, Third Edition, 2011
2.	IrvanPepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.
3.	Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2004.
4.	Kaven Pahlavan And Prashant Krishnamoorthy, "Principles Of Wireless Network", Prentice Hall Of India, 2010.
E-References:	
1.	http://freevideolectures.com/Course/2278/Data-Communication/30
2.	http://nptel.ac.in/courses/106105082/30
3.	https://nptel.ac.in/courses/106105183

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Compare ATM, Frame Relay and TCP/IP networks.	Analysing
CO2	Understand the concepts of queuing mechanism and congestion control techniques in packet switching and frame relay networks.	Understanding
CO3	Analyze the traffic management in TCP and ATM.	Analysing
CO4	Be familiar with the integrated and differentiated service architecture.	Remembering
CO5	Understand the protocols to support various levels of quality of service to different applications.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	1	2	1	-	-	-	-	2	-	1	2	2
CO2	3	-	1	2	2	2	-	-	-	-	-	-	1	1	1
CO3	2	-	1	2	1	2	-	-	-	-	-	-	2	2	2
CO4	1	-	1	1	1	1	-	-	-	-	-	-	1	2	1
CO5	1	-	1	1	2	1	-	-	-	-	2	-	2	2	2
Avg	1.8	-	1	1.4	1.6	1.4	-	-	-	-	2	-	1.4	1.8	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE611	ROBOTICS				SEMESTER VI		
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To understand the functions of the basic components of a Robot.
2.	To study the use of various types of End of Effectors and Sensors
3.	To impart knowledge in Robot Kinematics and Programming
4.	To learn Robot safety issues and economics.

Unit I	**FUNDAMENTALS OF ROBOT**	**9**	**0**	**0**	**9**

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

Unit II	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	**9**	**0**	**0**	**9**

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

Unit III	**SENSORS AND MACHINE VISION**	**9**	**0**	**0**	**9**

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Antilog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.

Unit IV	**ROBOT KINEMATICS AND ROBOT PROGRAMMING**	**9**	**0**	**0**	**9**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effectors commands and simple Programs.

Unit V	**IMPLEMENTATION AND ROBOT ECONOMICS**	**9**	**0**	**0**	**9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

Total (45L)= 45 Periods

Text Books:

1.	Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
2.	Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

Reference Books:

1.	Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008
2.	Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3.	Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.
4.	Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008

E-References:

1.	https://nptel.ac.in/courses/112105249
2.	https://nptel.ac.in/courses/112105236

3.	https://www.youtube.com/watch?v=7Bahzh3rniw

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	The students can able to apply the basic engineering knowledge for the design of robotics.	Understanding
CO2	Apply the knowledge on robot drive systems and end effectors.	Analysing
CO3	Have the knowledge on Sensors and meters	Analysing
CO4	Able to apply the Robotic kinematic and VAL Programming	Evaluating
CO5	Implement the robotics on economics and safety.	Creating

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	1	1	-	-	-	-	-	-	-	1	-	-
CO2	2	1	2	2	1	-	1	-	-	-	-	1	2	1	-
CO3	2	2	1	2	2	-	1	-	-	-	-	1	2	2	2
CO4	2	3	2	3	3	1	2	1	-	-	-	2	2	2	-
CO5	3	3	2	3	3	1	2	2	1	1	3	3	3	2	3
Avg	2	2.2	1.6	2.2	2	1	1.5	1.5	1	1	3	1.75	2	1.75	2.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECPE612	COMPUTER NETWORKS	SEMESTER VI				
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Nil		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the basic concept in modern data communication and computer networking.
2.	To in traduce the students the functions of different layers and in-depth knowledge of data link layer.
3.	To make students to get familiarized with different protocols and network layer components.
4.	To introduce the basic functions of trans port layer and congestion in networks.
5.	To understand the concepts of various network Applications and Data security.

Unit I	**NETWORK FUNDAMENTALS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**
Components – networks – Topologies – The OSI reference model - layers and duties. TCP/IP reference model – layers and duties, Physical Layer: Transmission Media – Guided media & unguided media - EIA 232, SONET					
Unit II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**
Logical link control Functions: - Framing, Flow control, Error control: CRC, LLC protocols -HDLC,P to P- Medium access layer: - Random access, Controlled access, Channelization - Wired LANs: Ethernet IEEE 802.3, IEEE 802.4, and IEEE 802.5. Internetworking, Interconnection issues, Interconnection devices: - Repeaters, Hubs, Routers/switches and Gateways.					
Unit III	**NETWORK LAYER**	**9**	**0**	**0**	**9**
Switching-Circuit switching, packet switching, message switching. Internet protocols; IPV4, IPV6, ARP, RARP, ICMP, IGMP, VPN. Network Routing Algorithms - Unicast routing protocol: Distance Vector Routing – Link State Routing – Multicast Routing.					
Unit IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**
Transport Services, Elements of Transport protocols, Connection management, – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control and Quality of services (QoS) – Integrated Services					
Unit V	**APPLICATION LAYER**	**9**	**0**	**0**	**9**
Domain Name Space (DNS) – Electronic mail (SMTP, MIME, POP3, IMAP4) - Application protocols: WWW, HTTP, FTP and TELNET, Network management protocol: SNMP.					
					Total (45L)= 45 Periods

Text Books:

1.	Behrouz A. Foruzan, “Data communication and Networking”, TMH, 4th edition, 2014.
2.	James. F. Kurouse& W. Ross, “Computer Networking: A Top down Approach Featuring”, Pearson, 2020.

Reference Books:

1.	LarryL.Peterson&PeterS.Davie,“ComputerNetworks”,HarcourtAsiaPvt.Ltd.,SecondEdition,2000.
2.	AndrewS.Tanenbaum,“ComputerNetworks”,PHI,FourthEdition,2003.
3.	An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education,2002.
4.	AjitPal,“DataCommunicationandComputerNetworks”,PHI,2014.

E-References:

1.	https://nptel.ac.in/courses/106105183
2.	https://www.mbit.edu.in/wp-content/uploads/2020/05/Computer-Networks-5th-Edition.pdf
3.	https://www.tutorialspoint.com/data_communication_computer_network/index.htm

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Explain the basic concept in modern data communication and different level of layers in the protocol	Understanding
CO2	:	Analyse the functions and services of data link layer	Analysing
CO3	:	Categorize the functions and services of network layer	Understanding
CO4	:	Examine the basic functions of transport layer and congestion in networks	Understanding
CO5	:	Analyse the concepts of various network applications and data security	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	-	1	-	-	-	-	-	-	-	2	-	1
CO2	2	1	2	-	1	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	3	1	2
CO4	3	2	1	-	2	-	-	-	-	-	-	-	2	-	2
CO5	2	1	1	-	1	-	-	-	-	-	-	-	1	1	1
Avg	2.2	1.2	1.2	-	1.25	-	-	-	-	-	-	-	2	1	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE71	AUTOMOTIVE ELECTRONICS					SEMESTER VII
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	The student will come to know the various stimuli that are to be measured in real life instrumentation.
2.	He will be able to select the right process or phenomena on which the sensor should depend on
3.	Aware of the various sensors available for measurement and control applications.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**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	**FUNDAMENTALS OF VIRTUAL INSTRUMENTATION PROGRAMMING**	**9**	**0**	**0**	**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**	**9**	**0**	**0**	**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**	**0**	**0**	**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**	**0**	**0**	**9**

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.

Total (45L)= 45 Periods

Text Books:

1.	Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2000.
2.	William B. Ribbens, "Understanding Automotive Electronics", 5th edition, Newnes Publishing, 2000.

Reference Books:

1.	Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2001.
2.	"Fuel System and Emission controls", Check Chart Publication, 2000.
3.	Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999.
4.	S.Gupta and J P Gupta , "PC Interfacing for Data Acquisition and Process Control" , Instrument Society of America,1994.

E-References:

1.	https://nptel.ac.in/courses/107106088
2.	https://www.youtube.com/watch?v=2IosZDDqctU
3.	https://www.renesas.com/in/en/application/automotive/chassis-safety

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Know the importance of emission standards in automobiles	Understanding
CO2	Understand the electronic fuel injection/ignition components and their function	Applying
CO3	Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.	Applying
CO4	Diagnose electronic engine control systems problems with appropriate diagnostic tools.	Applying
CO5	Understand the safety measures in chassis and vehicle.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3	3	3	2	-	-	-	3	3	3	-	2
CO2	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
CO3	3	3	3	3	3	3	2	-	-	-	3	3	3	-	2
CO4	3	3	2	3	3	3	2	-	-	-	2	3	3	-	2
CO5	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
Avg	3	3	2	3	3	3	2	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE72	EMBEDDED C			SEMESTER VII			
PREREQUISITE			CATEGORY	PE	Credit		3
1. C Programming			Hours/Week	L	T	P	TH
				3	0	0	3

Course Objectives:

1	To write embedded programs using the C programming language.
2	To understand and build skills in writing circuit and assembly-level code.
3	To impact knowledge on programming for real time problems.

Unit	Title	L	T	P	TH
Unit I	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9**	**0**	**0**	**9**
Introduction- Best Practices for Embedded Systems-Difference between C and Embedded C-Processor to use-Programming Language- Operating system- Develop embedded software. 8051 microcontroller- Introduction-external interface- Reset requirements- Clock-Memory-I/O pins and timers- Interrupts-Serial Interface & Power Consumption.					
Unit II	**EMBEDDED PROGRAMMING**	**9**	**0**	**0**	**9**
Introduction - Installing the Keil software and loading the project-Configuring the simulator- Building the target – Running the simulation – Dissecting the program – Aside: Building the hardware - Reading switches : Introduction – Basic techniques for reading from port pins – Example : Reading and writing bytes – bits- The need for pull-up resistors – Examples: Dealing with switch bounce – Reading switch inputs- counting goats					
Unit III	**REAL TIME PROGRAMMING**	**9**	**0**	**0**	**9**
Object oriented programming with C – The Project Header (Main.h)- The port header (Port h) – Example: Restructuring the ‘Hello Embedded World’ example – Restructuring the goat-counting example-Further examples- Meeting real- time constraints – Creating ‘hardware delays’ using Timer 0 and Timer 1- Example: Generating a precise 50 ms delay- Creating a portable hardware delay- Creating loop timeouts and hardware timeouts					
Unit IV	**EMBEDDED OS**	**9**	**0**	**0**	**9**
Creating an embedded operating system-Basis of a simple embedded OS- Introducing sEOS- -Using Timer 0 or Timer 1– Alternative system architectures – Important design constraints when using sEOS- Example-Milk pasteurization - Multi state systems and function sequences- Introduction – Implementing a multi-state system (timed) - Example: Traffic light sequencing and Animatronic dinosaur– Implementing a multi-state system (Input / Timed) - Example: Controller for a washing machine.					
Unit V	**INTERFACE AND CASE STUDY**	**9**	**0**	**0**	**9**
Using serial Interface- Introduction – RS-232- basic RS-232 protocol – Asynchronous data transmission and baud rates – Flow control – The software architecture – Using the on-chip UART for RS-232 communications- Memory-Example-Serial menu architecture-Example-Data acquisition and Remote – control robot. Case Study : Intruder alarm system.					
					Total(45L) =45 Periods

Text Books:

1.	Michael J.Pont,” Embedded C”, Pearson Education, 2008.
2.	Stephen Oualline, “Bare Metal C Embedded Programming for the Real World” , No Starch Press,2022

Reference Books:

1.	Mark Siegesmund, “Embedded C Programming Techniques and Applications of C and PIC MCUS”, Elsevier Science, 2014.
2.	Michael Barr,” Embedded C Coding Standard”, Create Space Independent Publishing Platform, 2018.
3.	Michael Barr, Anthony Massa, “Programming Embedded Systems With C and GNU Development Tools”, O'Reilly Media, 2006.
4.	LyLa B. Das, “Embedded Systems: An Integrated Approach”, Pearson Education India, 2012.

E-References:

1.	https://www.cranesvarsity.com/courses/embedded-c-course/
2.	https://www.udemy.com/course/embedded-c-programming-for-embedded-systems/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand basics of embedded systems and 8051 microcontroller	Understanding
CO2	Develop basic embedded programs	Applying
CO3	Develop advanced embedded programs	Applying
CO4	Relate and write programs for embedded Operating System	Remembering
CO5	Analyse the case study problems	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2	2	2	-	-	-	-	-	-	1	1	-	-
CO3	2	2	2	2	2	-	-	-	-	-	-	1	1	-	-
CO4	2	2	2	2	2	-	-	-	-	-	2	2	2	-	-
CO5	2	2	2	2	2	-	-	-	-	-	2	-	2	-	2
Avg	2	1.8	2	2	2	-	-	-	-	-	2	1.3	1.5	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE73	WIRELESS SENSOR NETWORKS				SEMESTER VII		
PRE-REQUISITE			**CATEGORY**	**PE**	**Credit**		**3**
1. Wireless networks			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	Learn fundamental of Ad hoc network and architecture
2.	Understand the MAC and routing protocols.
3.	Have an in-depth knowledge on QoS, security and sensor network platforms

Unit I	**ROUTING PROTOCOLS**	**9**	**0**	**0**	**9**

Elements of Ad hoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Ad hoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).

Unit II	**ARCHITECTURES OF WSN**	**9**	**0**	**0**	**9**

WSN application examples, Types of applications, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Single-Node Architecture: Hardware Components, Energy Consumption of Sensor Nodes, Operating systems and execution environments

Network Architecture: Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, gateway concepts.

Unit III	**INFRASTRUCTURE ESTABLISHMENT**	**9**	**0**	**0**	**9**

Time Synchronization – Introduction to the time synchronization problem – Protocols based on sender / receiver synchronization - Protocols based on receiver/ receiver synchronization - Localization and Positioning – Properties - possible approaches – Mathematical basis for the iteration problem - Single-hop localization – Positioning in multi-hop environments – Impact of anchor placement.

Unit IV	**QUALITY OF SERVICE AND ADVANCED APPLICATION SUPPORT**	**9**	**0**	**0**	**9**

Quality of Service: Coverage and deployment, Reliable data transport, Single packet delivery, Block delivery, Congestion control and rate control - Advanced application support: Advanced in-network processing, Security and Application-specific support.

Unit V	**SENSOR NETWORK PLATFORMS AND TOOLS**	**9**	**0**	**0**	**9**

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – Tiny OS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.

Total (45L) = 45 Periods

Text Books:

1.	C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008
2.	Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.

Reference Books:

1.	Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.
2.	Charles E. Perkins, ―Ad Hoc Networking‖, Addison Wesley, 2000.
3.	William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004
4.	I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, Computer Networks, Elsevier, 2002, 394 - 422.

E-References:

1.	https://nptel.ac.in/courses/106105183

2.	https://nptel.ac.in/courses/106105183
3.	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Know the basics of Ad hoc networks and Wireless Sensor Networks	Understanding
CO2	Have a knowledge on architecture of Wireless Sensor Networks	Applying
CO3	Establish the infrastructure with the understanding of time synchoronization problem.	Applying
CO4	Understand the transport layer and security issues possible in Ad hoc and sensor networks	Understanding
CO5	Be familiar with the OS used in Wireless Sensor Networks and build basic modules	Remembering

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3	3	3	2	-	-	-	3	3	3	-	2
CO2	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
CO3	3	3	3	3	3	3	2	-	-	-	3	3	3	-	2
CO4	3	3	2	3	3	3	2	-	-	-	2	3	3	-	2
CO5	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
Avg	3	3	2	3	3	3	2	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE74	TELECOMMUNICATION AND SWITCHING NETWORKS					SEMESTER VII
PRE-REQUISITE		**CATEGORY**	**PE**	**Credit**		**3**
1. Digital communication		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the fundamentals and application of telecommunication networks.
2.	To understand and design Modern digital telecommunication switching and networks.
3.	To understand recent topics like switching systems, time division switching systems, ISDN, voice data integration and importance of telephone traffic analysis and telephone networks.

Unit I	**MULTIPLEXING**	**9**	**0**	**0**	**9**
Transmission Systems, FDM Multiplexing and modulation, The Introduction to digits, Digital Transmission and Multiplexing: Pulse Transmission, Asynchronous and synchronous transmission, Line Coding, Binary N-Zero Substitution, Digital Biphase, Differential Encoding, error performance Time Division Multiplexing, Time Division Multiplex Loops and Rings.					
Unit II	**DIGITAL SWITCHING**	**9**	**0**	**0**	**9**
Switching Functions, Space Division Switching, Time Division Switching, two-dimensional Switching: STS Switching, TST Switching, No.4 ESS Toll Switch, Digital Cross-Connect Systems, Digital Switching in an Analog Environment. Elements of SSN07 signalling.					
Unit III	**NETWORK SYNCHRONIZATION CONTROL AND MANAGEMENT**	**9**	**0**	**0**	**9**
Timing: Timing Recovery, Phase-Locked Loop, Clock Instability, Elastic Store, Jitter Measurements, Systematic Jitter. Timing Inaccuracies: Slips, Asynchronous Multiplexing, Network Synchronization, U.S. Network Synchronization, Network Control, Network Management.					
Unit IV	**DIGITAL SUBSCRIBER ACCESS**	**9**	**0**	**0**	**9**
ISDN: Basic Rate Access Architecture, ISDN U Interface, ISDN D Channel Protocol. High-Data-Rate Digital Subscriber Loops: Asymmetric Digital Subscriber Line, VDSL, Digital Loop Carrier Systems: Universal Digital Loop Carrier Systems, Integrated Digital Loop Carrier Systems, Next-Generation Digital Loop Carrier, Fiber in the Loop, Hybrid Fiber Coax Systems, and Voice band Modems: PCM Modems, Local Microwave Distribution Service, Digital Satellite Services.					
Unit V	**TRAFFIC ANALYSIS**	**9**	**0**	**0**	**9**
Traffic Characterization: Arrival Distributions, Holding Time Distributions, Loss Systems, Network Blocking Probabilities: End-to-End Blocking Probabilities, Overflow Traffic, Delay Systems: Exponential service Times, Constant Service Times, Finite Queues.					
					Total (45L) = 45 Periods

Text Books:	
1.	J. Bellamy, "Digital Telephony", John Wiley, 2003, 3rd Edition.
2.	JE Flood, "Telecommunications Switching, Traffic and Networks", Pearson.
Reference Books:	
1.	R.A.Thomson, "Telephone switching Systems", Artech House Publishers, 2000.
2.	W. Stalling, "Data and Computer Communications", Prentice Hall, 1993.
3.	T.N.Saadawi, M.H.Ammar, A.E.Hakeem, "Fundamentals of Telecommunication Networks", Wiley Inter science, 1994.
4.	Syed. R. Ali ―Digital switching systems‖, McGraw Hill New York 1998
E-References:	
1.	https://www.telecommunications-tutorials.com/
2.	https://cosmolearning.org/video-lectures/sonetsdh-11113/
3.	https://ieeexplore.ieee.org/document/6770122

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the concepts of Frequency and Time division multiplexing	Understanding
CO2	Design the Space division switching and Time division switching	Applying
CO3	Understand the concepts of network organization of telephone networks	Understanding
CO4	To compare telephone network, data network and integrated service digital network.	Understanding
CO5	Analyze traffic in telephone networks	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO2	2	1	-	-	-	-	-	-	-	-	-	-	2	2	1
CO3	2	-	1	-	-	1	-	-	-	-	-	-	2	2	1
CO4	2	-	1	-	-	-	-	-	-	-	-	-	-	2	1
CO5	2	1	-	1	-	-	-	-	-	-	-	-	2	2	1
Avg	2	1	1	1	-	1	-	-	-	-	-	-	2	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE81	MULTIMEDIA COMPRESSION AND COMMUNICATION TECHNIQUES			SEMESTER VIII			
PRE-REQUISITE			**CATEGORY**	**PE**	**Credit**		**3**
1. Basic mathematical alysis skills and digital modulation techniques.			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Objectives:							
1.	Highlight the features of data redundancy and various compression techniques involved.						
2.	To understand the various challenges involved in text and audio compression.						
3.	To impart knowledge on various image and video compression techniques.						
Unit I	**INTRODUCTION AND TEXT COMPRESSION**			**9**	**0**	**0**	**9**
Introduction: Overview of information theory - Redundancy – Compression Techniques: Loss less compression - Lossy Compression – Measures of performance – Text compression: Shannon Fano coding – Huffman coding – Arithmetic coding –Dictionary techniques – LZW family algorithms – Entropy measures of performance – Quality measures.							
Unit II	**AUDIO COMPRESSION**			**9**	**0**	**0**	**9**
Introduction: Spectral masking, Temporal masking, and Psychoacoustic model - Basic sub bands coding - Application to speech coding: G.722 - Application to audio coding: MPEG audio - Progressive encoding for audio – Silence compression - Speech compression techniques– Vocoders.							
Unit III	**IMAGE COMPRESSION AND VIDEO COMPRESSION**			**9**	**0**	**0**	**9**
Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262 - ITU-T Recommendation H.263.							
Unit IV	**MULTIMEDIA COMMUNICATIONS**			**9**	**0**	**0**	**9**
Introduction – Multimedia networks: Telephone – Data – Broadcast television – ISDN – Broadband multiservice networks – Multimedia applications: Interpersonal communications – Interactive applications over the internet – Entertainment applications – Application and networking terminology: Media – Communication modes – Network – Multipoint conferencing – Network QoS – Application QoS.							
Unit V	**STANDARDS FOR MULTIMEDIA COMMUNICATIONS**			**9**	**0**	**0**	**9**
Introduction – Reference models: TCP/IP- Protocol basics – Standards relating to interpersonal communications: Circuit mode networks - Packet switched networks - Electronic mail - Standards relating to interactive applications over the internet: Information browsing- Electronic commerce - Intermediate systems - Java and JavaScript – Standards for entertainment applications: Movie/Video on demand - Interactive television.							
							Total (45L) = 45 Periods

Text Books:	
1.	Sayood Khaleed, - “Introduction to data compression”, Morgan Kauffman, London, 2006.
2.	Fred Halshall - “Multimedia communication - Applications, Networks, Protocols and Standards”, Pearson Education, 2007.
Reference Books:	
1.	Watkinson J, “Compression in video and audio”, Focal press, London,1995.
2.	Mark Nelson, — “Data compression book”, BPB Publishers, New Delhi, 1998.
3.	Jan Vozer, —Video compression for multimedia‖, AP 83rofess, New York, 1995
4.	Peter D. Johnson Jr., Greg A. Harris, D.C. Hankerson, “Introduction to Information Theory and Data Compression”, 2nd Edition, Chapman and Hall/CRC, February 26, 2003.
E-References:	
1.	http://freevideolectures.com/Course/2278/Data-Communication/30
2.	http://nptel.ac.in/courses/106105082/30

3.	https://www.google.co.in/books/edition/Multimedia_Communications_Applications_N/g_lECYMqrVwC?hl=en&gbpv=1&dq=Fred+Halsall,+%E_2%_80%_95_Multimedia + communication -+ Applications, + Networks, + Protocols + and + Standards % E 2% 80 % 96, + Pearson + education, + 2007 + pdf + download & printsec = frontcover

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To understand different coding techniques and apply various algorithms for compression.	Understanding
CO2	To understand the quality and performance of various text and audio compression algorithms.	Understanding
CO3	Apply various text and video compression algorithms for practical applications.	Applying
CO4	Apply the compression concepts in multimedia communication.	Applying
CO5	Able to configure multimedia communication network.	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	3	2	-	-	-	-	-	-	-	3	1	2
CO2	3	2	1	3	1	-	-	-	-	-	-	-	3	1	2
CO3	3	2	1	2	2	-	-	-	-	-	-	-	3	2	1
CO4	2	2	2	3	1	-	-	-	-	-	-	-	3	1	1
CO5	2	2	1	3	1	-	-	-	-	-	-	-	3	2	2
Avg	2.4	1.8	1.2	2.8	1.4	-	-	-	-	-	-	-	3	1.4	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE82	VLSI PHYSICAL DESIGN					SEMESTER VIII
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
1. VLSI design		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	Understand the concepts of Physical Design Process such as partitioning, Floor planning, Placement and Routing.
2.	Discuss the concepts of design optimization algorithms and their application to physical design automation.
3.	Understand the concepts of simulation and synthesis in VLSI Design Automation Formulate CAD design problems using algorithmic methods.

Unit I	**INTRODUCTION TO VLSI DESIGN AUTOMATION TOOLS**	**9**	**0**	**0**	**9**
VLSI design automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.					
Unit II	**LOGIC SYNTHESIS AND VERIFICATION**	**9**	**0**	**0**	**9**
Logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.					
Unit III	**LAYOUT COMPACTION, PLACEMENT AND PARTITIONING**	**9**	**0**	**0**	**9**
Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.					
Unit IV	**FLOOR PLANNING AND ROUTING**	**9**	**0**	**0**	**9**
Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.					
Unit V	**TIMING CLOSURE**	**9**	**0**	**0**	**9**
Overview of timing analysis – Delay parameters of combinational circuits, sequential circuits – Sequential circuits with clock skew and clock jitter – Setup and hold time check.					
					Total (45L)= 45 Periods

Text Books:

1.	Sebastin smith, "ASIC", Wesley Longman, 1997.
2.	Jan Rabiey, "Digital Integrated Circuits", Prentice Hall, 2003.

Reference Books:

1.	S.M. Sait, H. Youssef, "VLSI Physical Design Automation", Cambridge India, 2010.
2.	M.Sarrafzadeh, "Introduction to VLSI Physical Design", McGraw Hill (IE), 1996.
3.	Giovanni De Micheli, "Synthesis and Optimization of Digital Circuits", McGraw Hill, 2017
4.	Andrew B. Kahng and Jens Lienig "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer, 2011

E-References:

1.	https://nptel.ac.in/courses/106105161
2.	https://www.vlsi-expert.com/p/physical-design.html
3.	https://www.academia.edu/36687882/VLSI_Design_smd154_Physical_design_back_end

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Know to place the blocks and to partition the blocks while designing the layout for IC.	Understanding
CO2	Solve the performance issues in circuit layout.	Applying
CO3	Analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing	Analysing
CO4	Decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing	Applying
CO5	Students are able to analyze circuits using both analytical and CAD tools.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	-	-	-	-	-	-	-	-	1	1	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO4	1	1	1	1	-	1	-	-	-	-	-	-	1	1	-
CO5	3	3	1	1	3	1	-	-	-	-	-	-	1	2	3
Avg	1.8	1.8	1	1	3	1	-	-	-	-	-	-	1	1.3	3
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE83	RF&EMI/EMC TESTING					SEMESTER VIII
PRE-REQUISITE		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
1.	Physics for electromagnetism		**3**	**0**	**0**	**3**

Course Objectives:	
1.	To know the RF equipment's needed for testing.
2.	To explain the concepts of EMI and EMC in electrical circuits and their characteristics.
3.	To introduce the importance of measuring equipment's.
4.	To impart the knowledge on grounding and shielding measures and design aspects.
5.	To expose basic concepts of standards and regulations

Unit I	**RF EQUIPMENT FOR MEASUREMENT AND ANTENNA MEASUREMENT**	**9**	**0**	**0**	**9**
Spectrum Analyzer- Principle, Measurement procedure, Network Analyzer- Principle, Measurement procedure, Calibration. Antenna Measurement**:** Reflection coefficient, Return loss of different antennas, Measurement with Spectrum and Network Analyzer, Gain Measurement, Radiation pattern measurement in both Indoor and Anechoic chamber, Test ranges.					
Unit II	**EMC FUNDAMENTALS**	**9**	**0**	**0**	**9**
Definition of EMI and EMC, Sources and Simulators, Propagation Methods, Basic Aspects of EMI in System Environment, cross talk or near field coupling, EM coupling in Far field, EM topology and grounding, Filtering, Shielding.					
Unit III	**EMI FROM APPARATUS, CIRCUITS AND OPEN AREA TEST SITES**	**9**	**0**	**0**	**9**
Electromagnetic emissions, noise from relays and switches, nonlinearities in circuits, passive intermodulation, transients in power supply lines, electromagnetic interference. Open area test sites and measurements, open-area test site, normalized site attenuation, antenna factor measurement.					
Unit IV	**RADIATED AND CONDUCTED INTERFERENCE MEASUREMENT**	**9**	**0**	**0**	**9**
Anechoic chamber, TEM cell, giga-Hertz TEM Cell, comparison of test facilities, characterization of conduction currents /voltages, conducted EM noise on power lines, conducted EMI from equipment, immunity to conducted EMI, detectors and measurements.					
Unit V	**EMC STANDARDS**	**9**	**0**	**0**	**9**
Overview of EMC Standards, Radiated and Conducted Emission (RE/CE) Standards, Radiated and Conducted Immunity (RI/CI) Standards, Electrostatic Discharge (ESD) Standards.					
					Total (45L)= 45 Periods

Text Books:	
1.	IET Electrical Measurement Series, "Microwave Measurements" 3rd Edition.
2.	Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons, 2009.
Reference Books:	
1.	V.P. Kodali, Engineering Electromagnetic Compatibility, 2/e, Wiley-IEEE Press, 2001.
2.	Dipak L. Sengupta and Valdis V. Liepa,"Applied Electromagnetics and Electromagnetic Compatibility", John Wiley & Sons.
3.	C. R. Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, 2013.
4.	EMI/EMC Tesing, Society of Applied Microwave Electronics Engineering and Research
E-References:	
1.	http://edocs.soco.agilent.com
2.	https://archive.nptel.ac.in/courses/108/106/108106138/
3.	https://courseware.cutm.ac.in/courses/electromagnetic-compatibility/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basics of RF measurement and Experience testing of RF components.	Analysing
CO2	Find the source of Electromagnetic interference.	Analysing
CO3	Predict the proper grounding, Shield and safety equipment's.	Applying
CO4	Analyze the test conditions for the EUT.	Analysing
CO5	Explain the measurements with help of testing procedures and explain the standards for EMI/EMC.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	3	3	3	-	-	-	-	-	2	-	3	2	3
CO2	-	2	3	3	2	-	-	-	-	-	2	-	3	2	3
CO3	-	2	3	2	3	-	-	-	-	-	2	-	2	2	2
CO4	-	2	2	3	3	-	-	-	-	-	2	-	2	2	2
CO5	-	2	3	3	3	-	-	-	-	-	2	-	3	2	3
Avg	-	2	2.8	2.8	2.8	-	-	-	-	-	2	-	2.6	2	2.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE84	DEEP LEARNING					SEMESTER VIII	
PRE-REQUISITE		**CATEGORY**	**PE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:					
1.	Understanding the basics concepts of deep learning				
2.	Emphasizing knowledge on various deep learning algorithms				
3.	Understanding of CNN and RNN to model for real world applications				
4.	Understanding the various challenges involved in designing deep learning algorithms for varied applications.				
Unit I	**INTRODUCTON TO DEEP LEARNING**	**9**	**0**	**0**	**9**
Introduction to Deep Learning: Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.					
Unit II	**FEEDFORWARD NETWORKS**	**9**	**0**	**0**	**9**
Feed forward Networks: Multilayer Perceptron, Gradient Descent, Back propagation, Empirical Risk Minimization, regularization, auto encoders.					
Unit III	**CONVOLUTIONAL NETWORKS**	**9**	**0**	**0**	**9**
Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function - Structured Outputs - Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- Le Net, Alex Net					
Unit IV	**RECURRENT NEURAL NETWORKS**	**9**	**0**	**0**	**9**
Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks - The Long Short-Term Memory and Other Gated RNNs.					
Unit V	**DEEP GENERATIVE MODELS AND APPLICATIONS**	**9**	**0**	**0**	**9**
Deep Generative Models: Boltzmann Machines - Restricted Boltzmann Machines - Introduction to MCMC and Gibbs Sampling- gradient computations in RBMs - Deep Belief Networks- Deep Boltzmann Machines - Applications: Large-Scale Deep Learning - Computer - Speech Recognition - Natural Language Processing - Other Applications.					
					Total (45L) = 45 Periods

Text Books:	
1.	Ian Good fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2.	Bengio, Yoshua. "Learning deep architectures for AI." Boston Delft 2009
Reference Books:	
1.	N.D.Lewis, “Deep Learning Made Easy with R: A Gentle Introduction for Data Science”, January 2016.
2.	Nikhil Buduma, “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms”, O’Reilly publications.
3.	Tariq Rashid, “Make your own neural network “ Amazon Digital Services
4.	Anirudh Koul, “Practical Deep Learning for Cloud, Mobile, and Edge”, O'Reilly Media, 2019.
E-References:	
1.	https://machinelearningmastery.com/
2.	https://ai.google/education/
3.	https://in.coursera.org/learn/Deep-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	Understand basic idea behind deep learning.	Remembering
CO2	Develop concept of feed forward network and encoders	Applying
CO3	Apply concept of CNN in a real time application.	Applying
CO4	Apply concept of RNN for an application	Applying

CO5	Develop Deep Generative models	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	3	2	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE85	NETWORK SECURITY			SEMESTER VIII			
PRE-REQUISITE			**CATEGORY**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To understand Cryptography Theories, Algorithms and Systems.
2.	To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.

Unit I	**INTRODUCTON**	**9**	**0**	**0**	**9**
Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies - Model of network security – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography).- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.					
Unit II	**SYMMETRIC CRYPTOGRAPHY**	**9**	**0**	**0**	**9**
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**	**9**	**0**	**0**	**9**
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	**MESSAGE AUTHENTICATION AND INTEGRITY**	**9**	**0**	**0**	**9**
Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA –Digital signature and authentication protocols – DSS- Entity Authentication: Biometrics, Passwords, Challenge Response protocols- Authentication applications - Kerberos, X.509.					
Unit V	**SECURITY PRACTICE AND SYSTEM SECURITY**	**9**	**0**	**0**	**9**
Electronic Mail security – PGP, S/MIME – IP security – Web Security - SYSTEM SECURITY: Intruders – Malicious software – viruses – Firewalls.					
					Total (45L) = 45 Periods

Text Books:

1.	William Stallings, "Cryptography and Network Security: Principles and Practice", PHI 3rd Edition, 2006.
2.	BehrouzA.Foruzan, "Cryptography and Network Security", Tata McGraw Hill 2007

Reference Books:

1.	C K Shyamala, N Harini and Dr. T R Padmanabhan, "Cryptography and Network Security", Wiley India Pvt.Ltd
2.	Charlie Kaufman, Radia Perlman, and Mike Speciner, "Network Security: PRIVATE Communication in a PUBLIC World", Prentice Hall, ISBN 0-13-046019-2
3.	Cyber Security and Network Security Sabyasachi Pramanik , Debabrata Samanta, M. Vinay , Abhijit Guha Wiley Publication
4.	Arthur Salmon, " Applied Network Security", Packt Publishing, 2017.

E-References:

1.	https://geekflare.com/learn-network-security/
2.	https://www.checkpoint.com/cyber-hub/network-security/what-is-network-security/
3.	https://www.udemy.com/courses/it-and-software/network-and-security/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the fundamentals of networks security, security architecture, threats and vulnerabilities	Understanding
CO2	Apply the different cryptographic operations of symmetric cryptographic algorithms	Applying
CO3	Apply the different cryptographic operations of public key cryptography	Applying
CO4	Apply the various Authentication schemes to simulate different applications.	Applying
CO5	Understand various Security practices and System security standards	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	3	2	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE86	SATELLITE COMMUNICATION					SEMESTER VIII
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	The goal of the course is to introduce students to the fundamentals of satellite communication
2.	To provide them with a sound understanding of how a satellite communication system successfully transfers information from one earth station to another.
3.	To expose them to examples of applications and tradeoffs that typically occur in engineering system design, and to ask them to apply the knowledge in design problems.

Unit	Title	L	T	P	TH
Unit I	**OVERVIEW OF SATELLITE SYSTEMS, ORBITS AND LAUNCHING METHODS**	**9**	**0**	**0**	**9**

Introduction – Frequency Allocations for Satellite Services – INTELSAT – U.S.Domsats – Polar Orbiting Satellites- Kepler's First Law – Kepler's Second Law – Kepler's Third Law – Definitions of Terms for Earth -orbiting Satellites – Orbital Elements – Apogee and Perigee Heights – Orbital Perturbations - Local Mean Solar Time and Sun - Synchronous Orbits.

Unit	Title	L	T	P	TH
Unit II	**GEOSTATIONARY ORBIT & SPACE SEGMENT**	**9**	**0**	**0**	**9**

Introduction – Antenna Look Angels – The Polar Mount Antenna – Limits of Visibility – Near Geostationary Orbits – Earth Eclipse of Satellite – Sun Transit Outage – Launching Orbits - Power Supply – Attitude Control – Station Keeping – Thermal Control – TT&C Subsystem – Transponders - Antenna Subsystem – Morelos and Satmex5 – Anik-Satellites – Advanced Tiros - N Spacecraft.

Unit	Title	L	T	P	TH
Unit III	**EARTH SEGMENT & SPACE LINK**	**9**	**0**	**0**	**9**

Receive Only Home TV Systems – Master Antenna TV System – Community Antenna TV System – Transmit Receive Earth Stations - Equivalent Isotropic Radiated Power – Transmission Losses : Free-Space Transmission – Feeder Losses – Antenna Misalignment Losses – Fixed Atmospheric and Ionospheric Losses – Link Power Budget Equation – Carrier-to-Noise Ratio – Uplink – Down link - Effects of rain – Combined Uplink and Downlink C/N Ratio – Inter modulation Noise.

Unit	Title	L	T	P	TH
Unit IV	**SATELLITE ACCESS**	**9**	**0**	**0**	**9**

Single Access – Preassigned FDMA - Demand-Assigned FDMA - SPADE System - Bandwidth-limited and Power-limited TWT amplifier operation - TDMA -On-board signal Processing for TDMA / FDMA operation - Satellite switched TDMA - Code Division Multiple Access.

Unit	Title	L	T	P	TH
Unit V	**DBS & SATELLITE MOBILE AND SPECIALIZED SERVICES**	**9**	**0**	**0**	**9**

Direct Broadcast Satellite (DBS) Television - Orbital Spacing - Power Rating and Number of Transponders -Frequencies and Polarization -Transponder capacity - Bit rates for digital Television -The Home Receiver Outdoor Unit(ODU)-The Home Receiver Indoor Unit(IDU) – HDTV - Satellite Mobile Services – VSATs – GPS –Orbcomm.

Total (45L)= 45 periods

Text Books:

1.	Dennis Roddy, "Satellite Communications", Tata McGraw-Hill Education Private Limited, fourth edition,
2.	Barry George Evans, "Satellite communication systems", 3rd Edition, IETPublications 1999

Reference Books:

1.	Timothy Pratt – Charles Bostian& Jeremy Allmuti, Satellite Communications, John Willy & Sons (Asia) Pvt. Ltd, second edition 2014
2.	Wilbur L. Pritchars Henri G.SuyderHond Robert A.Nelson, Satellite Communication Systems Engineering, Pearson Education Ltd., Second edition 2003..

3.	M.Richharia, Satellite Communication Systems (Design Principles), Macmillan Press Ltd. Second Edition
4.	Satellite communication engineering By Michael O. Kolawole, CRC Press, 2002.
E-References:	
1.	http://nptel.ac.in/courses/117105131/
2.	http://nptel.ac.in/courses/106105082/33
3.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-851-satellite-engineering-fall-2003/lecture-

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Describe the motion of satellite in the orbit and understand orbital effects in communications system performance	Understanding
CO2	:	Calculate the received carrier power at the input of earth station receiver or satellite	Applying
CO3	:	Compute the noise power and carrier to noise ratio at the input of earth station or	Applying
CO4	:	Calculate losses and design both up-link and down link	Applying
CO5	:	design domestic satellite system using small earth station	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	2	2	1	-	-	-	-	-	-	-	1	2	1
CO2	2	1	1	2	1	-	-	-	-	-	-	-	1	2	2
CO3	2	1	1	1	1	-	-	-	-	-	-	-	1	2	1
CO4	2	1	1	1	1	-	-	-	-	-	-	-	2	2	1
CO5	1	1	1	1	1	-	-	-	-	-	-	-	2	1	1
Avg	1.75	1.2	1.2	1.4	1	-	-	-	-	-	-	-	1.4	1.8	1.2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE87	BIO MEDICAL ELECTRONICS					SEMESTER VIII
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Analog Electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To gain knowledge about the various physiological parameters both electrical and non-electrical, the methods of recording and also the method of transmitting these parameters.
2.	To study about various assist devices used in hospitals.

Unit I	**ELECTRO-PHYSIOLOGY AND BIOPOTENTIAL RECORDING**	**9**	**0**	**0**	**9**
The origin of Bio-potentials – Bio potential electrodes types - Bio amplifiers, ECG, EEG, EMG lead systems and recording methods, typical waveforms and signal characteristics.					
Unit II	**BIO-CHEMICAL AND NON-ELECTRICAL PARAMETER MEASUREMENT**	**9**	**0**	**0**	**9**
Measurement of pH, PO2 and PCO2, colorimeter - Blood flow meter - Cardiac output - Respiratory rate measurement - Blood pressure measurement - Heart rate measurement - Pulse rate measurement - Blood cell counters.					
Unit III	**MEDICAL IMAGING SYSTEM**	**9**	**0**	**0**	**9**
Radiography - Computer tomography – Mammography – Magnetic Resonance Imaging – Positron Emission Tomography - Ultrasonography - Thermography,					
Unit IV	**ASSIST DEVICES AND BIO-TELEMETRY**	**9**	**0**	**0**	**9**
Cardiac pacemakers - DC Defibrillator – Hemodialyzer, Heart Lung Machine, Telemetry: principles, Frequency selection, Biotelemetry - Radio pill					
Unit V	**RECENT TRENDS IN MEDICAL INSTRUMENTATION**	**9**	**0**	**0**	**9**
Endoscopy unit - Applications of Laser in medicine - Cryogenic application - Introduction to Telemedicine, Electrical safety in medical environment					
					Total (45L)= 45 Periods

Text Books:

1.	Khandpur, R.S., Handbook of Biomedical Instrumentation, TATA McGraw- Hill, New Delhi, 2014
2.	John G. Webster, Medical Instrumentation Application and Design, John Wiley and Sons, 4th edn., 2009

Reference Books:

1.	Joseph J.Carr and John M.Brown, Introduction to Biomedical equipment Technology, Pearson
2.	Education, 2013.
3.	Leslie Cromwell, Fred J. Weibell, "Erich A. Pfeiffer, Biomedical Instrumentation and Measurements", Pearson Education India, 2nd Edition, 2015.
4.	Edward J. Bukstein, Medical electronics, Ungar Publications, 2002

E-References:

1.	https://nptel.ac.in/courses/108108180
2.	https://biomedikal.in/2009/12/lecture-notes-on-biomedical-instrumentation/
3.	https://www.digimat.in/nptel/courses/video/108105101/L40.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire and analyze the various bio signals and vital parameters.	Analysing
CO2	Measure biochemical and other physiological information.	Applying

CO3	To understand the use of radiation for diagnostic and therapy	Understanding
CO4	Explain the function and application of various diagnostic and therapeutic equipment.	Understanding
CO5	Explain about the recent developments in the field of biomedical engineering and analyze the safety aspects of medical equipment.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	1	-	-	-	-	-	-	-	3	-	2
CO2	3	2	2	1	2	-	-	-	-	-	-	-	3	1	2
CO3	3	1	3	1	1	-	-	-	-	-	-	-	3	1	2
CO4	3	2	2	1	-	-	-	-	-	-	-	-	3	2	1
CO5	3	2	3	1	1	-	-	-	-	-	-	-	3	2	2
Avg	3	1.8	2.4	1.2	1.25	-	-	-	-	-	-	-	3	1.5	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE88	COGNITIVE RADIO			SEMESTER VIII			
PREREQUISITES			CATEGORY	PE	Credit		3
			Hours/Week	L	T	P	TH
				3	0	0	3

Course Objectives

1	To enable the student to understand the requirements in designing software defined radios and cognitive radio and its functionalities
2	To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
3	To analyse the spectrum management functions using cognitive radio systems and cognitive radio networks.

Unit I	**INTRODUCTION TO COGNITIVE RADIO**	9	0	0	9

Marking radio self-aware, the cognition cycle, organization of congnition tasks, structuring knowledge for cognition tasks, Enabling location and environment awareness in cognitive radios –concepts, architecture, design considerations.

Unit II	**INTRODUCTION TO SDR**	9	0	0	9

Software Defined Radio: Evolution - essential functions of the Software Defined Radio - architecture goals - quantifying degrees of programmability - top level component topology - computational properties of functional components - interface topologies among plug and play modules - architecture partitions - merits and demerits of SDR - problems faced by SDR.

Unit III	**COGNITIVE RADIO ARCHITECTURE**	9	0	0	9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture

Unit IV	**COGNITIVE RADIO NETWORK SECURITY**	9	0	0	9

Overview of IEEE 802.22 standard for broadband wireless access in TV bands -Primary user emulation attacks - security vulnerabilities in IEEE 802.22 - security threats to the radio software.

Unit V	**MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO**	9	0	0	9

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

Total (45 L) = 45 Periods

Text Books:

1	Alexander M. Wyglinski, MaziarNekovee, and Thomas Hou Y, “Cognitive Radio Communications and Networks - Principles and Practice”, Elsevier Inc., 2010
2	Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons Ltd, 2009

Reference Books:

1	Arslan H, “Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems”, University of South Florida, USA, Springer, 2007.
2	Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, “Cognitive Radio Networks - From Theory to Practice”, Springer Series: Analog Circuits and Signal Processing, 2009.
3	Mitola J, “Cognitive Radio: An Integrated Agent Architecture for software defined radio”, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
4	E. Biglieri, A.J. Goldsmith., L.J. Greenstein, N.B. Mandayam, H.V. Poor, “Principles of Cognitive Radio”, Cambridge University Press, 2013.

E-Reference:

1	http://www.wirelessinnovation.org/Cognitive_Radio_Architecture
2	http://www.xgtechnology.com/innovations/cognitive-radio-networks/
3	http://www.radio-electronics.com/info/rf-technology-design/cognitive-radio-cr/technologytutorial.php

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the concepts and design of cognitive radios.	Understanding
CO2	Study about the SDR architecture and analysis.	Remembering
CO3	Analyse the various cognitive radio network architectures.	Analysing
CO4	Analyse the various security threats to the radio software in cognitive radio network.	Analysing
CO5	To analyse the performance of MAC and network layer design for cognitive radio.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	2	2	1	-	2	-	1	-	1	1	2	-	1
CO2	-	2	2	1	2	-	1	-	1	-	1	1	2	1	1
CO3	-	1	3	1	1	-	1	-	1	-	1	1	2	1	1
CO4	-	2	2	1	-	-	2	-	1	-	1	1	2	2	1
CO5	-	2	3	1	1	-	1	-	1	-	1	1	2	2	1
Avg	-	1.8	2.4	1.2	1.25	-	1.4	-	1	-	1	1	2	1.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

OPEN ELECTIVE COURSES

22MAOE01	SAMPLING THEORY AND NUMERICAL METHODS				
PREREQUISTIES		**CATEGORY**	**L**	**T**	**P**	**C**
Basic 12th level knowledge of Probability, Statistics, Matrices, ODE and PDE.		**BS**	**3**	**0**	**0**	**3**

Course Objectives:

1.	To gain the knowledge of tests of significance for large and small samples.
2.	To find the numerical solution of linear, non-linear equations and to obtain the knowledge about fitting of curves by the method of least squares.
3.	To obtain the knowledge about numerical interpolation, differentiation and integration.
4.	To acquire the knowledge about numerical solutions to first order ordinary differential equations using single step and multi-step methods.
5.	To gain the knowledge about numerical solutions to second order partial differential equations by using explicit and implicit methods.

UNIT I	**SAMPLING THEORY**	**9**	**0**	**0**	**9**

Test of significance: Large Sample tests for Single proportion, difference of proportions, single mean and difference of means-Small Sample test for single mean, difference of means, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

UNIT II	**SOLUTION OF EQUATIONS**	**9**	**0**	**0**	**9**

Solutions of nonlinear equations by Newton Raphson Method-Solutions of linear system of equations by Gauss Elimination, Gauss Jacobi and Gauss Seidel methods, Curve fitting by the Method of Least Squares – Fitting of straight lines, second degree parabolas.

UNIT III	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9**	**0**	**0**	**9**

Interpolation using Newton’s Forward and Backward formula- Interpolation with unequal intervals: Newton’s divided difference and Lagrange’s formula -Numerical Differentiation and Integration: Trapezoidal rule, Simpson’s 1/3 rule and Simpson’s 3/8 rule.

UNIT IV	**NUMERICAL SOLUTION FOR ORDINARY DIFFERENTIAL EQUATIONS**	**9**	**0**	**0**	**9**

Ordinary differential equations: Taylor series method- Euler and modified Euler’s method- Runge-Kutta method of fourth order for solving first order differential- Milne’s and Adam’s predictor - corrector methods.

UNIT V	**NUMERICAL SOLUTION FOR PARTIAL DIFFERENTIAL EQUATIONS**	**9**	**0**	**0**	**9**

Partial differential equations: Finite difference solution of two-dimensional Laplace and Poisson equations- Implicit and Explicit methods for one dimensional heat equation (Bender Schmidt and Crank-Nicholson methods) - Finite difference explicit method for wave equation.

Total (45 L + 0T) = 45 Periods

Text Books:

1.	Veerarajan T, “Probability and Random Process (With Queuing theory)”, 4th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2016.
2.	Kandasamy.P, Thilagavathy.K, Gunavathi.K, “Numerical Methods”, S. Chand & Co., New Delhi, 2005.

3.	Gupta, S.C. and Kapoor, V.K., "Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi, 11th Edition, 2014.
Reference Books:	
1.	Freund John, E. and Miller Irwin, "Probability and Statistics for Engineers", 8th Edition, Prentice Hall India (P) Ltd, 2010.
2.	Gerald, C. F. and Wheatley, P.O., "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
3.	M.K. Venkataraman, "Numerical Methods in Science and Engineering", 5th Edition, National Publishing Company, 2000.
4.	Jain M.K, Iyengar K & Jain R.K., "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Ltd, Publishers, 2003.
5.	Manish Goyal, "Numerical Methods and Statistical techniques Using 'C", 1st Edition, Laxmi Publications (P) Ltd, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Learn about the concept of sampling theory and testing of hypotheses.	L2: Understanding
CO2	:	Find the numerical solution of equations and fitting the curves by Least Square Method.	L2: Understanding
CO3	:	Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.	L3: Applying
CO4	:	Solve the initial value problems for ordinary differential equations.	L3: Applying
CO5	:	Find the numerical solution of the partial differential equation by using the Finite difference method.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2									2		
CO2	3	2		2									2		
CO3	3	2		2									2		
CO4	3	2		2									2		
CO5	3	2		2									2		
Avg	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22MAOE02	NUMERICAL METHODS					
PREREQUISTIES		**CATEGORY**	**L**	**T**	**P**	**C**
Basic 12^{th} level knowledge of solution of equations, differentiation, integration, ODE and PDE.		**BS**	**3**	**0**	**0**	**3**

Course Objectives:

1.	To familiarize the numerical solution of the linear system of equations.
2.	To understand the concept of interpolation and approximation.
3.	To obtain the knowledge about numerical differentiation, integration.
4.	To familiarize the students on solving first order ordinary differential equations using single step and multi-step methods
5.	To enable them to solve boundary value problems associated with engineering applications using numerical methods.

UNIT I	**SOLUTION OF EQUATIONS**	**9**	**0**	**0**	**9**

Solutions of nonlinear equations by Newton Raphson Method-Solutions of linear system of equations by Gauss Elimination, Gauss Jordan, Gauss Jacobi and Gauss Seidel Methods.

UNIT II	**INTERPOLATION AND APPROXIMATION**	**9**	**0**	**0**	**9**

Interpolation with Equal Intervals-Newton's Forward and Backward interpolations- Unequal intervals-Newton's divided difference formula and Lagrangian Polynomials.

UNIT III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9**	**0**	**0**	**9**

Newton's Forward and Backward Differences to compute derivatives-Trapezoidal rule-Simpson's 1/3 rule, Simpson's 3/8 rule –Two- and three-point Gaussian quadrature formulas.

UNIT IV	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS**	**9**	**0**	**0**	**9**

Solving first order ODE – Single step method: Taylor series method-Euler and modified Euler Method-Fourth order Runge-Kutta method- Multistep method: Milne's and Adam's predictor and corrector methods.

UNIT V	**BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**	**9**	**0**	**0**	**9**

Finite difference solution of second order ordinary differential equations-Finite difference solutions of one-dimensional heat equation by explicit and implicit methods-One dimensional wave equation and two-dimensional Laplace and Poisson equations.

Total (45 L + 0 T) = 45 Periods

Text Books:

1.	Veerarajan. T and Ramachandran, "Numerical methods with Programs in C and C^{++}", Tata McGraw Hill, New Delhi, 2006.
2.	Kandasamy.P, Thilagavathy.K, Gunavathi.K, "Numerical Methods", S. Chand & Co., New Delhi, 2005.

Reference Books:

1.	Gerald, C. F. and Wheatley, P.O.," Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
2.	M.K. Venkataraman, "Numerical Methods in Science and Engineering", 5^{th} Edition, National Publishing Company, 2000.
3.	Jain M.K. Iyengar, K & Jain R.K., "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Ltd, Publishers, 2003.
4.	Manish Goyal, "Numerical Methods and Statistical Techniques Using 'C", 1^{st} Edition, Laxmi Publications (P) Ltd, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Obtain the numerical solutions of linear and nonlinear equations.	L2: Understanding
CO2	:	Acquired the techniques of interpolation and approximations.	L2: Understanding
CO3	:	Familiarize with numerical differentiation and integration.	L2: Understanding
CO4	:	Solve the initial value problems for ordinary differential equations.	L3: Applying
CO5	:	Acquire the techniques of solving Boundary value problems.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2		2									2		
CO2	3	2		2									2		
CO3	3	2		2									2		
CO4	3	2		2									2		
CO5	3	2		2									2		
Avg	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22MAOE03	PROBABILITY AND QUEUING THEORY				
PREREQUISTIES	**CATEGORY**	**L**	**T**	**P**	**C**
Basic 12th level knowledge of Probability and Statistics.	**BS**	**3**	**0**	**0**	**3**

Course Objectives:

1.	To understand the basic concepts of one-dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.
2.	To understand the concept of two-dimensional random variables, Correlation and linear regression.
3.	To provide necessary basic concepts in random processes for applications such as random signals, linear systems in communication engineering.
4.	To understand the concept of queueing models and apply in engineering.
5.	To understand the significance of advanced queueing models and develop probabilistic models which can be used in several areas of science and engineering

UNIT I	**RANDOM VARIABLES**	**9**	**0**	**0**	**9**

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

UNIT II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**9**	**0**	**0**	**9**

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

UNIT III	**RANDOM PROCESSES**	**9**	**0**	**0**	**9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations .

UNIT IV	**QUEUEING MODELS**	**9**	**0**	**0**	**9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

UNIT V	**ADVANCED QUEUEING MODELS**	**9**	**0**	**0**	**9**

Finite source models - M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E_K /1 as special case – Series queues – Open Jackson networks.

Total (45 L + 0 T) = 45 Periods

Text Books:

1.	Gross, D., Shortle, J.F, Thompson, J.M and Harris, C.M., "Fundamentals of Queueing Theory", Wiley, Student 4th Edition, 2014.
2.	Ibe, O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.

Reference Books:

1.	Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2.	Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.
3.	Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
4.	Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the fundamental knowledge of the standard distributions which can describe real life phenomenon.	L2: Understanding
CO2	:	Understand the concepts of two-dimensional random variables, Correlation and linear regression.	L2: Understanding
CO3	:	Apply the concept of random processes in engineering disciplines.	L3: Applying
CO4	:	Acquire skills in analysing queueing models.	L2: Understanding
CO5	:	Understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2		2									2		
CO2	3	2		2									2		
CO3	3	2		2									2		
CO4	3	2		2									2		
CO5	3	2		2									2		
Avg	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td colspan="2">22CEOE01</td><td colspan="2">ENVIRONMENTAL MANAGEMENT</td><td colspan="3">Semester</td><td>VI</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To study the variable natures of our environmental resources and to understand their importance associated with our societic life.</td></tr>
<tr><td>2</td><td colspan="7">To study the variable categories of pollutants and their controlling measures</td></tr>
<tr><td>3</td><td colspan="7">To impart an understanding of systems approach to Environmental Management as per ISO 14000 and to evaluate the management plan using gis tools</td></tr>
<tr><td>4</td><td colspan="7">To impart skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.</td></tr>
<tr><td>5</td><td colspan="7">To impart skills for managing the usage of our natural resources without disrupting balance and stability of the natural system.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="2">ENVIRONMENTAL RESOURCES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Non-renewable resources-Mineral use and exploitation; fossil fuels. Renewable resources: Water resources-supply, demand, dams-benefits and problems; Soil and Land resources- Structure, formation, erosion, conservation of soil, agricultural practices, land use,degradation and desertification; Fisheries- Inland and marine fisheries, aquaculture, overharvesting; Forest resources- Timber, Medicinal plants, fuel-wood, deforestation, forest management- Management of renewable and non-renewable resources; Sustainable use</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">ENVIRONMENTAL POLLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Definition of pollution and pollutants; types of pollution-Air, Water ,Soil, Noise, thermal, nuclear; causes of pollution, effects of pollution and control measures; Liquid and Solid waste management, nuclear holocausts. Case studies: leather industry, fly ash, thermal stations, nuclear power plants</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">ENVIRONMENTAL MANAGEMENT SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Environmental Management Systems; ISO14000 series; Environmental auditing: Environmental Impact Assessment; Life cycle assessment; Human health risk assessment. Management plans using GIS and RS tools</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">ENVIRONMENTAL LAW AND POLICY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Environmental Law and Policy – Objectives; Polluter pays principle, Precautionary principle; The Water and Air Acts with amendments; The Environment (Protection) Act (EPA) 1986; National Green Tribunal Act, 2010; National Environment Policy; Principles of International Law and International treaties.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="2">ENERGY-ENVIRONMENT AND SUSTAINABLE DEVELOPMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
</table>

Energy and Environment: Energy sources – overview of resources and reserves; Renewable and non-renewable energy sources; Energy-Environment nexus Sustainable Development: Definition and concepts of sustainable development; Sustainable development goals; Hurdles to sustainability; Environment and economics.
Total= 45 Periods

Text Books:	
1	"Natural Resources Conservation & Management" , K.K.SINGH -MD PUBLICATIONS PVT LTD
2	"Environmental Pollution " by N.MANIVASAKAM,2021
3	ISO 14001/14004: Environmental management systems –Requirements and Guidelines – International Organisation for Standardisation, 2004.
4	Fundamental Concepts in Environmental Studies by Dr.D.D Mishra
Reference Books:	
1	ISO 19011: 2002, "Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002.
2	Paul LBishop „Pollution Prevention: Fundamentals and Practice", McGraw -Hill International, Boston,2000.
3	Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, January 2001
4	Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems –a step by step guide" Earthscan Publications Ltd, London, 1999.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the importance of variable natural resources	Understand
CO2	Understand the necessity of environmental management that will be caused by projects or industries.	Understand
CO3	Develop, Implement, maintain and Audit Environmental Management systems for Organizations.	Understand /Evaluate
CO4	Gain the Knowledge about the legal requirements of Environmental management and auditing	Remembering
CO5	Understand eco-friendly business in order to achieve sustainable development	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	1	2	-	-	3	1	1	1	-	1	3	3	-	2
CO2	-	1	3	-	-	3	1	1	1	-	1	3	3	-	2
CO3	1	1	1	2	2	3	1	-	2	2	3	2	3	-	3
CO4	-	1	1	-	-	3	1	1	2	2	1	2	1	-	2
CO5	1	1	3	2	1	3	3	-	2	-	3	3	3	-	2
Avg	1	1	2	2	0.6	3	1.4	0.6	1.6	2	1.8	2.6	2.6	-	2.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEOE02	DISASTER MITIGATION AND MANAGEMENT			Semester		VI
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To provide students an exposure to disasters, their significance and types
2	To ensure that students begin to understand the relationship between vulnerability disasters, disaster prevention and risk reduction
3	To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
4	To enhance the institutional processes in the country
5	To evaluate the various case studies in disaster management

Unit I	**INTRODUCTION TO DISASTERS**	**9**	**0**	**0**	**9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters –Earthquake, Landslide, Flood, Drought, Fire etc – Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability- Global trends I n disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don‟ts during various types of Disasters.

Unit II	**APPROACHES TO DISASTER RISK REDUCTION (DRR)**	**9**	**0**	**0**	**9**

Disaster cycle – Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural-nonstructural measures, Roles and responsibilities of- community, Panchayat Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA)– Early Warning System – Advisories from Appropriate Agencies.

Unit III	**INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT**	**9**	**0**	**0**	**9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India – Relevance of indigenous knowledge, appropriate technology and local resources.

Unit IV	**DISASTER RISK MANAGEMENT IN INDIA**	**9**	**0**	**0**	**9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy – Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

Unit V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS**	**9**	**0**	**0**	**9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and fieldworks related to disaster management

Total= 45 Periods

Text Books:	
1	Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13:978-9380386423
2	Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt.Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]
Reference Books:	
1	Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2	Government of India, National Disaster Management Policy, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate the types of disasters, causes and their impact on environment and society	Analyze
CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation	Understand
CO3	Draw the hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.	Create
CO4	Use the GIS softwares for disaster risk management in india	Evaluate
CO5	Gain knowledge on various case studies of disaster management	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	2	1		1	1	1	1	1		1
CO2	1	1	1	2	1	1	1		1	1	2	1	1		1
CO3	2	1	2	2	1	-	1		2	1	2	1	1		1
CO4	1	1	2	1	3	3	2	1	3	2	3	2	2	2	3
CO5	1	2	2	2	2	2	2	1	2	2	2	2	2		2
Avg	1.4	1.2	1.6	1.6	1.6	1.6	1.4	1	1.8	1.4	2	1.4	1.4	2	1.6
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEOE03	REPAIR AND REHABILITATION OF BUILDING ELEMENTS		Semester			VI
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
Construction materials and Technology & Concrete Technology		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To get the knowledge on causes of deterioration of structure
2	To know about the assessment of distressed structures
3	To get the knowledge on maintenance of building systems
4	To know about the repairing of structures
5	To gain knowledge about the techniques involved in the demolition procedure

Unit I	**MAINTENANCE AND REPAIR STRATEGIES**	**9**	**0**	**0**	**9**

Maintenance, repair and rehabilitation, Facts of Maintenance, importance of Maintenance various aspects of inspection, assessment procedure for evaluating a damaged structure, causes of deterioration.

Unit II	**MAINTENANCE OF ELECTRICITY AND DOMESTIC WATER PUMP SYSTEMS**	**9**	**0**	**0**	**9**

Load rating of lighting devices and usual household appliances, electric supply from street line to building, devices for alternate supply during power failure, importance of earth leakage circuit breaker (ELCB), Maintenance of electric system in buildings. General specifications of water pumps, centrifugal pumps, jet pumps and submersible pumps, general rules in operation of water pumps. Maintenance of the sump.

Unit III	**MATERIALS AND TECHNIQUES FOR REPAIR**	**9**	**0**	**0**	**9**

Materials for Repair: Special concretes and mortar concrete chemicals construction chemicals Expansive cement polymer concrete sulphur infiltrated concrete Ferro cement Fibre reinforced concrete Rust eliminators and polymers coating for rebar foamed concrete dry pack vacuum concrete asphalt sheeting Techniques for Repairs Gunniting, grouting and Shotcrete Epoxy injection

Unit IV	**REPAIRS,REHABILITATION AND RETROFITTING OF BUILDING SYSTEMS**	**9**	**0**	**0**	**9**

Repairs of RC beams and columns damaged by steel corrosion, repair of rising dampness in walls, repair of efflorescence effect, repair of cracks in concrete structures, repair of rain water, groundwater leakage in buildings.

Unit V	**DEMOLITION TECHNIQUES**	**9**	**0**	**0**	**9**

Engineered demolition techniques for dilapidated structures- case studies

Total= 45 Periods

Text Books:	
1	Varghese P.C., Maintenance Repair Rehabilitation and Minor Works of Buildings, PHI Learning pvt.ltd.,NewDelhi,2014
Reference Books:	
1	Santhakumar A.R, Training Course notes on Damage Assessment and Repair in Low cost housing, "RHDC.NBO" Anna University, July 1992.
2	Shetty, M.S., Concrete Technology-Theory and Practice, S. Chand and company, NewDelhi,1992
3	RaikarR.N., Learning from failures- deficiencies in design, construction and services– R &D centre (SDCPL), raikar bhavan, Bombay,1987
4	Palaniyappan, N., Estate management, Anna Institute of Management, Chennai, 1992.
5	Lakshmipathy, M. et al., Lecture notes of workshop on Repairs and Rehabilitation of structures, 29-30thoctober 1999.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Carry out the damage assessment and Rapid Visual inspection of a building showing signs of deterioration and thus should be able to detect the possible cause /source of deterioration	Analyse
CO2	Know how to Maintain and repair the building systems like electricity, plumbing etc.	Remember
CO3	Know how of the Concrete repair industry equipped with variety of repair materials and techniques	Remember
CO4	Know the various repair works in building systems.	Remember
CO5	Demonstrate the dismantling and demolishing structures	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	1	1	1	1	1	2	1	1	-	1
CO2	-	-	-	-	2	1	1	1	1	1	2	1	1	-	1
CO3	-	-	-	-	2	1	1	1	1	1	1	1	2	-	1
CO4	-	-	-	-	2	1	1	1	1	-	-	-	1	-	1
CO5	-	-	-	-	1	2	1	2	2	2	1	1	1	-	1
Avg	-	-	-	-	1.6	1.2	1	1.2	1.2	1.25	1.5	1	1.2	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEOE04	MECHANICS OF DEFORMABLE BODIES			Semester		VI
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
Mechanics of Solids and Strength of Materials		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To learn the fundamental concepts of stress, strain and their relations based on linear elasticity with applications to bars and beams.
2	Analyze the bending of various types of beams under static loading conditions and compute the shear-moment diagrams of a beam and find the Maximum moment/shear and their locations for different cross sections of beams.
3	Understand the basic concept of theory of flexure and torsion, springs and strain energy.
4	To learn the principles of mechanics applied to different materials under static conditions and to develop problem solving skills through application of these principles to basic engineering problems.
5	To learn the principles of mechanical behavior of engineering materials, various tests under dynamics conditions and parametric studies.

Unit I	**SIMPLE STRESSES, BEHAVIOUR OF COMPOSITE SECTIONS, THERMAL STRESSES**	**9**	**0**	**0**	**9**

Mechanical properties of solids –Hooke's law, principle of superposition, Bars of varying sections –Elastic constants – composite sections – determination of stress, strain , deformation –Temperature stress ,strain

Unit II	**BENDING AND SHEAR**	**9**	**0**	**0**	**9**

Types of beams – shear force and bending moment. Theory of simple bending - Analysis of stress-load carrying capacity. Shear stress distribution of simple beams of different cross sections

Unit III	**TORSION AND SPRINGS**	**9**	**0**	**0**	**9**

Torsion of circular shaft – Hollow and solid circular section, torsional rigidity-stepped shaft-Twist and torsional stiffness-compound shaft-shafts springs-Stiffness and deflection of helical springs, leaf spring

Unit IV	**MECHANICAL BEHAVIOUR OF MATERIALS UNDER STATIC LOADS**	**9**	**0**	**0**	**9**

Tension tests – stress – strain diagram, Elastic and plastic regions – True stress – strain properties in tension – fracture under tensile loads – compression and Torsion tests – stress concentration –Residual stresses

Unit V	**MECHANICAL BEHAVIOUR OF MATERIALS UNDER DYNAMIC LOADS**	**9**	**0**	**0**	**9**

Fatigue loading and Fatigue fracture – Fatigue tests – Empirical relations between variable stress and mean stress – Fatigue stress concentration Factors – Cumulative Damage – Endurance limit –Impact – notched – Bar Impact tests, Charpy Impact tests – Izod Impact tests – Elevated temperature – Creep tests – Isochronous curves – stress Relaxation – Parametric methods

Total= 45 Periods

Text Books:	
1	James M.Gere, Mechanics of Materials, Brooke/Cole Thomson Learning, 5 Ed., 2001.
2	Dr.R.Vaithiyanathan, Dr. P. Perumal &Lingeswari", Mechanics of Solids and StructuresVolume-I" Sci- tech publications, India(Pvt) Chennai-17.
3	Srinath L.S; - Strength of materials – Macmillan India Limited – New Delhi,2017
Reference Books:	
1	Popov.E.P., "Engineering Mechanics of solids", Prentice- Hall of India, New Delhi
2	Beer F.P and Johnston R, "Mechanics of Materials", McGraw- Hill book Co, Third Edition
3	Timoshenko S.P., "Elements of Strength of Materials", Tata McGraw- Hill, New Delhi
4	Nash W.A., "Theory and Problems in Strength of Materials", Schuam outline Series, McGraw- Hill Book Co., New York.
5	Rajput. R.K., "Strength of Materials", S. Chand & Co, Delhi, Third Edition, 2003.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To acquire basic knowledge of stress strain and deformation of structures of varying cross sections of bars.	Knowledge
CO2	To draw Shear Force and Bending Moment Diagram for transverse loading under various types of loadings and beams.	Analyse
CO3	To solve problems of Torsional shear stress for shaft and stiffness and deflection of springs	Apply
CO4	Describe the mechanical behaviour of engineering materials subjected to various types of stresses	Understand
CO5	Understand the concept of mechanical behaviour under dynamic loading of various tests to find the stresses induced in the materials.	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	2	-	-	1	-	-	-	-	1	-	-	-
CO2	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	1	1	-	1	-	-	-	-	-	-	-	1	-	-	-
CO4	1	1	-	1	-	-	-	-	-	-	1	1	-	-	-
CO5	1	1	-	1	-	-	-	-	-	-	1	1	-	-	-
Avg	1	1	-	1.25	-	-	1	-	-	-	1	1	-	-	-

22CSOE01	OBJECT ORIENTED PROGRAMMING USING CONCEPTS						
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**	
Problem Solving and C Programming		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To understand object oriented programming concept
2.	To apply object oriented concept for problem solving
3.	To design solutions to the real world problems using object oriented concept.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Procedure oriented programming paradigm - Object oriented programming paradigm - Basic concepts of object oriented programming, benefits of OOP, application of OOP - C++ fundamentals –structure of C++ program, tokens, data types - Operators and expressions - Control structures - Functions.					
UNIT II	**CLASSES AND OBJECTS**	**9**	**0**	**0**	**9**
Classes and objects - friend functions- constructors and destructors- Operator overloading – binary and unary operator overloading using member function and friend function - Type conversions.					
UNIT III	**INHERITANCE AND VIRTUAL FUNCTIONS**	**9**	**0**	**0**	**9**
Inheritance – defining derived classes, types, virtual base classes, abstract classes, constructor in derived classes - Pointers-pointers to objects, this pointer, pointer to derived classes - Virtual functions.					
UNIT IV	**TEMPLATES AND EXCEPTION HANDLING**	**9**	**0**	**0**	**9**
Generic Classes – class template, class templates with multiple parameters - Generic Functions - function templates, function templates with multiple parameters, member function templates - Exception handling – basics, exception handling mechanism, rethrowing an exception .					
UNIT V	**CONSOLE I/O AND FILE HANDLING**	**9**	**0**	**0**	**9**
C++ Stream Classes – unformatted I/O operations, formatted console I/O operations, manipulators - Files-classes for file operation, opening and closing a file, detecting end of file, files modes, sequential file operations, random file operations.					
					Total (45 L) =45 Periods

Text Books:

1.	E. Balagurusamy “Object Oriented Programming with C++”, Eighth Edition, Tata McGraw-Hill, 2020.

Reference Books:

1.	Herbert Schildt, "The Complete Reference C++", Fifth Edition, Tata McGraw Hill, 2015.
2.	Bjarne Stroustrup, “The C++ programming language”, Fourth Edition Addison Wesley, 2013.
3.	K.R.Venugopal, Rajkumar Buyya, T.Ravishankar , Mastering in C++, Second Edition, Tata McGraw Hill,2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Familiarize the object oriented programming concepts, Generic Programming and handling exceptions.	Understand
CO2	Build Object Oriented Programming concepts for problem solving.	Apply
CO3	Develop solutions to real world problems using Object Oriented Concepts.	Apply

22CSOE02	OPERATING SYSTEMS PRINCIPLES						
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**	
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To understand the structure and functions of Operating systems
2.	To understand the process concepts and scheduling algorithms
3.	To understand the concept of process synchronization and deadlocks
4.	To learn various memory management schemes
5.	To illustrate various file systems and disk management strategies

UNIT I	INTRODUCTION AND OPERATING SYSTEM STRUCTURES	9	0	0	9

Main frame Systems, Desktop Systems, Multiprocessor Systems, Distributed Systems, Clustered Systems, Real Time systems, Hand held Systems; Operating Systems Structures - System Components, Operating System Services, System calls, System Programs, System Design and Implementation.

UNIT II	PROCESS MANAGEMENT	9	0	0	9

Processes-Process Concepts, Process Scheduling, Operation on Processes, Co-Operating Processes, InterProcess Communication; Threads- Multithreading Models, Threading Issues; CPU Scheduling-Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

UNIT III	PROCESS SYNCHRONIZATION AND DEADLOCKS	9	0	0	9

Process Synchronization- The Critical Section Problem, Semaphores, Classical Problem of Synchronization, Monitors; Deadlocks- Deadlock Characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance ,Deadlock Detection, Recovery from Deadlock.

UNIT IV	MEMORY MANAGEMENT AND VIRTUAL MEMORY	9	0	0	9

Memory Management- Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging; Virtual Memory - Demand paging, Page Replacement, Thrashing.

UNIT V	FILE SYSTEM AND MASS-STORAGE STRUCTURE	9	0	0	9

File System Interface - File Concepts, Access methods, Directory Structure, File Sharing, File Protection; File System Implementation - File System Structure and Implementation, Directory Implementation, Allocation Methods, Free Space Management; Mass-Storage Structure - Disk Structure, Disk scheduling, Disk Management, RAID Structure.

Total (45 L) =45 Periods

Text Books:

1.	Abraham Silberschatz, P.B.Galvin, G.Gagne ―Operating System Concepts 6th edition, John Wiley & Sons, 2003.

Reference Books:

1.	Andrew S. Tanenbaum, ―Modern Operating Systems, PHI , 2nd edition, 2001
2.	D.M.Dhamdhere, “Systems Programming and Operating Systems ", 2nd edition, Tata McGraw Hill Company, 1999.
3.	Maurice J. Bach, ―The Design of the Unix Operating System, 1st edition, PHI, 2004.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Interpret the components and functionalities of the operating system	Understand
CO2	Apply various services and concepts of operating system to real time applications	Apply
CO3	Analyze the issues related to operating system and provide suitable solutions.	Analyze

22CSOE03	COMPUTER COMMUNICATIONS AND NETWORKS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To study the concepts of data communications and functions of different ISO/OSI reference architecture
2.	To understand the error detection and correction methods and also the types of LAN
3.	To study the concepts of subnetting and routing mechanisms
4.	To understand the different types of protocols and congestion control
5.	To study the application protocols and network security

UNIT I	**DATA COMMUNICATIONS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**
Data Communication; Networks- Physical Structures (Types of Connections, Physical Topology),Categories of Networks, Interconnection of Networks: Internetwork; Protocols and Standards; Network Models-The OSI Model, Layers in the OSI Model, Addressing; Transmission media-Guided Media, Unguided Media.					
UNIT II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**
Introduction-Types of errors, Redundancy, Detection versus Correction; Block Coding-Error Detection and Correction (VRC, LRC, CRC, Checksum, Hamming Code);Data link Control- Flow Control (Stop- and-Wait, Sliding Window),Error Control (Automatic Repeat Request, Stop-and-wait ARQ, Sliding Window ARQ), HDLC; Local Area Networks- Ethernet, Token Bus, Token Ring.					
UNIT III	**NETWORK LAYER**	**9**	**0**	**0**	**9**
Network Layer services-Packet Switching-Network Layer Performance-IPv4 addresses-IPv6 addressing- Subnetting-Bridges-Gateways- Routers-Routing Algorithm-Distance Vector Routing, Link State Routing.					
UNIT IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**
Duties of the Transport layer-User Datagram Protocol-Transmission Control Protocol- Congestion Control and Quality of Service-Congestion, Congestion Control, Quality of Service, Techniques to improve QoS.					
UNIT V	**APPLICATION LAYER**	**9**	**0**	**0**	**9**
Domain Name System - Domain Name Space, DNS in the Internet; Electronic Mail-FTP- HTTP- World Wide Web.					
Total (45 L) =45 Periods					

Text Book:

1.	Behrouz A. Ferouzan, "Data Communications and Networking", 4th Edition, Tata McGraw-Hill, 2007.

Reference Books:

1.	Andrew S. Tanenbaum, "Computer networks "PHI, 4th edition 2008
2.	William Stallings," Data and computer communications", 10th edition,PHI, 2012
3.	Douglas E. comer," Internetworking with TCP/IP-Volume-I", 6th edition,PHI, 2008

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamental concepts of networking and working principles of various communication protocols.	Understand
CO2	Apply the various functionalities of OSI layers in real time applications	Apply
CO3	Analyze the various network issues in different layers and provide suitable solutions.	Analyze

22CSOE04	PYTHON PROGRAMMING						
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To Learn the basic concepts of python programming.
2	To write simple programs using python programming concepts.
3	To build simple real world applications using python.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction - Features- The Basics - Numbers, Sequence: Strings, Lists, Tuples, Mapping and set types. Variables- Operators- Expressions- Precedence of operators – Comments - Input and output functions - Formatting numbers and strings- Implicit/explicit type conversion.					
UNIT II	**CONDITIONS,CONTROL STRUCTURES AND FILES**	**9**	**0**	**0**	**9**
Conditionals and loops-if statement-else statement – elif-Conditional Expressions-while statement-for statement – break-continue –pass; Files and Input/ Output.					
UNIT III	**PYTHON EXCEPTIONS, MODULES AND PACKAGES**	**9**	**0**	**0**	**9**
Errors and Exceptions – Introduction-Detecting and handling Exceptions- Raising Exceptions – Assertions-Standard Exceptions – Modules: user defined modules, random and o s modules - Packages.					
UNIT IV	**FUNCTIONS**	**9**	**0**	**0**	**9**
Functions-Calling functions-Creating functions-Passing Functions-Formal Arguments-Variable length arguments- Variable scope – Recursion- Map, Filter, Reduce and List Comprehensions-Iterators -Generator Expressions.					
UNIT V	**OBJECT ORIENTED PROGRAMMING AND REGULAR EXPRESSION**	**9**	**0**	**0**	**9**
Introduction – Classes- Class Attributes – Instances-Instances attributes-Building and Method Invocation-Static methods and Class Methods – Inheritance-Operator overloading-Regular Expression.					
					Total (45 L) =45 Periods

Text Books:	
1.	Wesley J.Chun-“Core Python Programming” –Prentice Hall, Third Edition, 2012.
Reference Books:	
1.	Swaroop C N, “ A Byte of Python “, ebshelf Inc., 1st Edition, 2013
2.	“A Practical Introduction to python programming”, Brian Heinold,MountSt.Mary’s University,2012
3.	Learning to Program with Python,” Richard L. Halterman”., Southern Adventist University

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To understand the basic concepts of python programming.	Understand
CO2	To design simple programs using python programming concepts.	Apply
CO3	To apply python programming concepts in the real world application.	Analyze

22CSOE05	INTRODUTION TO PROGRAMMING IN JAVA					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
C Programming		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To familiarize and apply the Object Oriented concepts and java features
2.	To write the standalone applications and applet applications
3.	To build simple chart application and Database Connectivity

UNIT I	INTRODUCTION TO JAVA	9	0	0	9

Fundamentals of object oriented programming- java features, comparing JAVA with C and C++, JAVA environment; Overview of java language - java program structure, java tokens, java statements, implementing java program, java virtual machine, command line arguments; constants, variables and data types - Operators and expressions - Decision making – branching and looping.

UNIT II	JAVA FEATURES	9	0	0	9

Classes, objects methods – arrays, Strings and Vectors– Interfaces – Packages - Multithreaded programming- Exception handling.

UNIT III	APPLET	9	0	0	9

Applet programming- build applet code, applet life cycle, creating executable applet, designing a web page, applet tag, running the applet ,passing parameters to Applet; Graphics programming – graphics class, lines, rectangles, circles, ellipses, arcs and polygons

UNIT IV	AWT CONTROLS	9	0	0	9

Event handling – event handling Mechanisms, delegation event model, event classes, sources of events, event listener interfaces; AWT - AWT controls, Layout Managers, Menu Bars and Menus, Dialog Boxes, FileDialogs;

UNIT V	I/O FILES AND JDBC	9	0	0	9

I/O Files- concepts of stream, stream classes, byte stream classes, character stream classes, file classes, creation of files, reading and writing characters and bytes; Design of JDBC - JDBC drivers; JDBC programming concepts - Database concepts, making connection, executing SQL commands, managing connections, statements, and result sets; Query execution - Prepared Statements.

Total(45L)=45Periods

Text Books:

1.	E. Balaguruswamy, “Programming with java”, Sixth, TMH 2019 (Unit- I-III)
2.	Patrick Naughton , Herbert Schildt, “The Complete Reference Java 2” , Twelfth edition Tata McGraw Hills , 2021 (Unit IV - V)

Reference Books:

1.	Cay S. Horstmann, Gary Cornell “ Core Java 2” Eighth Edition, Pearson Education, 2008
2.	Graham Hamilton , Rick Cattell, Maydene Fisher ,”JDBC Database access with java”.1997
3.	PaulDeitel and Harvey Deitel, “Java How to Program”, Eleventh Edition, Pearson Prentice Hall 2017.

COURSEOUTCOMES: Upon completion of the course ,the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Familiarize the Object Oriented concepts and java features	Understand
CO2	Build the simple standalone applications and web applications	Create
CO3	Develop simple application using files and Database	Create

22CSOE06	COMPUTER ORGANIZATION				SEMESTER VI		
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**	
Digital Principles and System Design		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To understand the basic structure and operations of digital computer and to learn the working of different arithmetic operations.
2.	To expose different types of processor control and the concept of pipelining and to familiarize hierarchical memory system including cache memory and virtual memory
3.	To expose the different ways of communicating with I/O devices and standard I/O interfaces

UNIT I	INTRODUCTION	9	0	0	9

Functional units ,Basic Operational Concepts, Bus Structure ,Memory Locations and Addresses, MemoryOperations, Instruction and Instruction Sequencing, Addressing modes.

UNIT II	ARITHMETIC UNIT	9	0	0	9

Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, BoothAlgorithm, Fast Multiplication, Integer Division, Floating point number operations.

UNIT III	PROCESSOR UNIT AND PIPELINING	9	0	0	9

Fundamental Concepts, Execution of Instruction, Multi Bus Organization, Hardwired control, Micro programmed control, Basic Concepts of pipelining, Data Hazards, Instruction Hazards, Data path & Control Considerations.

UNIT IV	MEMORY SYSTEMS	9	0	0	9

Basic Concepts, Semiconductor RAM, ROM, Cache memory, Improving Cache Performance, Virtual memory, Memory Management requirements, Secondary Storage Device.

UNIT V	INPUT AND OUTPUT ORGANIZATION	9	0	0	9

Accessing I/O devices, Programmed I/O, Interrupts, Direct Memory Access, Interface circuits, Standard I/OInterfaces (PCI, SCSI, USB).

Total (45 L)= 45 Periods

Text Books:

1.	Carl Hamacher V.,Zvonko G.Vranesic, Safwat G. Zaky, " Computer organization ", Tata McGraw Hill,5th Edition, 2008.

Reference Books:

1.	Patterson and Hennessey, “Computer Organization and Design ". The Hardware/Software interface,Harcourt Asia Morgan Kaufmann, 3rd Edition, 2007
2.	Hayes, “Computer Architecture and Organization ", 3rd edition,Tata McGraw Hill, 2006
3.	Heuring V.P., Jordan H.F., " Computer System Design and Architecture ", 6th edition ,Addison Wesley,2008

COURSE OUTCOMES Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Understand the working principles of computer components	Understand
CO2	Design the arithmetic and processing units	Create
CO3	Analyze the various computer components	Analyze

22CSOE07	DATA STRUCTURES USING C++					SEMESTER VI		
PREREQUISITES			**Category**	**OE**	**Credit**			**3**
C Programming			**Hours/Week**	**L**	**T**		**P**	**TH**
				3	**0**		**0**	**3**

Course Learning Objectives

1	To comprehend the fundamentals of object oriend programming, particularly in C++
2	To design linear and non linear data structure using object programming concepts
3	To apply various sorting and searching alogorithims.

UNIT I	**DATA ABSTRACTION & OVERLOADING**	**9**	**0**	**0**	**9**
Overview of C++ – Structures – Class Scope and Accessing Class Members – Reference Variables – Initialization – Constructors – Destructors – Member Functions and Classes – Friend Function – Dynamic Memory Allocation – Static Class Members – Container Classes and Integrators – Overloading: Function overloading and Operator Overloading.					
UNIT II	**INHERITANCE AND POLYMORPHISM**	**9**	**0**	**0**	**9**
Base Classes and Derived Classes – Protected Members – Casting Class pointers and Member Functions – Overriding – Public, Protected and Private Inheritance – Constructors and Destructors in derived Classes – Implicit Derived – Class Object to Base – Class Object Conversion – Virtual functions – this Pointer – Abstract Base Classes and Concrete Classes – Virtual Destructors – Dynamic Binding.					
UNIT III	**LINEAR DATA STRUCTURES**	**9**	**0**	**0**	**9**
Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation –Singly Linked lists –Polynomial Manipulation – Stack ADT – Queue ADT – Evaluating arithmetic expressions.					
UNIT IV	**NON-LINEAR DATA STRUCTURES**	**9**	**0**	**0**	**9**
Trees – Binary Trees – Binary tree representation and traversals – Application of trees – Binary Search Tree - Heaps - Operations of Heaps - Binary Heap - Max Heap - Min Heap - Graph and its representations – Graph Traversals – Representation of Graphs – Breadth-first search – Depth-first search.					
UNIT V	**SORTING AND SEARCHING**	**9**	**0**	**0**	**9**
Sorting algorithms: Insertion sort – Quick sort – Merge sort – Searching: Linear search –Binary Search					
					Total (45 L) =45 Periods

Text Books:

1	Deitel and Deitel, “C++, How To Program”, Tenth Edition, Pearson Education, 2017.
2	Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, Fourth Edition, Addison Wesley, Copyright 2014.

Reference Books:	
1	Bhushan Trivedi, “Programming with ANSI C++, A Step-By-Step approach”, Oxford University Press,2010.
2	Goodrich, Michael T., Roberto Tamassia, David Mount, “Data Structures and Algorithms in C++”, 7thEdition, Wiley. 2004.
3	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Second Edition, Mc Graw Hill, 2002.
4	Bjarne Stroustrup, “The C++ programming language”, Fourth Edition Addison Wesley, 2013.
5	Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, “Fundamentals of Data Structures in C++”, Galgotia Publications, 2007.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the concepts of Object oriented programming	Understand
CO2	Design linear and non-linear data structure using object oriented programming concepts	Apply
CO3	Apply various sorting and searching Alogarithms.	Analyze

22CSOE08	CLOUD COMPUTING FUNDAMENTALS					
PREREQUISITES:		**CATEGORY**	**OE**	**Credit**		**3**
Computer Networks		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the broad perceptive of Parallel Computing, Distributed Computing and Cloud Computing.
2.	To understand the concept of Virtualization, Cloud Architecture and Storage.
3.	To understand the Cloud Platforms in Industry and Software Environments.
4.	To understand the concept of Cloud Security and Applications.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

The vision of Cloud Computing – Defining a Cloud – The Cloud Computing reference model –Characteristics and Benefits; Historical developments: Distributed systems – Virtualization - Web 2.0 - Service-oriented computing - Utility-oriented computing.
Principles of Parallel and Distributed Computing: Parallel vs. distributed computing - Elements of parallel and distributed computing - Technologies for distributed computing.

UNIT II	**VIRTUALIZATION**	**9**	**0**	**0**	**9**

Introduction - Characteristics of Virtualized environments - Virtualization techniques: Machine Reference Model – Hardware Level Virtualization - Programming Language Level Virtualization –Application Level Virtualization - Other types of Virtualization - Pros and cons of Virtualization.

UNIT III	**CLOUD ARCHITECTURE AND STORAGE**	**9**	**0**	**0**	**9**

The cloud reference model: IaaS, PaaS, SaaS; Types of clouds: Public clouds – Private clouds – Hybrid clouds – Community clouds ;Architectural design challenges.
Cloud Storage: Storage as a Service – Advantages of cloud storage – Cloud Storage Provider: Amazon Simple Storage Service (S3).

UNIT IV	**CLOUD INDUSTRIAL PLATFORMS AND SOFTWARE ENVIRONMENTS**	**9**	**0**	**0**	**9**

Cloud Platforms in Industry: Amazon Web Service - Google App Engine - Microsoft Azure; Cloud Software Environments -Hadoop –Map Reduce -Eucalyptus – Open Nebula;

UNIT V	**CLOUD SECURITY AND APPLICATIONS**	**9**	**0**	**0**	**9**

Security in the cloud: Cloud Security challenges – Software as a Service Security: Security Management – Security governance – Security Architecture Design -Virtual Machine Security – Identity Access Management.
Cloud Scientific Applications: Healthcare: ECG analysis in the cloud- Geo science: Satellite Image Processing.

Total (45 L)=45 Periods

Text Books:

1.	Rajkumar Buyya, Christian Vecchiola, S.TamaraiSelvi, ‘Mastering Cloud Computing-Foundations and Applications Programming”, TMGH,2013.
2.	Rittinghouse, John W., and James F. Ransome – Cloud Computing: Implementation, Management and Security. CRC Press, 2017.

Reference Books:

1.	Kai Hwang.GeoffreyC.Fox.JackJ.Dongarra, “ Distributed and Cloud Computing ,From Parallel Processing to The Internet of Things”, 2012 Elsevier

2.	Barrie Sosinsky, “Cloud Computing Bible”, Wiley Publisher, 2011

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Explain the main concepts and architecture of Parallel computing, Distributed Computing and Cloud Computing.	Understand
CO2	Analyze the concept of Virtualization, Cloud Architecture and Storage.	Analyze
CO3	Analyze the Cloud Platforms in Industry and Software Environments.	Analyze
CO4	Identify the security issues in scientific and real time applications.	Apply

22CSOE09	**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**						
PREREQUISITES:		**CATEGORY**	**OE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To learn the various characteristics of Intelligent agents, different search strategies and represent knowledge in solving AI problems
2.	To understand the need for machine learning for various problem solving
3.	To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.					
UNIT II	**PROBLEM SOLVING METHODS**	**9**	**0**	**0**	**9**
Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems – Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning.					
UNIT III	**KNOWLEDGE REPRESENTATION**	**9**	**0**	**0**	**9**
First Order Predicate Logic – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.					
UNIT IV	**LEARNING PROBLEMS**	**9**	**0**	**0**	**9**
Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.					
UNIT V	**NEURAL NETWORKS AND GENETIC ALGORITHMS**	**9**	**0**	**0**	**9**
Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evaluation and Learning.					
Total (45 L)=45 Periods					

Text Books:

1.	S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009
2.	I. Bratko, ―Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011
3.	Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

Reference Books:

1.	M. Tim Jones, ―Artificial Intelligence: A Systems Approach(Computer Science)‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008
2.	Nils J. Nilsson, ―The Quest for Artificial Intelligence‖, Cambridge University Press, 2009
3.	William F. Clocksin and Christopher S. Mellish,‖ Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003

E-References:	
1.	https://builtin.com/artificial-intelligence
2.	https://science.howstuffworks.com/robot6.htm
3.	https://onlinecourses.nptel.ac.in/noc18_cs40/preview, (Prof. Sudeshna Sarkar,IIT KHARAGPUR)
4.	Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning From Theory to Algorithms, Cambridge University Press, 2014
5.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use appropriate search algorithms for any AI problem	Apply
CO2	Represent a problem using first order and predicate logic	Understand
CO3	Differentiate between supervised, unsupervised, semi-supervised machine learning approaches	Analyze
CO4	Discuss the decision tree algorithm and identity and overcome the problem of over fitting	Apply

22ECOE01	FUNDAMENTALS OF ELECTRON DEVICES					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand the fundamentals of electron devices and apply the knowledge of these devices in electronic circuits.
2.	To design and analyse single stage and multistage amplifier circuits.
3.	To understand and classify different kinds of power and feedback amplifiers.

Unit I	**SEMICONDUCTOR DIODE**	**9**	**0**	**0**	**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.

Unit II	**BIPOLAR JUNCTION TRANSISTORS**	**9**	**0**	**0**	**9**

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

Unit III	**FIELD EFFECT TRANSISTORS**	**9**	**0**	**0**	**9**

JFETs — Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance- MOSFET-Characteristics- Threshold voltage, D-MOSFET, E-MOSFET- Characteristics — Comparison of MOSFET with JFET.

Unit IV	**SPECIAL SEMICONDUCTOR DEVICES**	**9**	**0**	**0**	**9**

Metal-Semiconductor Junction- MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode, LASER diode.

Unit V	**POWER DEVICES AND DISPLAY DEVICES**	**9**	**0**	**0**	**9**

UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS, LED, LCD, Photo transistor, Opto Coupler, Solar cell, CCD.

Total (45L) = 45 periods

Text Books:

1.	Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
2.	Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, “Electronic Devices and circuits”, Fourth Edition, Tata McGraw- Hill, 2016.

Reference Books:

1.	Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” Pearson Prentice Hall, 11th Edition, 2014.
2.	Bhattacharya and Sharma, “Solid State Electronic Devices”, 2nd Edition, Oxford University Press, 2014.
3.	R.S.Sedha, “A Textbook of Electronic Devices and Circuits”, 2nd Edition, S.Chand Publications, 2008.
4.	David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Oxford University Press, 2008.

E-References:

1.	https://archive.nptel.ac.in/courses/108/108/108108122/
2.	https://www.youtube.com/watch?v=qqQ8wO-lNmI
3.	https://slideplayer.com/slide/12438044/

Course Outcomes: Upon completion of this course, the students will be able to		Bloom’s Taxonomy Mapped
CO1	Analyze the characteristics of semiconductor diodes.	Understanding
CO2	Describe the problems of Transistor circuits using model parameters.	Analysing
CO3	Analyze the knowledge of various types of FET.	Analysing
CO4	Gain a knowledge on special semiconductor devices	Understanding
CO5	Understand the knowledge on Power and Display devices.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	3	1	2	-	-	-	-	-	-	-	-	2	-	-
CO3	2	3	1	3	-	-	-	-	-	-	-	-	3	-	-
CO4	1	2	1	-	-	-	1	-	-	-	1	3	3	-	1
CO5	1	3	1	1	1	-	1	-	-	-	2	3	3	1	2
Avg	1.6	2.8	1	2	2	-	2	-	-	-	1.5	3	2.4	1	1.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE02	PRINCIPLES OF MODERN COMMUNICATION SYSTEMS					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To have the knowledge of the basic concepts of AM, FM and PM.
2.	To gain knowledge about different pulse modulation and digital modulation techniques.
3.	To gain knowledge about technical information on satellite communication and wireless communication

Unit	Title	L	T	P	TH
Unit I	**FUNDAMENTALS OF ANALOG COMMUNICATION**	**9**	**0**	**0**	**9**

Modulation: Introduction - Amplitude modulation: Modulator and demodulator with waveforms - Angle Modulation: Frequency modulation: Modulator and demodulator with waveforms - Phase modulation - Equivalence between PM and FM - FM transmitters and receivers (Block diagram approach only) - Comparison of various Analog Communication System (AM – FM – PM).

Unit	Title	L	T	P	TH
Unit II	**BASICS OF DIGITAL COMMUNICATION AND PULSE MODULATION**	**9**	**0**	**0**	**9**

Pulse Amplitude Modulation (PAM) – Pulse Width Modulation (PWM) – Pulse code Modulation (PCM)–Differential Pulse Code Modulation - Pulse Position modulation: Generation and detection - Comparison of various Pulse Communication System (PAM – PWM – PCM - PPM).

Unit	Title	L	T	P	TH
Unit III	**DIGITAL MODULATION TECHNIQUES**	**9**	**0**	**0**	**9**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) - Minimum Shift Keying (MSK) –Binary Phase Shift Keying (BPSK) – QPSK –M- ary PSK- Comparison of various Digital Communication System (ASK – FSK – PSK).

Unit	Title	L	T	P	TH
Unit IV	**SATELLITE COMMUNICATION**	**9**	**0**	**0**	**9**

History of Satellites- Kepler's laws - Satellite Orbits-Geo synchrous Satellites - Satellite Classification - Footprints - Satellite system link models: Uplink model and down link model - Multiple Access Techniques: TDMA - FDMA-CDMA-SDMA - Comparison of Multiple Access Schemes - various satellite services.

Unit	Title	L	T	P	TH
Unit V	**CELLULAR MOBILE COMMUNICATION**	**9**	**0**	**0**	**9**

Cellular concept - Frequency reuse-Channel Assignment Strategy - Hand off mechanism - Basic propagation models: Reflection - diffraction and scattering - Bluetooth-WLAN-Global System for Mobile Communications (GSM) –GPRS.

Total (45L)= 45 Periods

Text Books:

1.	Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007
2.	Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2010

Reference Books:

1.	Dennis Roddy, John Coolen, "Electronic Communications", Prentice Hall of India, 4th Edition.,2016
2.	H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007.
3.	B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007.
4.	AnokhSingh , "Principles of Communication Engineering" ,S.CHAND Publication, 2002

E-References:

1.	http://www.nptelvideos.in/2012/11/communication-engineering.html
2.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm

3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-973-communication-system-design-spring-2006/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the need for modulation and how analog modulation takes place	Understanding
CO2	Understand the features of digital communication and pulse modulation.	Understanding
CO3	Analyse various digital modulation schemes.	Analysing
CO4	Have the knowledge about satellite communication.	Remembering
CO5	Have the basics of wireless and mobile communication.	Remembering

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	-	-	-	-	-	-	-	3	2	2
CO2	2	2	1	1	1	-	-	-	-	-	-	-	2	1	2
CO3	1	3	2	2	1	-	-	-	-	-	-	-	3	1	2
CO4	2	2	1	1	1	-	-	-	-	-	-	-	3	2	2
CO5	1	2	2	1	1	-	-	-	-	-	-	-	3	2	2
Avg	1.6	2.2	1.4	1.4	1	-	-	-	-	-	-	-	2.8	1.6	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE03	MICROCONTROLLERS AND ITS APPLICATIONS					OPEN ELECTIVE
PREREQUISITES		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To learn microcontroller basics and get exposure to 8051 architectures
2.	To embed and program with 8051 microcontrollers
3.	To introduce the advanced features in microcontrollers and its applications

Unit I	INTRODUCTION TO 8051 MICROCONTROLLER	9	0	0	9
Introduction to the concepts of microprocessors, microcontrollers, RISC, CISC, Harvard and Von Neumann architectures. Selection of microcontrollers, variants of MCS-51 family and their features. Applications of microcontrollers. 8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization.					
Unit II	ASSEMBLY LANGUAGE PROGRAMMING	9	0	0	9
Features of machine language, assembly language, middle-level and high-level languages. 8051 Addressing modes. Instruction set: Classification, syntax and function of instructions, example programs.					
Unit III	I/O PORT AND INTERRUPTS PROGRAMMING	9	0	0	9
Features of I/O ports. Byte size I/O, bit addressability and configuring I/O ports, interface I/O devices such as LED, buzzer, push-button switch, relay, example programs with assembly. Polling & interrupt methods, executing an interrupt, different types, IE and IP registers, enabling, disabling and priority setting, example programs in assembly.					
Unit IV	PIC MICROCONTROLLERS	9	0	0	9
Main characteristics of PIC microcontrollers – PIC microcontroller families-12-bit instruction word-14-bit instruction word-16-bit instruction word-Inside a PIC microcontroller.					
Unit V	APPLICATIONS	9	0	0	9
Multiplexed seven-segment display, LCD module, ADC 0804, wave form generation using DAC 0808, DC motor-PWM for speed control, Stepper motor, appropriate program.					
					Total (45L)= 45 Periods

Text Books:

1.	A.Mazidi , J.C. Mazidi&R.D.McKinlay,” The 8051 Microcontroller & Embedded systems using assembly and C” (2ndEdition)
2.	Lucio Di Jasio et.al., “PIC Microcontrollers: Know It All”, Elsevier Science,2007

Reference Books:

1.	Microcontrollers & applications, Ramani Kalpathi, & Ganesh Raja
2.	Embedded C - Michael .J.Pont - Pearson Education -2002
3.	I. Scott MacKenzie, Raphael C.-W. Phan “The 8051 Microcontroller” , Pearson/Prentice Hall Publishers, 2008.
4.	M. Mahalakshmi, “8051 Microcontroller Architecture, Programming and Application”, Laxmi Publications , 2008.

E-References:

1.	https://nptel.ac.in/courses/108105102
2.	https://www.youtube.com/playlist?list=PLm_MSClsnwm9hEIDpFfDnOEu-6kVnF4ug
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basics of microcontroller and 8051 architectures.	Understanding
CO2	Develop programs for control applications using assembly language	Applying
CO3	Illustrate the use of interrupts service routines	Applying
CO4	Understand the PIC microcontroller architecture.	Understanding
CO5	Design microcontroller based simple real-world applications	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	-	2	-	2	-	-	-	-	-	-	3	-	2
CO2	1	2	-	-	-	2	-	-	-	-	-	-	-	-	1
CO3	2	2	-	3	-	1	-	-	-	-	-	-	2	-	3
CO4	1	3	-	2	-	2	-	-	-	-	-	-	2	-	1
CO5	2	3	-	1	-	2	-	-	-	-	-	-	2	-	2
Avg	1.4	2.4	-	2	-	1.8	-	-	-	-	-	-	2.25	-	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE04	COMPUTER NETWORKS					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the basic concept in modern data communication and computer networking.
2.	To introduce the students the functions of different layers and in - depth knowledge of data link layer.
3.	To make students to get familiarized with different protocols and network layer components.
4.	To introduce the basic functions of transport layer and congestion in networks.
5.	To understand the concepts of various network Applications and Data security.

Unit I	**NETWORK FUNDAMENTALS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**
Components – networks – Topologies – The OSI reference model - layers and duties. TCP/IP reference model – layers and duties, Physical Layer: Transmission Media – Guided media & unguided media - EIA 232, SONET					
Unit II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**
Logical link control Functions: - Framing, Flow control, Error control: CRC, LLC protocols -HDLC, P to P- Medium access layer: - Random access, Controlled access, Channelization - Wired LANs: Ethernet IEEE 802.3, IEEE 802.4, and IEEE 802.5. Internetworking, Interconnection issues, Interconnection devices: - Repeaters, Hubs, Routers/switches and Gateways.					
Unit III	**NETWORK LAYER**	**9**	**0**	**0**	**9**
Switching-Circuit switching, packet switching, message switching. Internet protocols; IPV4, IPV6, ARP, RARP, VPN. Network Routing Algorithms - Unicast routing protocol: Distance Vector Routing – Link State Routing.					
Unit IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**
Transport Services, Elements of Transport protocols, Connection management, – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control and Quality of services (QoS) – Integrated Services					
Unit V	**APPLICATION LAYER**	**9**	**0**	**0**	**9**
Domain Name Space (DNS) – Electronic mail (SMTP, MIME, POP3, IMAP4) - Application protocols: WWW, HTTP, FTP and TELNET, Network management protocol: SNMP.					
					Total (45L)= 45 Periods

Text Books:

1.	Behrouz A. Foruzan, “Data communication and Networking”, TMH, 4th edition, 2014.
2.	James. F. Kurouse& W. Ross, “Computer Networking: A Top down Approach Featuring”, Pearson, 2020.

Reference Books:

1.	LarryL.Peterson&PeterS.Davie,“ComputerNetworks”,HarcourtAsiaPvt.Ltd.,SecondEdition.
2.	AndrewS.Tanenbaum,“ComputerNetworks”,PHI,FourthEdition,2003.
3.	An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education
4.	AjitPal,“DataCommunicationandComputerNetworks”,PHI,2014.

E-References:

1.	https://nptel.ac.in/courses/106105183
2.	https://www.mbit.edu.in/wp-content/uploads/2020/05/Computer-Networks-5th-Edition.pdf
3.	https://www.tutorialspoint.com/data_communication_computer_network/index.htm

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Explain the basic concept in modern data communication and different level of layers in the protocol	Understanding
CO2	:	Analyse the functions and services of data link layer	Analysing
CO3	:	Categorize the functions and services of network layer	Understanding
CO4	:	Examine the basic functions of transport layer and congestion in networks	Understanding
CO5	:	Analyse the concepts of various network applications and data security	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	-	1	-	-	-	-	-	-	-	2	-	1
CO2	2	1	2	-	1	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	3	1	2
CO4	3	2	1	-	2	-	-	-	-	-	-	-	2	-	2
CO5	2	1	1	-	1	-	-	-	-	-	-	-	1	1	1
Avg	2.2	1.2	1.2	-	1.25	-	-	-	-	-	-	-	2	1	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE05	BASICS OF EMBEDDED SYSTEMS					OPEN ELECTIVE
PREREQUISITES		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To impart knowledge on embedded system architecture and embedded development Strategies
2.	To understand the bus Communication in processors and peripheral interfacing
3.	To understand basics of Real Time Operating System

Unit I	**BASICS OF EMBEDDED SYSTEMS**	**9**	**0**	**0**	**9**
Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Examples - Programming Languages - Recent Trends in Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning - Development Environment.					
Unit II	**MEMORY MANAGEMENT AND INTERRUPTS**	**9**	**0**	**0**	**9**
Memory Access Procedure - Types of Memory - Memory Management Methods - DMA – Memory Interfacing - Polling Vs Interrupts - Types of Interrupts - Interrupt Latency - Interrupt Priority – Programmable Interrupt Controllers - Interrupt Service Routines.					
Unit III	**COMMUNICATION INTERFACES**	**9**	**0**	**0**	**9**
Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth					
Unit IV	**REAL TIME OPERATING SYSTEMS**	**9**	**0**	**0**	**9**
Real-Time Concepts - Task Management - Task Scheduling - Classification of Scheduling Algorithms - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing - Priority Inheritance Protocol - Priority Ceiling Protocol - Inter Task Communication - Mutex - Semaphores - Message Queues - Timers - Commercial RTOS.					
Unit V	**VALIDATION AND DEBUGGING**	**9**	**0**	**0**	**9**
Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer – Background Debug Mode - InCircuit Emulator CASE STUDY: RFID Systems - GPS Navigation System – Development of Protocol Converter.					
Total (45L)= 45 Periods					

Text Books:

1.	Sriram VIyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2.	Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.

Reference Books:

1.	Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003
2.	Heath, "Embedded Systems Design‖", Newnes an Imprint of Elsevier, Massachusetts, 2003.
3.	Tammy Noergaard, "Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4.	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013

E-References:

1.	https://lecturenotes.in/subject/225/embedded-system-es
2.	https://nptel.ac.in/courses/108102045/19
3.	https://www.coursera.org/learn/introduction-embedded-systems.

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Outline the concepts of embedded systems	Remembering
CO2	Understand the concept of memory management system and interrupts.	Understanding
CO3	Know the importance of interfaces.	Understanding
CO4	Understand real time operating system concepts.	Understanding
CO5	To realize the applications of validation and debugging.	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3	3	3	2	-	-	-	3	3	3	-	2
CO2	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
CO3	3	3	3	3	3	3	2	-	-	-	3	3	3	-	2
CO4	3	3	2	3	3	3	2	-	-	-	2	3	3	-	2
CO5	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
Avg	3	3	2	3	3	3	2	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE06	BASICS OF INTERNET OF THINGS			OPEN ELECTIVE			
PREREQUISITES			**CATEGORY**	**OE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:					
1.	To understand the vision of M2M to IOT.				
2.	To gain an understanding of IOT market perspective.				
3.	To acquire knowledge on Io T Technology Fundamentals and applications				
4.	To build small system using Raspberry Pi.				
Unit I	**M2M TO IOT – THE VISION**	**9**	**0**	**0**	**9**
Introduction - From M2M to Io T- M2M towards Io T: M2M Communication - The global context - A use case example – Differing Characteristics.					
Unit II	**M2M TO IOT – A MARKET PERSPECTIVE**	**9**	**0**	**0**	**9**
Introduction - Some Definitions - M2M Value Chains – Io T Value Chains - An emerging industrial structure for Io T-International driven global value chain and global information monopolies - M2M to Io T-An Architectural Overview – Building an architecture - Main design principles and needed capabilities - An Io T architecture outline - Standards considerations.					
Unit III	**IOT TECHNOLOGY FUNDAMENTALS**	**9**	**0**	**0**	**9**
Io T Enabling technologies – Io T levels and deployment templates - Devices and gateways - Data management - Business processes in Io T - Everything as a Service (XaaS) - M2M and Io T Analytics.					
Unit IV	**BUILDING IOT WITH HARDWARE PLATFORMS**	**9**	**0**	**0**	**9**
Io T Systems-Logical Design using Python –Io T Physical Devices and End Points- Io T Device - Raspberry Pi - Interfaces – Programming – Other Io T devices – Io T Reference Model - Real World Design Constraints.					
Unit V	**IOT USE CASES AND APPLICATIONS**	**9**	**0**	**0**	**9**
Home automation-Automatic lighting-Home intrusion detection- Cities-Smart parking – Environment - Weather monitoring system-Air pollution Monitoring-Forest Fire Detection- Agriculture- Smart irrigation. Commercial Building Automation – Introduction - Case study (Phase one) : Commercial building automation today - Case study (Phase two) - Commercial building automation in the future.					
					Total (45L)= 45 Periods

Text Books:	
1.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2.	Arshdeep Bahga, Vijay Madisetti, “Internet of Things-A hands-on approach”, Universities Press, 2015
Reference Books:	
1.	Olivier Hersent, davidBoswarthick, Omar Elloumi, ‘The Internet of Things Applications to the smart grid building automation’, John Wiley & Sons, 2012
2.	Francis daCosta, “Rethinking the Internet of Things : A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013
3.	HakimaChaouchi, ‘The Internet of Things Connecting Objects’, John Wiley & Sons, 2010.
4.	FabriceTheoleyr, Ai-Chun Pang, ‘Internet of Things and M2M Communications’, River Publishers, 2013.
E-References:	
1.	https://nptel.ac.in/courses/106105166
2.	https://onlineitguru.com/IoT-online-training.html
3.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the vision of IoT from a global context.	Understanding
CO2	:	Determine the Market perspective of IoT.	Remembering
CO3	:	Understand the IoT technology fundamentals.	Understanding
CO4	:	Build small system using Raspberry Pi.	Applying
CO5	:	Analyse applications of IoT and case studies	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2	2	2	-	-	-	-	-	-	1	1	-	-
CO3	2	2	2	2	2	-	-	-	-	-	-	1	1	-	-
CO4	2	2	2	2	2	-	-	-	-	-	2	2	2	-	-
CO5	2	2	2	2	2	-	-	-	-	-	2	-	2	-	2
Avg	2	1.8	2	2	2	-	-	-	-	-	2	1.3	1.5	-	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECOE07	BASICS OF ARTIFICIAL INTELLIGENCE						OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**			**3**
		Hours/Week	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Objectives:

1.	Study about uninformed and Heuristic search techniques.
2.	To Learn techniques for reasoning under uncertainty
3.	Introduce Machine Learning and supervised learning algorithms
4.	Study about ensemble and unsupervised learning algorithms.
5.	Learn the basics of deep learning using neural networks.

Unit I	**PROBLEM SOLVING**	**9**	**0**	**0**	**9**
Introduction to AI - AI applications – problem solving agents – search algorithms – Uninformed search strategies – Heuristic search strategies – local search and optimization problems –adversarial search – constraing satisfaction problems(CSP) .					
Unit II	**PROBABILISTIC REASONING**	**9**	**0**	**0**	**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**	**0**	**0**	**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.					
Unit IV	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**	**9**	**0**	**0**	**9**
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN					
Unit V	**NEURAL NETWORKS**	**9**	**0**	**0**	**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) –batch normalization, regularization, dropout.					
					Total (45L)= 45 Periods

Text Books:	
1.	Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021
2.	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006
Reference Books:	
1.	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
2.	Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3.	Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4.	Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.
E-References:	
1.	https://machinelearningmastery.com/
2.	https://ai.google/education/
3.	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Use appropriate search algorithms for problem solving	Understanding
CO2	Apply reasoning under uncertainty	Applying
CO3	Build supervised learning models	Applying
CO4	Build ensembling and unsupervised models	Applying
CO5	Build deep learning neural network models	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	3	2	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EEOE01	RENEWABLE ENERGY SOURCES		SEMESTER			VI / VII
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
Basic Electrical and Electronics Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on the different renewable energy sources and technologies.

UNIT	TITLE	L	T	P	TH
UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil Nadu, India and around the World – Potentials – Achievements / Applications – Economics of Renewable Energy Systems.					
UNIT II	**SOLAR ENERGY**	**9**	**0**	**0**	**9**
Solar Radiation – Measurements of Solar Radiation – Flat Plate and Concentrating Collectors – Solar Direct Thermal Applications – Solar Thermal Power Generation – Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.					
UNIT III	**WIND ENERGY**	**9**	**0**	**0**	**9**
Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects.					
UNIT IV	**BIO – ENERGY**	**9**	**0**	**0**	**9**
Biomass Direct Combustion – Biomass Gasifiers – Biogas Plants – Digesters – Ethanol Production – Bio Diesel – Cogeneration – Biomass Applications.					
UNIT V	**OTHER RENEWABLE ENERGY SOURCES**	**9**	**0**	**0**	**9**
Tidal Energy – Wave Energy – Open and Closed Ocean Thermal Energy Conversion(OTEC) Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage – Fuel Cell Systems – Hybrid Systems.					
					Total (45L+0T) = 45 Periods

Text Books:

1.	Rai. G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2011.
2.	Twidell, J.W. & Weir, A., “Renewable Energy Sources”, EFN Spon Ltd., UK, 2006.
3.	Godfrey Boyle, “Renewable Energy, Power for A Sustainable Future”, Oxford University Press, U.K., 1996.

Reference Books:

1.	Chetan Singh Solanki, Solar Photovoltaics, “Fundamentals, Technologies and Applications”, PHI Learning Private Limited, New Delhi, 2009.
2.	Tiwari. G.N., Solar Energy – “Fundamentals Design, Modelling & Applications”, Narosa Publishing House, New Delhi, 2002.
3.	Freris. L.L., “Wind Energy Conversion Systems”, Prentice Hall, UK, 1990.
4.	Johnson Gary, L. “Wind Energy Systems”, Prentice Hall, New York, 1985
5.	David M. Mousdale – “Introduction to Biofuels”, CRC Press, Taylor & Francis Group, USA 2010

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Recall the available renewable Energy Sources	L1: Remembering
CO2	:	Illustrate the types of generators.	L4: Analysing
CO3	:	Apply different types of mechanism for energy conversion.	L3: Applying
CO4	:	Analyze the benefits and challenges in harnessing renewable Energy.	L4: Analysing
CO5	:	Recognize and apply appropriate renewable energy sources.	L2: Understanding

COURSE ARTICULATION MATRIX															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1
CO2	3	1	1	3	1	1	1	1	1	1	1	1	2	1	1
CO3	1	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO4	3	1	1	3	2	1	1	1	1	1	1	1	2	1	1
CO5	2	1	1	2	1	1	2	1	1	1	1	1	2	1	1
Avg	**2.2**	**1.2**	**1.2**	**2**	**1.4**	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1.7**	**1.2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEOE02	INDUSTRIAL DRIVES				SEMESTER			VI / VII
PREREQUISITES				CATEGORY	OE	Credit		3
Power Electronics, and Electrical Machines				Hours/Week	L	T	P	TH
					3	0	0	3

Course Objectives:

1.	To understand the basic components of electric drive system,
2.	To analyze the operation and performance of the chopper fed DCdrive,
3.	To understand the operation and performance of AC motor drives
4.	To understand the advanced techniques in the control of industrial drives.

Unit I	BASICS OF ELECTRIC DRIVE	9	0	0	9

Electric drive - introduction and advantages, types and choice of electric drive, components of electric drive system, motor duty class classification continuous, short time and intermittent duty, speed-torque characteristics of DC and Induction motor drive.

Unit II	DC DRIVES	9	0	0	9

Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting,
Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking

Unit III	AC DRIVES	9	0	0	9

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque speed curve with applied voltage, applied frequency and applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.

Unit IV	CONTROL OF DC AND AC DRIVES	9	0	0	9

Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.
Generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor. Operation of slip-ring induction motor with external rotor resistance, power electronic based rotor side control of slip ring motor, slip power recovery schemes.

Unit V	ADVANCED TECHNIQUES	9	0	0	9

Microcontroller based control of DC drive, Phase locked loop control of DC motor, AC/DC drive using microprocessor. Synchronous motor drives, Stepper motor - ratings, specifications, stepper motor drive employing microcontroller.

Total (45L+0T) = 45 Periods

Text Books:

1.	G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
2.	Subrahmanyam, Vedam “Electrical Drives Concepts and Applications”, Mc-Graw Hill Publishing, New Delhi, 2016
3.	S.K.Pillai, “A first course on Electric Drives”, Wiley Eastern Ltd., New Delhi, 2016

Reference Books:

1.	G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2.	W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.
3.	Jai P.Agrawal, “Power Electronics Systems - Theory and Design”, Pearson Education, Inc., New Delhi, 2016

Course Outcomes:

Upon completion of this course, the students will be able to:			Bloom’s Taxonomy Mapped
CO1	:	Identify the electric drive for the required speed-torque characteristics	L1: Remembering
CO2	:	Understand the functioning of DC drive using converters	L2: Understanding
CO3	:	Understand the functioning of AC drive using converters	L2: Understanding
CO4	:	Analyse the various control schemes for AC and DC drive	L4: Analyzing

CO5	:	To use microcontroller based system for motor control	L6: Creating

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	1	2	1							1	1	2	
CO2	2	2	2	3	2		1					1	1	2	
CO3	2	2	2	3	2		1					1	2	3	
CO4	2	3	3	3	3	1	2	2				3	2	3	2
CO5	1	2	2	3	3		2					3	1	2	2
Avg	**1.6**	**2**	**2**	**2.8**	**2.2**	**1**	**1.5**	**2**	**-**	**-**	**-**	**1.8**	**1.4**	**2.4**	**2**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22EEOE03	ENERGY CONSERVATION AND MANAGEMENT			SEMESTER		VI / VII
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
Basic Electrical and Electronics Engineering or Principles of Electrical Engineering or Basic Electrical Engineering for Metallurgy		**Hours/Week**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To understand basics of energy.
2.	To familiarize the energy scenario in India.
3.	To understand the energy conservation approaches.
4.	To get knowledge on energy management approaches.
5.	To update the knowledge in energy efficient technologies.

UNIT I	**ENERGY SCENARIO**	**9**	**0**	**0**	**9**
Energy scenario of India – Present non-renewable energy scenario – Gross domestic product- Energy intensity – Current energy production and pricing – Energy security - Energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.					
UNIT II	**BASICS OF ENERGY**	**9**	**0**	**0**	**9**
Introduction – Work, power and energy – Electricity basics – Thermal energy basics – Energy units and conversions – Energy performance – Matching energy usage to requirement.					
UNIT III	**ENERGY CONSERVATION APPROACHES**	**9**	**0**	**0**	**9**
Energy saving opportunities in electric motors, Benefits of Power factor improvement and its techniques-Shunt capacitor, Synchronous Condenser etc., Energy conservation by industrial drives, Methods and techniques of energy conservation in ventilation and air conditioners, compressors pumps, fans and blowers. Energy conservation in electric furnaces, ovens and boilers., lighting techniques – Natural , CFL, LED lighting sources and fittings.					
UNIT IV	**ENERGY MANAGEMENT**	**9**	**0**	**0**	**9**
Demand side management (DSM)– DSM planning – DSM Techniques – Load management as a DSM strategy – energy conservation – tariff options for DSM - Energy audit – instruments for energy audit – Energy audit for generation, distribution and utilization systems – economic analysis.					
UNIT V	**ENERGY EFFICIENT TECHNOLOGIES**	**9**	**0**	**0**	**9**
Maximum demand controllers - Automatic power factor controllers - Energy efficient motors -Softstarters with energy saver - Variable speed drives - Energy efficient transformers - Electronic ballast - Occupancy sensors - Energy efficient lighting controls - Energy saving potential of each technology.					
					Total (45 L+0 T)= 45 Periods

Text Books:	
1.	Sonal Desai, “Handbook of Energy Audit”, McGraw Hill, 2015.
2.	Tripathy, S. C, “Utilization of Electrical Energy and Conservation”, McGraw Hill, 1991.
Reference Books:	
1.	Guide books for National Certification Examination for Energy Manager / Energy AuditorsBook-1, General Aspects (available online).
2.	Guide books for National Certification Examination for Energy Manager / Energy AuditorsBook-3, Electrical Utilities (available online)
3.	Murphy. W.R and McKay. G, “Energy Management”, Butterworths Publications, London, 1982.
4.	Wayne C Tuner, “Energy Management Hand Book”, John Wiley and Sons, 1982.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Identify the present energy scenario.	L2: Understanding
CO2	:	Recognize the various form of energy.	L2: Understanding
CO3	:	Interpret the process of energy conservation.	L3: Applying
CO4	:	Categorize the methods improving energy management.	L4: Analysing
CO5	:	Examine the role of energy efficient devices in energy conservation	L4: Analysing

COURSE ARTICULATION MATRIX															
CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	3	2	2		3				2	2	2	2	1
CO 2	1	2	2	2	2		3				3	3	2	2	1
CO 3	2	2	2	3	2		3				2	3	1	3	1
CO 4	2	3	2	2	3		3				3	3	3	3	1
CO 5	2	2	3	1	2		3				2	1	3	2	1
Avg	**1.6**	**2.2**	**2.4**	**2**	**2.2**	**-**	**3**	**-**	**-**	**-**	**2.4**	**2.4**	**2.2**	**2.4**	**1**
3/ 2/ 1 – indicates strength of correlation (3- High, 2-Medium, 1-Low)															

22EEOE04	ELECTRIC VEHICLES			SEMESTER			VI / VII
PREREQUISITES		CATEGORY		OE	Credit		3
Electrical Machines		Hours/Week		L	T	P	TH
				3	0	0	3

Course Objectives:

1.	To learn the components of Electric Vehicle, configurations and its architectural design
2.	To study the energy storage options for Electric vehicle.

UNIT I	**ELECTRIC VEHICLES**	**9**	**0**	**0**	**9**
Configurations of Electric Vehicles (EV), Performance of Electric Vehicles: Traction Motor Characteristics, Tractive Effort and Transmission Requirement and Vehicle Performance, Tractive Effort in Normal Driving , Energy Consumption					
UNIT II	**HYBRID ELECTRIC VEHICLES**	**9**	**0**	**0**	**9**
Concept of Hybrid Electric Drive Trains, Classification of hybrid electric vehicles , Architectures of Hybrid Electric Drive Trains: Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains, Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains					
UNIT III	**PLUG-IN HYBRID ELECTRIC VEHICLES (PHEV)**	**9**	**0**	**0**	**9**
Functions And Benefits Of PHEV, Components of PHEV, Operating Principles of Plug-In Hybrid Vehicle, Plug-In Hybrid Vehicular Architecture, Compound PHEV Architecture, Control Strategy of PHEV, Charging of PHEV					
UNIT IV	**FUEL CELL ELECTRIC VEHICLE**	**9**	**0**	**0**	**9**
Operating Principles of Fuel Cells, Fuel Cell System Characteristics, Fuel Cell Technologies, Hydrogen Storage, Configuration of a Fuel cell hybrid Electric Vehicle, Control Strategy of Fuel cell Electric Vehicle					
UNIT V	**ENERGY STORAGE SYSTEM**	**9**	**0**	**0**	**9**
Status of Battery Systems for Automotive Applications, Battery Technologies: Nickel–Metal Hydride (Ni–MH) Battery, Lithium–Polymer (Li–P) Battery, Lithium-Ion (Li-Ion) Battery, Ultracapacitors: Features, operation and performance, Hybridization of Energy Storages					
Total (45L+0T)= 45 Periods					

Text Books:

1.	Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, Taylor & Francis Group, Second Edition ,2011.
2.	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, AliEmadi,, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles” CRC Press, 2016

Reference Books:

1.	Ali Emadi, Mehrdad Ehsani, John M.Miller ,“Vehicular Electric Power Systems”, Ali Emadi, Mehrdad Ehsani, John M.Miller, Special Indian Edition, Marcel dekker, Inc 2010

E-Reference

1	https://archive.nptel.ac.in/courses/108/106/108106170/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Level**
CO1	:	Recall the concept of Electric Vehicle technology	L1: Remembering
CO2	:	Draw the configuration of different types of Electric Vehicle	L4: Analyzing
CO3	:	Describe the selection and sizing of Fuel cell for hybrid electric vehicle.	L2: Understanding
CO4	:	Select control strategy and control for Plug In Hybrid Electric vehicle	L4: Analyzing
CO5	:	Use the battery management system for electric vehicle	L3: Applying

COURSE ARTICULATION MATRIX															
COs/ POs	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	1		1	3	1	2	1		1	2	1	1	1	2	1
CO2	1	2	3	1		1	2	1	1		1	2	1	2	
CO3	1	1			2		3	2	1	2	1		1	1	1
CO4	3	1	2	1	2	1	1				3	2	1	2	1
CO5	1	2	1	2	1	2		1	2	1		1	1	2	1
Avg	**1.4**	**1.5**	**1.75**	**1.75**	**1.50**	**1.5**	**1.75**	**1.33**	**1.25**	**1.67**	**1.5**	**1.5**	**1**	**1.8**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22MEOE01	DESIGN OF MACHINE ELEMENTS AND MACHINING						SEMESTER VI/VIII
		CATEGORY	OE	Credit			3
		Hours/Week	L	T		P	TH
			3	0		0	3

COURSE OBJECTIVES	
1	To familiarize the various steps involved in the design process.
2	To understand the basic concepts of machining techniques.
3	To know the factors influencing the processes and their applications.
4	Applying the principles of milling and gear cutting machines.
5	To gain the knowledge of cutting tool materials and surface finishing process.

UNIT I	**STRESSES IN MACHINE ELEMENTS**	**9**	**0**	**0**	**9**
Stress in simple machine members- axial, bending, torsional, bearing stress, Hertz contact stress; combined stresses, principle stresses, Theories of failure, factor of safety, stress concentration, preferred numbers.					
UNIT II	**DESIGN OF SHAFTS AND WELDED JOINTS**	**9**	**0**	**0**	**9**
Design of shaft members subjected to simple and combined stresses - Welded joints- Types of welding symbols, design of welded joints subjected to various load -Design of Riveted joints					
UNIT III	**DESIGN OF MACHINE ELEMENTS**	**9**	**0**	**0**	**9**
Springs: Design of helical springs- stresses and deflection - design procedure. Bearings: Need for bearing, Types, sliding and rolling contact bearings, hydro- dynamic and hydro static bearings- Life of bearings – Selection of bearings-Problems.					
UNIT IV	**METAL CUTTING**	**9**	**0**	**0**	**9**
Theory of metal cutting: Introduction, mechanics of metal cutting, orthogonal and oblique cutting, merchants' equation, chip formation, heat generation, cutting fluids, cutting tool life, recent developments and applications (Dry machining and high-speed machining)					
UNIT V	**MACHINE TOOLS AND SURFACE FINISHING PROCESSES**	**9**	**0**	**0**	**9**
Tools and machine tools: Cutting tool materials, cutting tool nomenclature, introduction to machine tools, lathe, shaper, planning, milling, drilling and boring machines, working principle, operations, work holding devices. Surface finishing processes: Introduction to Grinding honing, lapping processes and machines. Introduction to CAD/CAM/CIM.					
					Total(45L) = 45Periods

REFERENCE BOOKS:	
1	Rao P N, "Manufacturing Technology" Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2006
2	HMT, "Production Technology" Tata McGraw-Hill Co., New Delhi, 1998
3	Milton C Shaw, "Metal Cutting Principles", Clarendon Press, Oxford, 1999.
4	James Brown, "Advanced Machining Technology Handbook", McGraw- Hill Book Company, New York, 1988.
5	Robert L Mott, "Machine Elements in Mechanical Design", Macmillan Publishing Co., London. UK, 1992.
6	Shighley and Mische, "Mechanical Engineering Design" McGraw Hill, 1992.
7	Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.
E-REFERENCES:	
1.	https://nptel.ac.in/courses/112105124
2.	Design of Machine Elements - V. B. Bhandari - Google Books

3.	"A Textbook of Machine Design" by R.S.Khurmi and J.K.Gupta

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Analyze the stresses induced in a machine element.	Analyze
CO2	Familiarize the design concept of joints under various loading.	Remember
CO3	Familiarize the design of various types of bearings and Spring.	Remember
CO4	Identify the process parameters associated with various machining processes.	Apply
CO5	Familiarize the cutting tools materials and surface finishing processes.	Remember

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	2		1	1				1		3	2
CO2	2	2	1	2		1	1				1		3	2
CO3	2	2	1	2		1	1				1		3	2
CO4	2	2	1	2		1	1				1		3	2
CO5	2	2	1	2		1	1				1		3	2
Avg	**2**	**2**	**1**	**2**		**1**	**1**				**1**		**3**	**2**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)														

22MEOE02	INDUSTRIAL ENGINEERING				SEMESTER VI / VIII			
		CATEGORY	OE	Credit	3			
		Hours/Week	L	T	P	TH		
			3	0	0	3		

COURSE OBJECTIVES	
1	Assume technical and managerial roles in the industries.
2	Apply engineering principles to the working environment.
3	Use quality tools to foresee and solve issues in the industrial situations.
4	Work collaboratively.
5	To know the importance of EBQ.

UNIT I	**FORECASTING**	**9**	**0**	**0**	**9**
Characteristics and Principles - Qualitative Methods, Delphi Technique, Market Research -Time Series Methods- Moving Average, Exponential Smoothing- Box Jenkins Method – Auto Regressive Moving Average (ARMA) or Auto Regressive Integrated Moving Average (ARIMA) models – Fitting Regression Models - Measurement of Forecast Errors, Coefficient of Correlation - Problem solving.					
UNIT II	**FACILITIES PLANNING AND WORK STUDY**	**9**	**0**	**0**	**9**
Factors affecting Site Location Decisions - Principles and Types of Layout - Layout Planning -Layout Tools and Computerised Layout Techniques - Design of Group Technology Layout – Line Balancing - Line Balancing Methods- Objectives of Work Study -Method Study Procedure, Recording Techniques - Motion Study - Principles of Motion Economy - Techniques of Work measurement - Time Study - Synthesis Method - Analytical Estimating - Predetermined Motion Time System (PMTS) - Work Sampling Techniques.					
UNIT III	**LEAN MANUFACTURING**	**9**	**0**	**0**	**9**
Elements of Just In Time (JIT) - Pull and Push System, Kanban System- Optimized ProductionTechnology and Synchronous Manufacturing – Implementation of Six Sigma - Single Minute Exchange of Die (SMED) 5S concept - Concurrent Engineering- Cellular Manufacturing – Enablersof Agile Manufacturing – Rapid Manufacturing - Business Process Re-engineering (BPR) - Basics of Supply Chain Management, Supply chain and “Keiretsu” – Enterprises Resources Planning (ERP) - Role of KAIZEN, Quality Circles and POKA YOKE in Modern Manufacturing – Seven wastes in Lean Manufacturing.					
UNIT IV	**AGGREGATE PRODUCTION PLANNING**	**9**	**0**	**0**	**9**
Objectives of Aggregate Planning - Capacity Requirement Planning (CRP) Process - Types of Capacity Planning - Strategies for Aggregate Capacity Planning - Master Production Scheduling - Procedure for Developing MPS – Materials Requirements Planning (MRP-I), Issues in MRP, Designing and Managing the MRP System, Evaluation of MRP - Manufacturing Resources Planning (MRP-II).					
UNIT V	**SCHEDULING OF OPERATIONS**	**9**	**0**	**0**	**9**
Operations Planning and Scheduling - Scheduling Techniques - Stages in Scheduling – Loading, Dispatching, Expediting - Finite Loading and Infinite Loading - Load Charts and Machine Loading Charts - Priority Sequencing -Dynamic Sequencing Rules - Batch Scheduling – Economic Batch Quantity (EBQ) or Economic Run Length (ERL) – Scheduling in Repetitive, Batch and Job Shop Manufacturing – Allocation of units for a single resource, allocation of multiple resources – Resource balancing - Flexible Manufacturing System.					
Total (45L) = 45 Periods					

REFERENCE BOOKS:	
1	R.Panneerselvam, “Production & Operations Management”, 3rd Edition, PHI LearningPrivate Limited, New Delhi, 2012
2	Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production/Operation Management”, 8th Edition, John Wiley & Sons, 2000

3	Dilworth B.James, “Operations Management Design, Planning and Control forManufacturing and Services”, Mcgraw Hill Inc., New York, 1992
4	Vollman T.E, “Manufacturing Planning and Control Systems”, Galgotia Publications, 2002.
E-REFERENCES:	
1.	https://www.newtondesk.com/industrial-engineering-study-notes-hand-written
2.	https://en.wikipedia.org/wiki/Lean_manufacturing
3.	https://www.planettogether.com/blog/types-of-scheduling-in-production-planning-and-control

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Apply the knowledge of engineering and sciences to improve the productivity of industries.	Apply
CO2	Design a system to meet the desired needs within realistic constraints.	Create
CO3	Function in multidisciplinary teams.	Apply
CO4	Use the techniques, skills, and modern engineering tools in manufacturing practice.	Understand
CO5	Perform as an effective industrial engineer integrating high and low levels of management	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3			2	2									3
CO2			3											2
CO3						3	2		3	2	3	2	3	
CO4	3	3		2	3	3						2		3
CO5						3	2	3					3	
Avg	**3**	**3**	**3**	**2**	**2.5**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2.6**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MEOE03	INDUSTRIAL ROBOTICS			SEMESTER VI/VII			
			CATEGORY	OE	Credit		3
			Hours/Week	L	T	P	TH
				3	0	0	3

COURSE OBJECTIVES

1	To explore concepts of robot technologies that is playing vital role in manufacture.
2	Describe various robot technology applications.
3	Develop an understanding of robot Kinematics and dynamics.
4	Explain and summarize robot end effectors and Sensors.
5	Explore conceptual understanding of Robot programming.

UNITI	INTRODUCTION	9	0	0	9

Robot - definition - robot anatomy - co-ordinate systems - work envelope - types and classification - specifications – joint notations – types of joints - speed of motion - pay load - robot parts and their functions - need for robots in Indian scenario.

UNIT II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9	0	0	9

Drives - hydraulic, pneumatic, mechanical and electrical - servo motors - stepper motors - salient features, application – end effectors – types: tools - grippers - mechanical grippers - pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, multiple grippers.

UNIT III	SENSORS AND MACHINE VISION	9	0	0	9

Requirements of sensors – principles, types and applications of following types of sensors proximity (inductive, Hall effect, capacitive, ultrasonic and optical) – range (Triangulation, structured light approach, laser range) – speed, position (resolvers, optical encoders, pneumatic) – force – torque – touch sensors (binary, analog sensor) - Introduction to machine vision -functions - image processing and analysis.

UNIT IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9	0	0	9

Forward kinematics and reverse kinematics of manipulators - two, three degrees of freedom (in 2 dimensional) – homogeneous transformation matrix - simple problems - lead through programming, robot programming languages - VAL programming –motion commands - sensor commands - end effecter commands - simple programs for loading, unloading and palletizing operations.

UNIT V	APPLICATIONS, IMPLEMENTATION AND ROBOT ECONOMICS	9	0	0	9

Robot cell design – types - Application of robots in processing - assembly - inspection - material handling - loading - unloading - automobile - implementation of robots in industries - safety considerations for robot operations – economic analysis of robots - pay back method and rate of return method.

Total (45L) = 45Periods

REFERENCE BOOKS:

1	Mikell. P. Groover, ‘Industrial Robotics Technology’, Programming and Applications, McGraw Hill Co, 1995.
2	Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
3	Richard D.Klafter, Thomas A.Chmielewski and MichealNegin, “Robotic engineering –An Integrated Approach”, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 2005.
4	Janakiraman.P.A. “Robotics and Image Processing”, Tata McGraw-Hill, 1995.
5	YoramKoren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992.
6	A.K.Gupta and S.K.Arora, “Industrial Automation and Robotics”, Laxmi Publications Pvt ltd, 2007.

7	Fu. K. S., Gonzalez. R. C. & Lee C.S.G., 'Robotics control, sensing, vision and intelligence', McGraw Hill Book co, 1987.
8	Craig. J. J. 'Introduction to Robotics mechanics and control',Addison- Wesley, 1999
9	Ray Asfahl. C., 'Robots and Manufacturing Automation', John Wiley & Sons Inc., 1985.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the basic concepts, parts of robots and types of robots.	Understand
CO2	Understand the potential applications of robots in industries as part of automation tool.	Understand
CO3	Familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots.	Remember
CO4	Discuss about the various applications of robots, justification, implementation and safety of robot	Analyze
CO5	Select an appropriate robot for a particular application.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1			1							1	1
CO2			1		1	1							1	1
CO3		1	0										1	1
CO4			1			3								1
CO5		2											1	2
Avg	**3**	**1.7**	**1**		**1**	**1.7**							**1**	**1.2**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)														

22MEOE04	POWER PLANT ENGINEERING					SEMESTER VI/VII
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
1. Having sufficient knowledge on basics of power plant		**Hours/Week**	**L**	**T**	**P**	**TH**
2. Basic unit calculation for consumption of power			**3**	**0**	**0**	**3**

COURSE OBJECTIVES:	
1.	Understanding of thermal power plant operations and its components.
2.	Location of hydro power plant and its components to generate power.
3.	Complete knowledge about diesel and gas power plant.
4.	Basic knowledge of nuclear reaction and types of nuclear power plant.
5.	Basic knowledge of power plant economics and various tariff methods.

UNIT I	**STEAM POWER PLANT**	**9**	**0**	**0**	**9**
Layout of steam power plant – boilers - Modern high pressure and supercritical boilers - Preparation and handling of coal - Pulverizer - Dust collector - Ash removal; Stokers - Different types - Pulverized fuel burning; Draught - Different types - Chimney design - Selection of blowers, Cooling towers - Different types - Waste heat recovery, Fluidised Bed and Circulated Fluidised Bed boilers					
UNIT II	**HYDRO ELECTRIC POWER PLANT**	**9**	**0**	**0**	**9**
Layout of hydel power plant- classification –working – components – layout of pumped storage power plant - Plant equipment for Pumped Store Schemes.					
UNIT III	**DIESEL AND GAS POWER PLANT**	**9**	**0**	**0**	**9**
Layout of Diesel power plant- Important components – performance analysis – Layout of gas power plant – classification of gas turbine cycles – components – relative thermal efficiencies of different cycles.					
UNIT IV	**NUCLEAR, MHD POWER GENERATION**	**9**	**0**	**0**	**9**
Elementary treatment - nuclear fission, chain reaction - Pressurized water reactors, boiling water reactors, gas cooled reactors - Fast breeder reactors, Magneto Hydro Dynamic power- open cycle and closed cycle system.					
UNIT V	**ECONOMICS AND SAFETY**	**9**	**0**	**0**	**9**
Economics and safety - Actual load curves - Fixed and operating costs - Tariff methods for electrical energy - Peak load and variable load operations - Selection of generation type and general equipment. Introduction to safety aspects in power plants - Environmental impacts - assessment for thermal power plant.					
					Total(45L) = 45 Periods

TEXT BOOKS:	
1.	S. Domkundwar, A.V. Domkundwar, S.C. Arora.A Course in Power Plant Engineering, Dhanpat Rai Publications. 2013
2.	P.K. Nag, Power Plant Engineering, Tata McGraw Hill, Laxmi Publications Pvt.Ltd New Delhi, 5th Edition, 2014.
REFERENCES:	
1	R.K. Rajput. A Text of Power Plant Engineering, Laxmi publications, New Delhi 5th Edition, 2016.
2	G.R. Nagpal, Power Plant Engineering, Khanna Publications 1998.
3	Bernhardt G. Askrotzki and William A. Vopat, "Power Station Engineering and Economy", Tata McGraw Hill Publishing Co. Ltd., 1972.
4	Frederick T. Mores, "Power Plant Engineering", Affiliated East-West Press Private Ltd., 1953.
5	Joel Weisman and Roy Eckart, "Modern Power Plant Engineering", Prentice Hall International Inc., 1985.

E-REFERENCES:	
1.	https://en.wikipedia.org/wiki/Power_plant_engineering
2.	https://onlinecourses.nptel.ac.in/noc21_me86/preview

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Ample knowledge on thermal power plant operation and its merits and demerits.	Analyze
CO2	Potential Power of water to convert into useful energy by hydropower.	Remember
CO3	Augment with diesel and gas power plant operation and its components.	Understand
CO4	Able to cope with recent developments on nuclear power plant.	Understand
CO5	Understanding of various economics to construct power plant and to measure the consumption of power by different tariff.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	1		1	1	2		2	2	2	1	2
CO2	1	2	3	2	1		1	1	2		2	2	2	1	2
CO3	1	2	3	2	1		1	1	2		2	2	2	1	2
CO4	1	2	3	2	1		1	1	2		2	2	2	1	2
CO5	2		1	2				2	2	1	1	1	2		
Avg	**1.2**	**2**	**2.6**	**2.0**	**1**		**1**	**1.2**	**2.0**	**1**	**1.8**	**1.8**	**2.0**	**1**	**2**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEOE05	PRINCIPLES OF MANAGEMENT					SEMESTER VI/VIII	
		CATEGORY	OE	Credit			3
		Hours/Week	L	T	P		TH
			3	0	0		3

COURSE OBJECTIVES

1.	To understand the management basic features of management.
2.	Principles usages in all walks of life and industrial growth.
3.	Able to have a clear understanding of the managerial functions like planning, organizing, staffing, leading and controlling.
4.	To gain some basic knowledge in international aspect of management.

		L	T	P	TH
UNITI	**MANAGEMENT - AN INTRODUCTION AND OVERVIEW**	**9**	**0**	**0**	**9**

Definitions of management – features of management – Management thoughts – different schools of management – Scientific management – Arts or Science, Management Vs administration – Principles of Management.

		L	T	P	TH
UNIT II	**FUNCTIONS OF MANAGEMENT**	**9**	**0**	**0**	**9**

Role of managers. Functions approach to management, Management functions, Management levels – reconciling functions and role, responsibility of managers – towards subordinates, peers, supervisors, customers, government, company, creditors, shareholders, competitors etc.

		L	T	P	TH
UNIT III	**MANAGERIAL PLANNING AND DECISION MAKING**	**9**	**0**	**0**	**9**

Planning fundamentals, objectives. Management by objectives – Changes in objectives – goal distortions – major types of planning, policies and objectives, procedures – methods, rules, programmes and schedule, projects, budgets – importance of decision making, types of decisions, decision making process – decision theory – quantitative techniques – decision making conditions – Operation Research (OR), Definition, successful areas of operation research - Decision tree.

		L	T	P	TH
UNIT IV	**ORGANIZATION**	**9**	**0**	**0**	**9**

Organization: Basic concepts – organization as a structure – as a process – as a group property of modern organization – typology, importance of organization – business /industrial organization – sole trading, partnership company, co-operative, public enterprise line (military), line and staff, functional, matrix committee-based organization - departmentalization – need, bases of departmentation – career planning and management.

		L	T	P	TH
UNIT V	**STAFFING, CONTROLLING AND COMMUNICATION**	**9**	**0**	**0**	**9**

Nature and purpose of staffing – man power planning, aims and objectives of HR recruitment, selection and training sources of recruitment, process of recruitment, training methods – performance appraisal methods – communication – importance process – barriers to communications. How to remove obstacles of effective communication – controlling – definition – Characteristics of control – types of control – requirements of effective control – direct and preventive control repairing, control techniques.

Total (45L) = 45Periods

REFERENCE BOOKS:

1	Herald knootz and Heinz weihrich, Essentials of Management ‖, McGraw-Hill Publishing Company, Singapore International Edition, 2007
2	Joseph L, Massie, Essentials of Management. Prentice Hall of IndiaPvt., Ltd (Pearson) Fourth Edition, 2003.
3	Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management" 7th Edition, Pearson Education, 2011.
4	Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.

5	Harold Koontz & Heinz Weihrich "Essentials of management" Tata McGraw Hill, 1998.
6	Tripathy PC & Reddy PN, "Principles of Management", Tata McGraw Hill, 1999.
7	R.S.N. Pillai & S. Kala "Principles and Practice of Management", S Chand & company, 2014.
E-REFERENCES:	
1.	https://nptel.ac.in/courses/110105146
2.	https://nptel.ac.in/courses/122106031

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the basic concept of management.	Understand
CO2	Familiarize the contribution sand functions, types of business organization.	Understand
CO3	List the various types of leadership and evaluate the motivation the oriesand techniques.	Evaluate
CO4	Select forecasting models for future demands and to make decision in the management processes.	Evaluate

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1							1	3	1		2	2	1	1
CO2							1	1	2		3	2	1	1
CO3								1	2		1	1	1	1
CO4							2	1	2		2	1	1	1
Avg							**1.3**	**1.5**	**1.75**		**2**	**1.5**	**1**	**1**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MEOE06	PROFESSIONAL ETHICS IN ENGINEERING					SEMESTER VI/VIII
		CATEGORY	OE	Credit		3
		Horus/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES

1	To create awareness on Engineering Ethics and providing basic knowledge about engineering Ethics, Variety of moral issues and Professional Ideals.
2	To provide basic familiarity about Engineers as responsible Experimenters, Codes of Ethics, Industrial Standards.
3	To inculcate knowledge and exposure on safety and risk, risk benefit analysis.

UNIT I	**HUMAN VALUES**	**9**	**0**	**0**	**9**
Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality.					
UNIT II	**ENGINEERING ETHICS**	**9**	**0**	**0**	**9**
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**	**9**	**0**	**0**	**9**
Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law – the challenger case study.					
UNIT IV	**SAFETY, RESPONSIBILITIES AND RIGHTS**	**9**	**0**	**0**	**9**
Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three-mile island and Chernobyl case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest – occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.					
UNIT V	**GLOBAL ISSUES**	**9**	**0**	**0**	**9**
Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE),India.					
					Total(45L) = 45Periods

REFERENCE BOOKS:

1	Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 2005.
2	Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
3	Tripathi A N, "Human values", New Age international Pvt. Ltd., New Delhi, 2002.
4	Charles D. Fleddermann, "Engineering Ethics", Pearson Education / Prentice Hall, New Jersey, 2004.
5	Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Wadsworth Thompson Learning, United States, 2000.
6	John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.
7	R S Naagarazan, "A Textbook on Professional Ethics and Human Values" New age international (p) limited, publishers, New Delhi – 110002, 2006.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the importance of ethics and values in life and society.	Understand
CO2	Understood the core values that shape the ethical behavior of an engineer.	Understand
CO3	Exposed awareness on professional ethics and human values.	Remember

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2	1	3	2		1				1
CO2						1	1	3	1		1				1
CO3						2	1	3	1		1				1
Avg						**1.66**	**1**	**3**	**1.33**		**1**				**1**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MEOE07	RENEWABLE SOURCES OF ENERGY					SEMESTER VI/VIII
PRE-REQUISITE: 1. Basic idea about solar radiation and other renewable energy that exists. 2. Understanding about various chemical reactions occur in the energy conversion process		**CATEGORY**	**OE**	**Credit**		**3**
		Horus/Week	**L**	**T**	**P**	**TH**
			3	**0**	**1**	**4**

COURSE OBJECTIVES

1.	To recognize the consciousness of energy conservation in scholars
2.	To identify the employ of renewable energy sources for electrical power generation
3.	To collect different energy storage methods
4.	To detect about environmental effects of energy conversion

UNIT I	**SOLAR RADIATION AND ITS MEASUREMENTS**	**9**	**0**	**0**	**9**
Alternative energy sources, Global and Indian energy scenario. Solar Energy: Introduction – Solar Radiation Measurement and Instruments – Data and estimation.					
UNIT II	**SOLAR ENERGY COLLECTORS, SOLAR ENERGY STORAGE AND APPLICATIONS OF SOLAR ENERGY**	**9**	**0**	**0**	**9**
Flat Plate and Concentrating Collectors –Solar direct Thermal Applications – Solar thermal Power Generation – Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation –Solar Energy Storage: Thermal energy, Chemical Energy and Electromagnetic energy storage; Solar PV Applications: Solar water heating, Space heating and cooling, Solar distillation, Solar pumping, Solar furnace, Solar cooking.					
UNIT III	**BIOMASS AND ITS CONVERSION TECHNOLOGIES**	**9**	**0**	**0**	**9**
Bio-mass conversion Techniques: Direct combustion (incineration); Thermo-chemical conversion-Gasification and its types; Wet Process- Classification of biogas plant- types of Anaerobic digestion (Khadi and Village Industries type, Pragati design, Gasnesh biogas plant and Ferro-cement digester biogas plant) – Fermentation process;					
UNIT IV	**WIND, GEOTHERMAL AND TIDAL ENERGY**	**9**	**0**	**0**	**9**
Basic principle of wind energy conversion, types of wind energy conversion; Geothermal sources – hydrothermal geothermal resources, geopressurised resources, hot dry rock resources of petrothermal systems, Magma resources – Comparison of flashed steam and total flow concept. Basic principle of tidal power, components of tidal power plants, operation methods of utilization of tidal power.					
UNIT V	**CHEMICAL ENERGY, HYDROGEN ENERGY AND MAGNETO HYDRO DYNAMIC**	**9**	**0**	**0**	**9**
Design and principle operation of a Fuel cells, classification of fuel cells, types of fuel cells, Advantages, disadvantages and applications of fuel cells. Basic principle of Magneto Hydro Dynamic – Open cycle and closed cycle system.					
Total (45L) = 45Periods					

REFERENCE BOOKS:

1	G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
2	Suhas P. Sukhatme, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., 2007.
3	Khan, B.H., "Non-Conventional Energy Resources", The McGraw Hill Companies, 2009.
4	Twidell, J.W. & Weir, A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2005.
5	Solanki: Renewable Energy Technologies: Practical Guide for Beginners, PHI Learning Pvt.Ltd., 2008
6	D. Mukherjee: Fundamentals of Renewable Energy Systems, New Age International publishers, 2007.

7	Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.
E-REFERENCES:	
1.	https://en.wikipedia.org/wiki/Renewable_energy
2.	Ellabban, Omar; Abu-Rub, Haitham; Blaabjerg, Frede (2014). "Renewable energy resources: Current status, future prospects and their enabling technology". Renewable and Sustainable Energy Reviews. 39: 748–764 [749]

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the principles of solar radiation and its measuring devices	Understand
CO2	Comprehend the ideology of solar energy collectors, solar photovoltaic power generationsolar energy storage and applications of solar energy	Analyze
CO3	Acquire awareness about biomass sources of energy technologies	Understand
CO4	Design various renewable energy gadgets such as wind and tidal plant	Create
CO5	Learn about extracting energy from chemical methods	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	3	2	1		2	2	3	1	1	2	2	1
CO2	1	2	3	2	1		2	2	3	1	1	2	2	1
CO3		2	3	2	1		2	2	3	1	1	2	2	1
CO4	1	2	3	2			2	2	3	1	1	2	2	1
CO5	1	2	3	2	1		2	2	3	1	1	2	2	1
Avg	**1**	**2**	**3**	**2**	**1**		**2**	**2**	**3**	**1**	**1**	**2**	**2**	**1**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

2MEOE08	ROBOTIC PROCESS AUTOMATION					SEMESTER VI/VIII
Pre-requisite:		**CATEGORY**	**OE**	**Credit**		**3**
Basics in kinematics and dynamics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

COURSEOBJECTIVES

1.	To study the various parts of robots and fields of robotics.
2.	To study the various kinematics and inverse kinematics of robots.
3.	To study the Euler, Lagrangian formulation of Robot dynamics.
4.	To study the trajectory planning for robot.
5.	To study the control of robots for some specific applications

UNIT I	**BASIC CONCEPTS**	**9**	**0**	**0**	**9**
Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov‟s laws of robotics – dynamic stabilization of robots.					
UNIT II	**POWER SOURCES AND SENSORS**	**9**	**0**	**0**	**9**
Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors					
UNIT III	**MANIPULATORS, ACTUATORS AND GRIPPERS**	**9**	**0**	**0**	**9**
Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.					
UNIT IV	**KINEMATICS AND PATH PLANNING**	**9**	**0**	**0**	**9**
Solution of inverse kinematics problem – multiple solution jacobian work envelop – Hill Climbing Techniques – robot programming languages					
UNIT V	**CASE STUDIES**	**9**	**0**	**0**	**9**
Multiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.					
					Total (45L) = 45 Periods

REFERENCE BOOKS:

1	Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., “Industrial Robotics”, Mc Graw-Hill Singapore, 1996.
2	Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
3	Deb. S.R., “Robotics Technology and flexible Automation”, John Wiley, USA 1992.
4	Klafter R.D., Chimielewski T.A., Negin M., “Robotic Engineering – An integrated approach”, Prentice Hall of India, New Delhi, 1994.
5	Barry Leatham – Jones, “Elements of industrial Robotics” PITMAN Publishing, 1987.
6	Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, “Industrial Robotics Technology, Programming and Applications “, McGraw Hill Book Company 1986.
7	Fu K.S. Gonzaleaz R.C. and Lee C.S.G., “Robotics Control Sensing, Vision and Intelligence” McGraw Hill International Editions, 1987.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Explain the basic concepts of working of robot.	Understand
CO2	Analyze the function of sensors in the robot.	Analyze
CO3	Analyze the working of manipulates, actuators and grippers.	Analyze
CO4	Write program to use a robot for a typical application.	Create
CO5	Use robots in different applications.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2		2					1		2	2	2
CO2	1	3	2	1	1							2	1	3
CO3		2	2	1	1							2	1	3
CO4		1	1	2	3			1	3	2	1	2		
CO5		1	2	2	2	1	2	2	3	2	1	2		
Avg	**1**	**1.6**	**1.8**	**1.5**	**2**	**1**	**2**	**1.5**	**3**	**1.7**	**1**	**2**	**1.3**	**2.7**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)														

22MEOE09	TOTAL QUALITY MANAGEMENT					SEMESTER VI/VIII
		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES

1.	Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
2.	Explain the TQM Principles for application.
3.	Define the basics of six sigma and apply traditional tools, new tools, Benchmarking and FMEA.
4.	Describe Taguchi's Quality Loss Function, Performance measures and apply techniques like QFD, TPM, COQ and BPR.
5.	Illustrate and apply QMS and EMS in any organization.

UNIT I	INTRODUCTION	9	0	0	9

Definition of Quality - Dimensions of Quality - Quality planning - Quality costs, Analysis techniques for quality costs- Basic concepts of total quality management (TQM) - Historical review - Principles of TQM – Leadership - Role of senior management - Quality council, Quality statements - Strategic planning- Deming philosophy - Barriers to TQM implementation

UNIT II	TQM PRINCIPLES	9	0	0	9

Customer satisfaction - Customer perception of quality, Customer complaints, Service quality, Customer Retention, Employee involvement - Motivation, Empowerment, Teams, Recognition and reward, Performance appraisal - Continuous process improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen - Supplier Partnership, Sourcing, Supplier selection, Supplier rating, Relationship development - Performance measures, Basic concepts, Strategy

UNIT III	STATISTICAL PROCESS CONTROL (SPC)	9	0	0	9

The seven tools of quality, Statistical fundamentals – Measures of central tendency and dispersion, Population and sample, Normal curve - Control charts for variables and attributes, Process capability - Concept of six sigma, New Seven Management Tools.

UNIT IV	TQM TOOLS	9	0	0	9

Benchmarking – Reasons to benchmark, Benchmarking process, Quality function deployment (QFD) process – House of quality, Benefits - Taguchi quality loss function - Total productive maintenance (TPM) concept, Improvement needs - FMEA – Stages of FMEA.

UNIT V	QUALITY MANAGEMENT SYSTEMS	9	0	0	9

Need for ISO 9000 and other quality systems, benefits of ISO registration, ISO 9001:2008 quality system – Elements, Implementation of quality system, Documentation, Quality auditing, AS 9100,TS 16949:2002 and TL 9000

Total (45L) = 45Periods

REFERENCE BOOKS:

1	Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2	Feigenbaum.A.V. “Total Quality Management”, McGraw Hill, 1991.
3	Joel.E. Ross, “Total Quality Management – Text and Cases”, Routledge. 2017.
4	Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
5	Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.

6	Suganthi.L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006
7	Narayana V and Sreenivasan, N.S, “Quality Management – Concepts and Tasks”, New Age International, 1996.
E-REFERENCES:	
1.	https://www.oreilly.com/library/view/total-quality-management/9780815330486/xhtml/Reference1.xhtml
2.	https://www.sanfoundry.com/best-reference-books-total-quality-management/
3.	https://www.routledge.com/Total-Quality-Management-TQM-Principles-Methods-and-Applications/Luthra-Garg-Agarwal-Mangla/p/book/9780367512835

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Ability to apply TQM concepts in a selected enterprise.	Apply
CO2	Ability to apply TQM principles in a selected enterprise.	Apply
CO3	Ability to understand Six Sigma and apply Traditional tools, new tools, Benchmarking and FMEA.	Understand
CO4	Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.	Understand
CO5	Ability to apply QMS and EMS in any organization.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3			2		1		2			2	1	2
CO2	1	2							2			2		
CO3	1	2	2		1			1				2	1	
CO4	1	2			2	3		2		3		2	2	2
CO5	1	2	2		2	2	1	2	2	3		2	2	2
Avg	**1**	**2.2**	**2**		**1.75**	**2.5**	**1**	**1.7**	**2**	**3**		**2**	**1.5**	**2**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MTOE01	FOUNDRY AND WELDING TECHNOLOGY				
PREREQUISITES: Manufacturing Technology	**Category**	**OE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1.	To know the basic concepts of metal casting technology and to apply them to produce of new materials.
2.	To know the concepts of different materials joining technology and emphasis on underlying science and engineering principle of every processes.

		L	T	P	TH
UNIT I	**MOULDING MATERIALS AND PATTERNS**	**9**	**0**	**0**	**9**

Introduction to foundry operations, patterns - functions, types, allowances, selection of pattern materials, colourcodes, core boxes, moulding practice, ingredients of moulding sand and core sand, Testing of Moulding sands. Sand preparation, Sand reclamation in foundries.

		L	T	P	TH
UNIT II	**MOULDING AND CASTING TECHNIQUES**	**9**	**0**	**0**	**9**

Sand moulding: green sand moulding, dry sand moulding, skin dry sand moulding, shell moulding, carbon- di-oxide process, permanent mould casting, die casting, centrifugal casting, investment casting, squeeze casting, full mould process, Rheocasting, Thixo casting.

		L	T	P	TH
UNIT III	**MELTING PRACTICE**	**9**	**0**	**0**	**9**

Melting practice and special precautions for steels, alloy steels, cast irons, aluminium alloys, copper alloysand magnesium alloys, Cleaning and repair of castings. Casting defects and remedies

		L	T	P	TH
UNIT IV	**WELDING AND OTHER JOINING PROCESSES**	**9**	**0**	**0**	**9**

Classification of welding processes- oxy-acetylene welding, arc welding-manual, submerged arc welding, gas tungsten arc and gas metal arc welding, electro slag and electro gas welding. Brazing, soldering and cutting processes

		L	T	P	TH
UNIT V	**SPECIAL WELDING PROCESSES**	**9**	**0**	**0**	**9**

Principle, equipment, process variables, merits, limitations and applications of Electron beam, plasma arc andlaser beam welding processes. Friction, friction stir welding, ultrasonic explosive and diffusion welding.

Total (45+0) = 45 Hours

Text Books:

1.	Heine R W., Loper, C.R.Rosenthal, P.C.,"Principles of Metal Casting",Tata-McGraw Hill PublishingCo Ltd, New Delhi, 2008.
2.	Srinivasan N K.,"Foundry Engineering", Khanna Tech Publications, New Delhi, 2005.
3.	Parmar, R.S., ―Welding Processes and Technology‖, 2nd edn. Khanna Publishers, New Delhi, 2001
4.	Srinivasan N K ,"Welding Technology", Khanna Publications, Delhi, 2000

Reference Books:

1.	Beeley P R., "Foundry Technology", Butterworths, London, 1982.
2.	Howard B. Cary, "Modern Welding Technology", Prentice Hall, New Jersey, USA, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the alloying element effect on the steels and mention the precaution to be taken in mouldingand melting of steels.	L2: Understanding
CO2	:	Distinguish different moulding and casting techniques.	L3:Applying
CO3	:	Apply the melting procedure for the various alloys like steels, stainless steels,discuss the slag-metal reactions	L3:Applying
CO4	:	Illustrate the conventional welding processes and allied joining processes.	L2: Understanding
CO5	:	Compare the various special welding processes.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1										2			
CO2	1	1		1	1								1			1
CO3	2	1	1				1						2			
CO4	1	1	1	1	1	1							1			1
CO5	2	1		1	1								1			
Avg.	1.6	1.0	1.0	1.0	1.0	1.0	1.0						1.4			1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTOE02	ADVANCED SURFACE ENGINEERING					
PREREQUISITES: **Manufacturing Technology**		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	Analyze the various concepts of surface engineering and comprehend the design difficulties

UNIT I	**TRIBOLOGY AND PLATING PROCESSES**	**9**	**0**	**0**	**9**

Introduction to tribology, Wear: Types of wear - adhesive, abrasive, oxidative, corrosive, erosive and trotting wear, roles of friction and lubrication and wear testing. Plating Processes: Fundamentals of electrode position, plating of nickel, chromium, tin and copper, pulsed plating, hydrogen embrittlement, plating adhesion, electrolessplating, electrochemical conversion coating, selective plating for repair, plating properties, hard anodizing.

UNIT II	**HARD FACING PROCESSES**	**9**	**0**	**0**	**9**

SMAW, GTAW, GMAW, FCAW, SAW, PAW, Oxy-Acetylene Welding, Furnace fusing, Thermal-spray, Flamespray processes - HVOF, Detonation gun and Jet kote processes, Hard facing consumables.

UNIT III	**SPECIAL DIFFUSION PROCESSES**	**9**	**0**	**0**	**9**

Principle of diffusion processes - Boriding, Aluminising, Siliconising, Chromising - Selection of diffusion processes - Characteristics of diffused layer - micro structure and micro hardness evaluation - properties andapplications.

UNIT IV	**THIN FILM COATINGS**	**9**	**0**	**0**	**9**

Physical vapour deposition processes - Thermal evaporation - sputter coating - Ion plating - Chemical vapour deposition - reactive sputtering - TiC, TiN, Alumina, CBN, Diamond and DLC coatings. Structure, properties and applications.

UNIT V	**HIGH ENERGY MODIFICATION AND SPECIAL PROCESSES**	**9**	**0**	**0**	**9**

Electron beam hardening, glazing, Laser beam hardening glazing ion implantation, Composite surface created by laser and Electron beam. Surface cements, Wear tiles, Electro spark deposition, fused carbide cloth,thermal / chemical. Ceramic coatings, centrifugal cast wear coatings, Wear sleeves and Wear plates.

Total (L+T) = 45 Hours

Text Books:

1.	Chattopadhyay R., Surface Wear: Analysis, Treatment, Prevention, ASM International, USA, 2001
2.	Kenneth G. Budinski, Surface Engineering for Wear Resistance, Prentice Hall, Englewood Cliff, 1990.

Reference Books:

1.	ASM Metals Handbook, Vol 5: Surface Engineering, ASM International, Ohio, 1994.
2.	Ernest Rabinowicz, Friction and Wear of Materials, 2nd ed., John Wiley & Sons, NY, 1995.
3.	Davis J.R., Surface Engineering for Corrosion and Wear resistance, ASM International, 2001.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the influence of the tribological characteristics.	L2: Understanding
CO2	:	Discuss the various hard facing processes.	L3:Applying
CO3	:	Demonstrate the surface properties with diffusion of foreign atoms into the outer surface of thematerial such as boriding, aluminizing, etc.	L2: Understanding
CO4	:	Demonstrate the various vapour deposition processes of different materials on the surface of native materials using the Chemical, Physical and Thermal vapour deposition processes.	L2: Understanding
CO5	:	Describe the Modern processes and high energy processes like electron beam hardening, laser beamhardening.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1		1	1								1	1		1
CO2	2	1			1	1						1	1			1
CO3	1	1		1	1		1					1	2			1
CO4	2	1	1		1									2		1
CO5	1			1	1								1			1
Avg.	1.4	1.0	1.0	1.0	1.0	1.0	1.0					1.0	1.3	1.5		1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTOE03	DESIGN AND SELECTION OF MATERIALS					
PREREQUISITES: **Manufacturing Technology**		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To know different types of materials and properties and to select better materials forDifferent applications.

		L	T	P	TH
UNIT I	**DESIGN PROCESS**	**9**	**0**	**0**	**9**
Materials in Design, Evolution of Engineering Materials, Design process, Types of design, Design flow chart-tools and material data, Interaction between Function, Material, Shape and Process.					
UNIT II	**MATERIAL PROPERTIES**	**9**	**0**	**0**	**9**
Revision of engineering materials and properties, Material properties inter-relationship charts such as Young"s modulus-density, Strength-density, Young"s modulus-Strength, wear rate-hardness, Young's modulus– relative cost, strength relative cost and others.					
UNIT III	**MATERIAL SELECTION**	**9**	**0**	**0**	**9**
Materials selection, selection strategy: material attributes, attribute limits, selection procedure, computer aided selection, structural index; Case studies: table legs, flywheel, springs, pressure vessels, bearings, heat exchangers, airframes, ship structures, automobile structures.					
UNIT IV	**PROCESSES AND PROCESS SELECTION**	**9**	**0**	**0**	**9**
The processes: shaping, joining and finishing, Process selection, ranking processes, cost, computer based process selection, Case studies: fan, pressure vessel, optical table, economical casting.					
UNIT V	**MULTIPLE CONSTRAINTS AND OBJECTIVES**	**9**	**0**	**0**	**9**
Selection under multiple constraints, conflicting objectives, penalty-functions, exchange constants, Case studies: connecting rods for high performance engines, windings of high field magnets.					
					Total (L+T) = 45 Hours

Text Books:	
1.	Michael F. Ashby, Materials Selection in Mechanical Design, third edition, Butterworth-Heinemann,2005
2.	J. Charles, F.A.A. Crane, J. A.G. Furness, Selection and Use of Engineering Materials, third edition,Butterworth-Heinemann, 2006
Reference Books:	
1.	ASM Metals Handbook, Vol.20: Materials Selection and Design, ASM International,1997
2.	Myer Kutz, Handbook of Materials Selection, John Wiley & Sons, Inc., New York, 2002

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the design process and design flow chart tools for the materials selection criterion.	L2: Understanding
CO2	:	Apply the materials for corrosion and wear resistance processes.	L3:Applying

CO3	:	Apply the materials for auto and aero industry.	L3:Applying
CO4	:	Classify the process selection criterion for high temperature materials.	L2: Understanding
CO5	:	Suggest the process selection criterion for high performance materials..	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1		1	1								1		1	
CO2	2	1	1			1	1							2		
CO3	1	1		1	1								1	1		
CO4	2	1	1		1									2		
CO5	1	1		1	1											1
Avg.	1.4	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.7	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTOE04	NANOSCIENCE AND TECHNOLOGY					
PREREQUISITES: **Engineering material and metallurgy**		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1. To study about nanomaterials and its application

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Definition, Length scales, surface area/volume ratio of micron to nanoscale materials, Importance of Nanoscale and Technology, Top down and bottom up approaches, Classification of nanomaterials, Properties of selected nanomaterials including carbon nanotubes (CNT), graphene, metal nanoparticles, clays, nanowires, quantum dots (QDs), effect of size on thermal, mechanical and electrical properties of nanomaterials.

UNIT II	**SYNTHESIS OF NANOMATERIALS**	**9**	**0**	**0**	**9**

Fabrication of Nanomaterials: Top-down approaches-lithography, Mechanical alloying milling, Severe PlasticDeformation, Bottom-up approaches-chemical vapour deposition, physical vapour deposition, atomic layer deposition (ALD), and Sol-gel method, Synthesis and purification of CNT, synthesis of expanded graphite (EG) orgraphene.

UNIT III	**NANOCOMPOSITES**	**9**	**0**	**0**	**9**

Fabrication of nanocomposites: Fabrication of Clay-rubber, Clay-polymer, CNT-polymer, EG-polymer, magnetic particle-polymer, CNT-metal, trade off between the composites and nanocomposites etc. Consolidation of nanomaterials.

UNIT IV	**CHARACTERIZATION OF NANOMATERIALS**	**9**	**0**	**0**	**9**

Characterization of Nanomaterials:, X-ray diffraction (XRD), Dynamic Light Scattering, Scanning electron microscope (SEM), Transmission Electron Microscope (TEM), UV-Visible spectroscopy, Scanning probe microscopy- Atomic force microscope (AFM) and scanning tunneling microscope (STM). Nanoindentation.

UNIT V	**APPLICATIONS OF NANOMATERIALS**	**9**	**0**	**0**	**9**

Applications of nanomaterials: Electronics, structural, biomedical, sensors nanofluids, optical, magnetic, biomedicalfields, solar cells, LED, LCD, electrically conducting polymers, batteries, fuel cells, SMART Materials. Environmental and health issues related to nanomaterials.

Total (L+T) = 45 Hours

Text Books:

1.	B.S. Murty, P. Shankar, Baldev Raj, B BRath, James Murday, Textbook of Nanoscience and Nanotechnology,University Press (I) Pvt. Ltd., 2013.
2.	Bharat Bhushan (Ed), Springer Handbook of Nanotechnology, Springer-Verlag Berlin Heidelberg, 2004

Reference Books:

1.	Charles P Poole and Frank J Owens, –Introduction to Nanotechnology‖, John Wiley and Sons, New York, 2003.
2.	Michael Wilson, KamaliKannagara and Geoff Smith, ―Nanotechnology: Basic Science and Emerging Technology‖, Chapman and Hall, New York, 2002.
3.	Pradeep T, –Nano: The Essentials‖, Tata McGraw Hill, New Delhi, 2007.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Define and differentiate engineering materials on the basis of structure and properties for engineeringapplications.	L2: Understanding
CO2	:	Explain the various applications of nanomaterials.	L3:Applying
CO3	:	Discuss the fabrications of composites and nano composites.	L2: Understanding
CO4	:	Describe the charactrization of nanomaterials using SEM & TEM.	L4: Analyzing
CO5	:	Apply the applications of nanomaterials.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	2		1	1								1			1
CO2	2	2		1	1		1						1			1
CO3	3	2	1		1									1	1	
CO4	1	1		1	1	1							1	2		
CO5	1	1		1	1									1		
Avg.	1.6	1.6	1.0	1.0	1.0	1.0	1.0						1.0	1.3	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTOE05	MATERIALS FOR AUTOMOTIVE COMPONENTS				
PREREQUISITES: Engineering material and metallurgy	**Category**	**OE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1.	To give an overview of material properties, use of materials selection chart and considerations for material selection
2.	To impart knowledge about the basis of materials selection
3.	To give insight about the factors that influence materials selection for engines and transmission system
4.	To instill the knowledge required for the selection of materials for automotivestructures
5.	To render the basis of material selection for electronics devices in the automobile.

UNIT I	**ENGINEERING MATERIALS AND THEIR PROPERTIES**	**9**	**0**	**0**	**9**

Classes of engineering materials - the evolution of engineering materials, Definition of materials properties, Displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment. Selection of materials for automotive, aerospace, marine and defence applications.

UNIT II	**BASIS OF MATERIAL SELECTION**	**9**	**0**	**0**	**9**

Selection strategy, Attribute limits and Material indices, structural index Selection procedure: Design process - types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes - Materials processing and design processes and their influence on design, Process attributes, Systematic process selection, Process selection diagrams, Process cost, Energy consumption for production, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection.

UNIT III	**MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS**	**9**	**0**	**0**	**9**

Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.

UNIT IV	**MATERIALS FOR AUTOMOTIVE STRUCTURES**	**9**	**0**	**0**	**9**

Materials selection for bearings, leaf springs, chasis& frames, Bumper, shock absorbers, Damping fluid, wind screens, panels, brake shoes, Disc, wheels, differentials , damping and Antifriction fluids, Tyres and tubes.

UNIT V	**ELECTRONIC MATERIALS FOR AUTOMOTIVE APPLICATIONS**	**9**	**0**	**0**	**9**

Materials for electronic devices meant for engine control, ABS, Steering, Suspension, Sensors, Temperature sensors forclimate control, anti-collision, Anti-fog, Head lamps.

Total (L+T) = 45 Hours

Text Books:

1.	Charles J A and Crane. F A. A., –Selection and Use of Engineering Materials‖, 3rd Edition, Butterworths, London UK, 1996.
2.	Jason Rowe, ―Advanced Materials in Automotive Engineering‖, Wood Head Publishing, 2012.

Reference Books:

1.	Ahmed E, ―Advanced composite materials for Automotive applications, Wiley, 2013
2.	Don H Wright,‖ Testing Automotive Materials and Components‖, SAE 1993.
3.	Geoff Davis, ― Materials for Automobile bodies‖, Butter Worth Heinemann, 2012

4.	Hiroshi Yamagata, –The Science and Technology of Materials in Automotive Engines‖, Elsvier, 2005
5.	Mstislav A M, Valentin N A, Gleb V M, ―Automotive materials: a handbook for the mechanical engineer‖, NTIS, 1972.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Identify the criteria and forces that cause the changes in materials selection.	L3:Applying
CO2	:	Investigate the influence of structural index, manufacturing process, design and Functional requirements on selection strategies.	L4:Analysing
CO3	:	Recognize the temperature regime, nature of load and property requirements of materials for engines and transmission system.	L4:Analysing
CO4	:	Analyse the various stresses acting on the structural members of automobile underDynamic loading and select suitable material.	L4:Analysing
CO5	:	Prepare the apt material for electronic devices used in automobiles	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1									2		1
CO2	3	2		1		1								2	1	
CO3	2	3	1		1								1			1
CO4	2	1		1	1								2			
CO5	1	1			1		1							1		
Avg.	1.8	1.6	1.0	1.0	1.0	1.0	1.0						1.5	1.7	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

ELECTIVES FOR HONOURS

22ECH101	VLSI TECHNOLOGY				Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
VLSI Design		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives

1	To understand the concepts of wafer preparation, epitaxy and oxidation.
2	To study the use of various deposition and diffusion.
3	To impart knowledge in ion implementation and VLSI process integration.

Unit I	CRYSTAL GROWTH, WAFER PREPARATION, EPITAXY AND OXIDATION	9	0	0	9

Electronic Grade Silicon - Czochralski crystal growing - Silicon Shaping - processing consideration - Vapor phase Epitaxy - Molecular Beam Epitaxy - Silicon on Insulators, Growth Mechanism and kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopants at interface, Oxidation of Poly Silicon, Oxidation induced Defects.

Unit II	LITHOGRAPHY AND RELATIVE PLASMA ETCHING	9	0	0	9

Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, relative Plasma Etching techniques and Equipments.

Unit III	DEPOSITION AND DIFFUSION	9	0	0	9

Deposition process, Polysilicon, Silicon Dioxide- Silicon Nitride- plasma assisted Deposition, Models of Diffusion in Solids, Flick’s one dimensional Diffusion Equation – Atomic Diffusion Mechanism –Measurement techniques.

Unit IV	ION IMPLEMENTATION AND METALLIZATION	9	0	0	9

Range theory- Implant equipment. Annealing-Shallow junction – High energy implantation – Metallization Applications- Metallization choices- Physical vapor deposition – Patterning.

Unit V	VLSI PROCESS INTEGRATION AND PACKAGING OF VLSI DEVICES	9	0	0	9

NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology – Bipolar IC Technology – IC Fabrication. Package types– banking design consideration – VLSI assembly technology – Package fabrication technology.

Total (45 L) = 45 Periods

Text Books:

1	Sze, S.M., “VLSI Technology”, Second Edition, McGraw-Hill, New York, 1998.
2	Mukherjee, Amar., “Introduction to NMOS and CMOS VLSI System Design”, Prentice Hall India, New Delhi, 2000.

Reference Books:

1	Plummer, James D., Deal, Michael D. and Griffin, Peter B., “Silicon VLSI Technology: Fundamentals Practice and Modeling”, Prentice Hall India, New Delhi, 2000.
2	Hubert Kaeslin., “Digital Integrated Circuit Design From VLSI Architectures to CMOS Fabrication” Cambridge, 2008.
3	Douglas A.Pucknell, “Basic VLSI Design", Third Edition, Mc Graw Hill Book Co., 2015.
4	Sorab K.Ghandhi., “VLSI Fabrication Principles: Silicon and Gallium Arsenide”, 2nd Edition, John Wiley & Sons, 1994.

E-Reference:	
1	https://nptel.ac.in/courses/117106093
2	https://freevideolectures.com/course/3183/vlsi-technology-i
3	http://www.infocobuild.com/education/audio-video-courses/electronics/VLSITechnology-IIT-Madras/lecture-09.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Summarize the approach for wafer preparation, Epitaxy and Oxidation	Understanding
CO2	Distinguish the various methods for lithography and plasma etching	Analysing
CO3	Illustrate the various Deposition and diffusion process	Analysing
CO4	Infer the process of ion implantation and metallization	Understanding
CO5	Realize the various IC technology and Package types	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	1	1	-	-	-	-	-	1	1	1	2	-
CO2	3	-	2	1	1	-	-	-	-	-	2	1	2	2	-
CO3	3	-	2	1	2	-	2	-	-	-	2	1	2	3	-
CO4	3	1	2	1	2	-	2	-	-	-	1	2	2	3	-
CO5	3	2	2	3	3	1	2	2	1	1	3	3	3	3	3
Avg	3	1.5	2	1.4	1.8	1	2	2	1	1	1.8	1.6	2	2.6	3

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH102	ANALOG CMOS IC DESIGN			Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
VLSI Design			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To design the fundamentals of analog circuits and MOS device models.
2	To design high frequency amplifiers and analyse Operational amplifiers.
3	To analyse two stage amplifiers and design current sources and sinks.

Unit I	**SINGLE STAGE AMPLIFIERS**	9	0	0	9

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**	9	0	0	9

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.

Unit III	**FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS**	9	0	0	9

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 AND FREQUENCY COMPENSATION OF TWO STAGE AMPLIFIER**	9	0	0	9

Analysis Of Two Stage Op Amp – Two Stage Op Amp Single Stage CMOS CS as Second Stage and Using Cascode Second Stage, Multipole Systems - Phase Margin - Frequency Compensation - Compensation Of Two Stage Op Amps - Slewing In Two Stage Op Amps - Other Compensation Techniques.

Unit V	**BANDGAP REFERENCES**	9	0	0	9

Current sinks and sources - current mirrors - Wilson current source - Widlar current source - cascode current source - design of high swing cascode sink - current amplifiers - supply independent biasing - temperature independent references - PTAT and CTAT current generation - constant-gm biasing.

Total (45 L) = 45 Periods

Text Books:	
1	BehzadRazavi, “Design Of Analog CMOS Integrated Circuits”, Tata Mcgraw Hill, 2001.
2	Willey M.C. Sansen, “Analog Design Essentials”, Springer, 2006.
Reference Books:	
1	Grebene, “Bipolar And MosAnalog Integrated Circuit Design”, John Wiley & Sons,Inc.,2003.
2	Phillip E.Allen, Douglas R .Holberg, “CmosAnalog Circuit Design”, Oxford University Press, 2nd Edition, 2002
3	Recorded Lecture Available at 6. Jacob Baker “CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.
4	Uyemura John P Uyemura "CMOS Logic Circuit Design", Kluwer Academic Publishers, 1999.
E-References:	
1	http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
2	https://onlinecourses.nptel.ac.in/noc22_ee37/
3	https://archive.nptel.ac.in/courses/117/106/117106030/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Design MOS amplifiers to meet user specifications	Applying
CO2	Analyze the frequency and noise performance of MOS amplifiers	Analysing
CO3	Design and analyze feedback amplifiers and one stage op amps	Applying
CO4	Design and analyze two stage op amps	Applying
CO5	Design and analyze current mirrors and current sinks with MOS devices.	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	1	1	-	1	-	-	-	1	-	1	2	1
CO2	2	2	1	1	1	-	1	-	-	-	1	-	1	2	1
CO3	2	3	2	1	2	-	1	-	-	-	2	1	1	2	1
CO4	2	3	2	1	2	-	2	1	2	-	2	2	1	2	1
CO5	2	3	1	1	2	-	2	1	2	-	3	2	1	2	1
Avg	2	2.6	1.4	1	1.6	-	1.4	1	2	-	1.8	1.7	1	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

<table>
<tr><td>22ECH103</td><td colspan="2">DEVICE MODELLING</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="2">Prerequisites</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Electronic Devices and Circuits</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Objectives</td></tr>
<tr><td>1</td><td colspan="6">To study the MOS capacitors and to model MOS Transistors</td></tr>
<tr><td>2</td><td colspan="6">To understand the various CMOS design parameters and their impact on performance of the device</td></tr>
<tr><td>3</td><td colspan="6">To study the device level characteristics of BJT transistors</td></tr>
<tr><td>Unit I</td><td colspan="2">MOS CAPACITORS</td><td>9</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Surface Potential: Accumulation - Depletion, and Inversion - Electrostatic Potential and Charge Distribution in Silicon - Capacitances in an MOS Structure - Polysilicon-Gate Work Function and Depletion Effects - MOS under Nonequilibrium and Gated Diodes - Charge in Silicon Dioxide and at the Silicon–Oxide Interface - Effect of Interface Traps and Oxide Charge on Device Characteristics - High-Field Effects - Impact Ionization and Avalanche Breakdown - Band-to-Band Tunneling - Tunneling into and through Silicon Dioxide - Injection of Hot Carriers from Silicon into Silicon Dioxide - High-Field Effects in Gated Diodes - Dielectric Breakdown</td></tr>
<tr><td>Unit II</td><td colspan="2">MOSFET DEVICES</td><td>9</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Long-Channel MOSFETs - Drain-Current Model - MOSFET I–V Characteristics - Subthreshold Characteristics - Substrate Bias and Temperature Dependence of Threshold Voltage - MOSFET Channel Mobility - MOSFET Capacitances and Inversion-Layer Capacitance Effect - Short-Channel MOSFETs - Short-Channel Effect - Velocity Saturation and High-Field Transport Channel Length Modulation - Source–Drain Series Resistance - MOSFET Degradation and Breakdown at High Fields</td></tr>
<tr><td>Unit III</td><td colspan="2">CMOS DEVICE DESIGN</td><td>9</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">MOSFET Scaling - Constant-Field Scaling - Generalized Scaling - Nonscaling Effects - Threshold Voltage - Threshold-Voltage Requirement - Channel Profile Design - Nonuniform Doping - Quantum Effect on Threshold Voltage - Discrete Dopant Effects on Threshold Voltage - MOSFET Channel Length - Various Definitions of Channel Length - Extraction of the Effective Channel Length - Physical Meaning of Effective Channel Length - Extraction of Channel Length by C–V Measurements</td></tr>
<tr><td>Unit IV</td><td colspan="2">CMOS PERFORMANCE FACTORS</td><td>9</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Basic CMOS Circuit Elements - CMOS Inverters - CMOS NAND and NOR Gates - Inverter and NAND Layouts - Parasitic Elements - Source–Drain Resistance - Parasitic Capacitances - Gate Resistance - Interconnect R and C - Sensitivity of CMOS Delay to Device Parameters - Propagation Delay and Delay Equation - Delay Sensitivity to Channel Width, Length, and Gate Oxide Thickness - Sensitivity of Delay to Power-Supply Voltage and Threshold Voltage - Sensitivity of Delay to Parasitic Resistance and Capacitance - Delay of Two-Way NAND and Body Effect - Performance Factors of Advanced CMOS Devices - MOSFETs in RF Circuits - Effect of Transport Parameters on CMOS Performance – Low temperature CMOS.</td></tr>
<tr><td>Unit V</td><td colspan="2">BIPOLAR DEVICES</td><td>9</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">n–p–n Transistors - Basic Operation of a Bipolar Transistor - Modifying the Simple Diode Theory for Describing Bipolar Transistors - Ideal Current–Voltage Characteristics - Collector Current - Base Current - Current Gains - Ideal IC–VCE Characteristics - Characteristics of a Typical n–p–n Transistor - Effect of Emitter and Base Series Resistances - Effect of Base–Collector Voltage on Collector Current - Collector Current Falloff at High Currents - Nonideal Base Current at Low Currents - Bipolar Device Models for Circuit and Time-Dependent Analyses Basic dc Model - Basic ac Model - Small-Signal Equivalent-Circuit Model - Emitter Diffusion Capacitance - Charge-Control Analysis - Breakdown Voltages - Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche - Saturation Currents in a Transistor - Relation Between BVCEO and BVCBO.</td></tr>
<tr><td colspan="7" align="right">Total (45L)= 45 Periods</td></tr>
</table>

Text Books:	
1	Donald A. Neamen , “Semiconductor Physics and Devices”, University of New Mexico, 4th Edition, 2012.
2	J P Collinge, C A Collinge, “Physics of Semiconductor devices” Springer 2002 Edition.
Reference Books:	
1	Behzad Razavi, “Fundamentals of Microelectronics” Wiley Student Edition, 2nd Edition, 2013.
2	Yuan Taur and Tak H. Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2nd Edition, 2009.
3	A.S. Sedra and K.C. Smith, “Microelectronic Circuits”, 7th edition, Oxford University Press, 2015.
4	Ben G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices” ,7th edition, Pearson, 2014.
E-References:	
1.	http://www.nptelvideos.com/course.php?id=527
2.	https://www.digimat.in/nptel/courses/video/108105188/L28.html
3.	https://freevideolectures.com/course/4072/nptel-microelectronics

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Design MOSFET and BJT devices to desired specifications.	Understanding
CO2	Model MOSFET and BJT devices to desired specifications.	Applying
CO3	Analyze the CMOS Parameters and performance.	Analysing
CO4	Apply the mathematical techniques for device simulations	Applying
CO5	Analyze concepts about Bipolar Devices.	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	1	-	-	-	-	-	-	-	-	2	2	1
CO2	2	1	1	1	-	-	-	-	-	-	-	-	2	2	1
CO3	2	2	2	1	-	1	-	-	-	-	-	-	2	2	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	2	1	-	1	-	-	-	-	-	-	2	2	2
Avg	2	1.8	1.6	1	-	1	-	-	-	-	-	-	2	2	1.6

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH104	NETWORK ON CHIP				Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
1.Computer Networks		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives

1	To understand the concept of network - on - chip
2	To learn router architecture designs
3	To study fault tolerance and three dimensional integration of network - on - chip

Unit I	**INTRODUCTION TO NOC**	**9**	**0**	**0**	**3**
Introduction to NoC – OSI layer rules in NoC - Interconnection Networks in Network-on-ChipNetwork Topologies - Switching Techniques - Routing Strategies - Flow Control Protocol Quality-of-Service Support					
Unit II	**ARCHITECTURE DESIGN**	**9**	**0**	**0**	**3**
Switching Techniques and Packet Format - Asynchronous FIFO Design -GALS Style of Communication - Wormhole Router Architecture Design - VC Router Architecture Design - Adaptive Router Architecture Design.					
Unit III	**ROUTING ALGORITHM**	**9**	**0**	**0**	**3**
Packet routing-Qos, congestion control and flow control – router design – network link design – Efficient and Deadlock-Free Tree-Based Multicast Routing Methods - Path-Based Multicast Routing for 2D and 3D Mesh Networks- Fault-Tolerant Routing Algorithms - Reliable and Adaptive Routing Algorithms					
Unit IV	**TEST AND FAULT TOLERANCE OF NOC**	**9**	**0**	**0**	**3**
Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-on Chips-Test and Fault Tolerance for Networks-on-Chip Infrastructures-Monitoring Services for Networks-on-Chips.					
Unit V	**THREE-DIMENSIONAL INTEGRATION OF NETWORK-ON-CHIP**	**9**	**0**	**0**	**3**
Three-Dimensional Networks-on-Chips Architectures. – A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures - Resource Allocation for QoS On-Chip Communication – Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-on-Chip					
					Total (45L+0T)= 45 Periods

Text Books:

1	Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, Chita R.Das" Networks-on - Chip " Architectures Holistic Design Exploration", Springer. 2009.
2	Fayezgebali, Haythamelmiligi, HqhahedWatheq E1-Kharashi "Networks-on-Chips theory and practice CRC press, 2009.

Reference Books:	
1	Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-on-Chip Architectures" 2013
2	Palesi, Maurizio, Daneshtalab, Masoud "Routing Algorithms in Networks-on-Chip" 2014
3	SantanuKundu, SantanuChattopadhyay "Network-on-Chip: The Next Generation of System on-Chip Integration", CRC Press, 2014.
4	Sheng Ma, Libo, Mingche, Shi, Zhiying, "Networks-on-chip", Morgan Kaufmann, 2014.
E-References:	
1.	https://archive.nptel.ac.in/courses/106/103/106103183/
2.	https://www.digimat.in/nptel/courses/video/108106149/L93.html
3.	https://slideplayer.com/slide/7253925/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Discuss different routing algorithms	Understanding
CO2	Compare different architecture design	Understanding
CO3	Explain three dimensional networks - on-chip architectures	Applying
CO4	Analyze test and fault tolerance of Communications in NoC	Analysing
CO5	Apply the 3D Integration procedures in NoC	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	2	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO3	1	3	1	2	-	-	-	-	-	-	-	-	2	3	-
CO4	2	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO5	1	3	2	2	-	-	-	-	-	-	-	-	2	3	2
Avg	1.4	2.8	1.8	1.8	-	-	-	-	-	-	-	-	1.8	2.8	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH105	DSP INTEGRATED CIRCUITS			Semester		
PREREQUISITES		Category	PE	Credit		3
1.Digital Signal Processing		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives

1	To familiarize the concept of DSP and DSP algorithms.
2	To introduce the Multirate systems and finite wordlength effects
3	To know about the basic DSP processor architectures and the synthesis of the processing elements

Unit I	INTRODUCTION TO DSP INTEGRATED CIRCUITS	9	0	0	3

Introduction to Digital signal processing - Sampling of analog signals - Selection of sample frequency - Signal-processing systems - Frequency response - Transfer functions - Signal flow graphs - Filter structures - Adaptive DSP algorithms - DFT-The Discrete Fourier Transform - FFT Algorithm - Image coding - Discrete cosine transforms - Standard digital signal processors - Application specific ICs for DSP - DSP systems - DSP system design - Integrated circuit design.

Unit II	DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS	9	0	0	3

FIR filters - FIR filter structures - FIR chips - IIR filters - Specifications of IIR filters - Mapping of analog transfer functions - Mapping of analog filter structures - Multi rate systems - Interpolation with an integer factor L - Sampling rate change with a ratio L/M - Multi rate filters. Finite word length effects - Parasitic oscillations - Scaling of signal levels - Round-off noise - Measuring round-off noise - Coefficient sensitivity - Sensitivity and noise.

Unit III	DSP ARCHITECTURES	9	0	0	3

DSP system architectures - Standard DSP architecture-Harvard and Modified Harvard architecture. Ideal DSP architectures - Multiprocessors and multi computers - Systolic and Wave front arrays - Shared memory architectures.

Unit IV	SYNTHESIS OF DSP ARCHITECTURES	9	0	0	3

Synthesis: Mapping of DSP algorithms onto hardware - Implementation based on complex PEs - Shared memory architecture with Bit – serial PEs. Combinational & sequential networks- Storage elements – clocking of synchronous systems - Asynchronous systems -FSM

Unit V	ARITHMETIC UNIT AND PROCESSING ELEMENTS	9	0	0	3

Conventional number system - Redundant Number system - Residue Number System - Bit-parallel and Bit-Serial arithmetic - Digit Serial arithmetic - CORDIC Algorithm - Basic shift accumulator - Reducing the memory size - Complex multipliers - Improved shift-accumulator. Case Study: DCT and FFT processor

Total (45L)= 45 Periods

Text Books:	
1	Lars Wanhammer, "DSP Integrated Circuits", Academic press, New York, 1999.
2	John J. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, 2002.
Reference Books:	
1	Keshab Parhi, "VLSI Digital Signal Processing Systems design & Implementation", John Wiley & Sons, 1999.
2	B.Venkatramani, M.Bhaskar, "Digital Signal Processors", Tata McGraw-Hill, 2002.
3	Avtar Singh and S. Srinivasan, "Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx", cengage Learning India Private Limited, Delhi 2012
4	S.K. Mitra, "Digital Signal Processing, A Computer Based approach", 4th Edition, McGraw-Hill, 2010.
E-References:	
1	http://www.nptelvideos.com/lecture.php?id=7678
2	https://www.digimat.in/cgi-bin/search.cgi
3	https://www.allaboutcircuits.com/video-tutorials/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Get to know about the Digital Signal Processing concepts and its algorithms	Remembering
CO2	Get an idea about finite word length effects in digital filters	Understanding
CO3	Concept behind multi rate systems is understood.	Understanding
CO4	Get familiar with the DSP processor architectures	Understanding
CO5	Perform the synthesis of processing elements	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	2	1	-	-	-	-	-	-	-	-	2	2	2
CO2	2	-	1	1	-	-	-	-	-	-	-	-	1	2	1
CO3	3	-	1	1	-	-	-	-	-	-	-	-	2	-	1
CO4	1	-	1	1	-	-	-	-	-	-	-	-	2	2	1
CO5	2	2	2	1	-	-	-	-	-	-	-	-	1	2	1
Avg	1.8	2	1.4	1	-	-	-	-	-	-	-	-	1.6	2	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH106	VLSI SIGNAL PROCESSING				Semester		
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
VLSI Design			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Objectives							
1	To introduce fundamentals of VLSI signal processing and expose them to examples of applications.						
2	To design and optimize VLSI architectures for basic DSP algorithms.						
3	To impart knowledge in asynchronous pipelining.						
Unit I	**PIPELINING AND PARALLEL PROCESSING OF DIGITAL FILTERS**			**9**	**0**	**0**	**3**
Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path - Loop bound - iteration bound - Longest path matrix algorithm - Pipelining and Parallel processing of FIR filters - Pipelining and Parallel processing for low power.							
Unit II	**ALGORITHMIC STRENGTH REDUCTION TECHNIQUE I**			**9**	**0**	**0**	**3**
Retiming – definitions and properties - Unfolding – an algorithm for unfolding - properties of unfolding - sample period reduction and parallel processing application - Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter - 2-parallel fast FIR filter - DCT architecture - rank-order filters - Odd-Even merge-sort architecture - parallel rank-order filters.							
Unit III	**ALGORITHIMIC STRENGTH REDUCTION -II**			**9**	**0**	**0**	**3**
Fast convolution – Cook-Toom algorithm - modified Cook-Toom algorithm - Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters - Look-Ahead pipelining with powerof-2 decomposition - Clustered look-ahead pipelining - Parallel processing of IIR filters - combined pipelining and parallel processing of IIR filters.							
Unit IV	**BIT-LEVEL ARITHMETIC ARCHITECTURES**			**9**	**0**	**0**	**3**
Bit-level arithmetic architectures – parallel multipliers with sign extension - parallel carry-ripple and carry-save multipliers - Design of Lyon"s bit-serial multipliers using Horner"s rule - bit-serial FIR filter - CSD representation - CSD multiplication using Horner"s rule for precision improvement - Distributed Arithmetic fundamentals and FIR filters.							
Unit V	**NUMERICAL STRENGTH REDUCTION, WAVE AND ASYNCHRONOUS PIPELINING**			**9**	**0**	**0**	**3**
Numerical strength reduction – subexpression elimination - multiple constant multiplication - iterative matching - synchronous pipelining and clocking styles - clock skew in edge-triggered single phase clocking - two-phase clocking - wave pipelining - Asynchronous pipelining bundled data versus dual rail protocol.							
							Total (45 L) = 45 Periods

Text Books:	
1	Keshab K. Parhi, "VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2010.
2	U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004
Reference Books:	
1	Magdy A. Bayoumi, Magdy A. Bayoumi, E. Swartzlander, "VLSI Signal Processing Technology",Kluwer Academic Publishers.October 1994.
2	Isamail, Mohammed and Fiez, Terri, "Analog VLSI Signal and Information Processing", McGraw-Hill, New York, 1994.

3	S.Y. Kuang, H.J. White House, T.Kailath, "VLSI and Modern Signal Processing", Prentice Hall, 1995.
4	Jose E. France, YannisTsividls, "Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing", Prentice Hall, 1994.
5	Richard. J. Higgins, "Digital Signal Processing in VLSI", Prentice Hall, 1990.
e-Reference:	
1	https://nptel.ac.in/courses/108105157
2	https://slideplayer.com/slide/8932417/
3	https://www.youtube.com/watch?v=gIgNlhuqxWo

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand VLSI design methodology for signal processing systems.	Understanding
CO2	Perform the pipelining and parallel processing in FIR systems to achieve high speed and low power.	Analysing
CO3	Apply the algorithmic strength reduction using various techniques.	Analysing
CO4	Modify the existing or new DSP architectures suitable for VLSI.	Evaluating
CO5	Implement the strength reduction and asynchronous pipelining.	Creating

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	-	-	-	-	-	-	-	2	-	-
CO2	3	1	2	2	1	-	2	-	-	-	-	2	2	1	-
CO3	3	2	1	2	2	2	1	-	-	-	-	2	2	2	2
CO4	2	2	2	3	3	1	2	1	-	-	-	2	2	2	1
CO5	3	3	2	3	3	1	2	2	2	1	3	3	3	2	3
Avg	2.8	2	1.6	2.2	2	1.3	1.75	1.5	2	1	3	2.25	2.2	1.75	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH107	MIXED SIGNAL VLSI DESIGN			Semester			
PREREQUISITES		Category	PE	Credit			3
VLSI Design		Hours/Week	L	T	P		TH
			3	0	0		3

Course Objectives

1	To analyze the characteristics of IC based CMOS filters.
2	To design various data converter architecture circuits.
3	To design oscillators and phase lock loop circuit.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction to Active Filters - Switched capacitor filters - Switched capacitor resistors - amplifiers – comparators - sample & hold circuits – Integrator- Biquad

Unit II	**INTEGRATOR BASED CMOS FILTERS**	**9**	**0**	**0**	**9**

Integrator Building Blocks - low pass filter - Active RC integrators, MOSFET-C Integrators, gm- C integrators - Discrete time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function.

Unit III	**DATA CONVERTER ARCHITECTURES**	**9**	**0**	**0**	**9**

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures- Flash, Two-step flash ADC, Pipeline ADC, Integrating ADC's, Successive Approximation ADC.

Unit IV	**DATA CONVERTER MODELING AND SNR**	**9**	**0**	**0**	**9**

Sampling and Aliasing: A modeling approach, Impulse sampling, The sample and Hold, Quantization noise. Data converter SNR: An overview, Clock Jitter, Improving SNR using Averaging, Decimating filter for ADCs, Interpolating filter for DACs, Band pass and High pass sinc filters - Using feedback to improve SNR.

Unit V	**OSCILLATORS AND PLL**	**9**	**0**	**0**	**9**

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops.

Total (45 L) = 45 Periods

Text Books:

1	CMOS Mixed Signal Circuit Design by R.Jacob Baker, Wiley India, IEEE Press, reprint 2008.
2	CMOS Circuit Design, Layout and Simulation by R.Jacob Baker, Wiley India, IEEE Press, Second Edition, reprint 2009.

Reference Books:

1	Design of Analog CMOS Integrated Circuits by Behzad Razavi, McGraw Hill, 33rd Re- print, 2016.
2	M.L.Bushnell & V.D.Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed signal VLSI Circuits",Kluwer Academic Publishers, 2004
3	*N*.K Jha and S.G Gupta ,"Testing of Digital Systems", Cambridge University Press, 2003.
4	Laung-Terng Wang,Cheng-Wen Wu,Xiaoqing Wen,VLSI "Test Principles and Architectures", Morgan Kaufmann Publishers, 2006

E-Reference:	
1	http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
2	https://onlinecourses.nptel.ac.in/noc22_ee37/
3	https://archive.nptel.ac.in/courses/117/106/117106030/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Apply the concepts for mixed signal MOS circuit.	Understanding
CO2	Analyze the characteristics of IC based CMOS filters.	Understanding
CO3	Design of various data converter architecture circuits.	Applying
CO4	Analyze the signal to noise ratio and modeling of mixed signals.	Applying
CO5	Design of oscillators and phase lock loop circuit.	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	-	-	-	-	-	1	-	1	2	1
CO2	3	2	2	2	1	-	-	-	-	-	1	-	2	2	1
CO3	3	3	3	2	1	-	-	-	2	-	1	-	2	2	1
CO4	2	2	2	3	2	-	2	-	2	-	2	1	2	2	1
CO5	2	2	2	3	2	-	2	-	2	-	2	2	2	2	2
Avg	2.4	2.2	2	2.4	1.4	-	2	-	2	-	1.4	1.5	1.8	2	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH108	VLSI FOR WIRELESS COMMUNICATION			Semester			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**	
1. Wireless Communication 2. VLSI Design		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives	
1	To understand the concepts of basic wireless communication concepts.
2	To design low noise amplifiers, mixers and various types of mixers designed for wireless communication.
3	To design PLL and VCO and to understand the concepts of back end of the transmitters and front end of the receiver in wireless communication.

Unit I	**WIRELESS COMMUNICATION CONCEPTS**	**9**	**0**	**0**	**9**
Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.					
Unit II	**RECEIVER ARCHITECTURE AND LOW NOISE AMPLIFIERS**	**9**	**0**	**0**	**3**
Receiver front end – Filter design – Non-idealities and Design parameters – Noise figure and Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching and Core amplifier.					
Unit III	**MIXERS**	**9**	**0**	**0**	**9**
Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer - Switching Mixer – Distortion, Conversion Gain and Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer - Sampling Mixer - Conversion Gain, Distortion, Intrinsic and Extrinsic Noise in Single ended sampling Mixer.					
Unit IV	**FREQUENCY SYNTHESIZERS**	**9**	**0**	**0**	**9**
PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters and design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.					
Unit V	**TRANSMITTER ARCHITECTURES AND POWER AMPLIFIERS**	**9**	**0**	**0**	**9**
Transmitter back end design – Quadrature Local Oscillator generator – Power amplifier design.					
					Total (45 L) = 45 Periods

Text Books:	
1	Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002
2	B.Razavi ,”RF Microelectronics” , Prentice-Hall communication engineering and emerging technologies series, 2012.
Reference Books:	
1	Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999
2	Emad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI wireless design – Circuits & Systems”, Kluwer Academic Publishers, 2000.
3	Crols and M. Steyaert, “CMOS Wireless Transceiver Design,” Boston, Kluwer Academic Pub., 1997
4	Thomas H.Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Cambridge University Press ,2003.
E-Reference:	
1	https://nptel.ac.in/courses/117104099/
2	http://www.nptelvideos.in/2012/12/wireless-communication.html
3	http://videos.gitam.edu/nptel/ece.html

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the fading concepts	Understanding
CO2	Design Low Noise amplifier for wide band and narrow band.	Applying
CO3	Design mixers with noise	Applying
CO4	Evaluate the performance of Frequency synthesizers.	Evaluating
CO5	Design and analyze Power amplifiers.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	2	2	1	2	2	1	1	-	-	-	2	2	2	-	2
CO2	1	2	2	2	1	1	2	-	-	-	1	2	1	-	2
CO3	2	1	2	1	1	2	1	-	-	-	2	1	2	-	1
CO4	1	1	2	2	1	1	2	-	-	-	1	1	1	-	2
CO5	2	1	2	1	2	2	1	-	-	-	2	2	1	-	1
Avg	1.6	1.4	1.8	1.6	1.4	1.4	1.4	-	-	-	1.6	1.6	1.4	-	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH109	VLSI FOR IOT SYSTEMS			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
VLSI Design &IOT		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To analyze the components of IOT and IC technology for IOT.
2	To acquire the electronic system design for IOT.
3	To impart the knowledge on System design for IOT and applications.

Unit I	**INTRODUCTION**	9	0	0	9

Concept of connected world - Need, Legacy systems for connected world-features and limitations - Key features of loT architecture - Merits and Demerits of loT technology. Applications driven by loT technology – examples.

Unit II	**COMPONENTS OF IOT**	9	0	0	9

Review of classic embedded system architecture - Basic building blocks of an IoT system - Artificial Intelligence - Connectivity. Sensors and Computing nodes. Sensors used in loT systems - Characteristics and requirements. Types of sensors propertiesfor loT systems - Compute nodes of loT Connectivity technologies in loT - Software in loT systems - features and properties

Unit III	**IC TECHNOLOGY FOR IOT**	9	0	0	9

SoC architecture for lot Devices - Application Processors - Microcontrollers - Smart Analog - Memory architecture for loT - Non Volatile Memories (NVM). Embedded Non-Volatile Memories - Anti-Fuse One Time Programmable (OTP) memories - Power Management - Low Dropout Regulator - DC-to-DC Converters - Voltage References - Power Management Units (PMUS) in IC's and Systems - Role of Field Programmability in IoT systems.

Unit IV	**ELECTRONIC SYSTEM DESIGN FOR IOT**	9	0	0	9

Electronic System Design for loT Requirements - Computing blocks in IoT systems - MCU's, DSPS and FPGA - System Power Supply Design for IoT systems - Mixed Signal challenges in hardware systems - Form Factor- Guidelines and prevailing standards - Component models & System Design - Feasibility and challenges - System Level Integration - Operating conditions of loT devices and impact on Electronic System Design - Hardware Security issues - EMI/EMC, SI/P) and Reliability Analysis in IOT systems.

Unit V	**APPLICATIONS**	9	0	0	9

Automated Design of Reconfigurable Microarchitectures for Accelerators Under Wide-Voltage Scaling - Approximate Adder Circuits Using Clocked CMOS Adiabatic Logic (CCAL) for IoT Applications -Battery Management Technique to Reduce Standby Energy Consumption in Ultra-Low Power IoT and Sensory Applications

Total (45 L) = 45 Periods

Text Books:	
1	Alloto. "Enabling the Internet of Things- From Integrated Circuits to Integrated Systems", Springer Publications, First Edition, 2017.
2	Pieter Harpe, Kofi A. A Makinwa, Andrea Baschirotto, "Hybrid ADCs, Smart Sensors for the loT, and Sub-1V & Advanced Node Analog Circuit Design". Springer International Publishing AG, 2017
Reference Books:	
1	Rashid Khan, KajariGhoshdastidar, AjithVasudevan, "Learning lot with Particle Photon and Electron". Packt Publishi Limited (Verlag), 2016.
2	Shubakar Kalya, Muralidhar Kulkarni, Shivaprakasha, Advances in VLSI, Signal Processing, Power Electronics, IoT, Communication and Embedded Systems, Springer, 2021.
3	Ibrahim (Abe) M. Elfadel (Editor), Mohammed Ismail (Editor), TheIoT Physical Layer: Design and Implementation, Springer, 2018.
4	JyotiKandpal, Opportunity and Challenges for VLSI in IoT Application, DOI:10.4018/978-1-6684-3855-8.ch0105Bosco H Leung "VLSI for Wireless Communication", PearsonEducation, 2002
E-Reference:	
1	http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
2	https://onlinecourses.nptel.ac.in/noc22_ee37/
3	https://archive.nptel.ac.in/courses/117/106/117106030/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the basic concepts of IOT	Understanding
CO2	Infer the components of IOT	Understanding
CO3	Understand the IC technology for IOT	Understanding
CO4	Acquire the electronic system design for IOT	Applying
CO5	Infer the applications of IOT	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	-	-	-	-	-	-	1	-	1	2	-
CO2	1	1	1	1	-	-	-	-	-	-	2	-	1	2	-
CO3	1	1	1	1	2		1	-	-	-	2	-	1	2	-
CO4	1	1	1	1	2	1	1	1	-	-	2	2	1	2	2
CO5	1	1	1	1	2	1	1	1	1	-	2	2	1	2	2
Avg	1	1	1	1	2	1	1	1	1	-	1.8	2	1	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH110	CAD FOR VLSI DESIGN			Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
VLSI Design			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives	
1	To introduce the VLSI design methodologies, data structures and algorithms required for VLSI design.
2	To study algorithms for partitioning, placement, floor planning and routing.
3	To study algorithms for modelling, simulation and synthesis.

Unit I	**INTRODUCTION**	9	0	0	9
Introduction to VLSI Design Methodologies – VLSI Design Cycle – New Trends in VLSI Design Cycle – Physical Design Cycle – New Trends in Physical Design Cycle – Design Styles – Review of VLSI Design Automation Tools					
Unit II	**DATA STRUCTURES AND BASIC ALGORITHMS**	9	0	0	9
Introduction to Data Structures and Algorithms – Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable Problems – General Purpose Methods for Combinatorial Optimization.					
Unit III	**ALGORITHMS FOR PARTITIONING AND PLACEMENT**	9	0	0	9
Layout Compaction – Problem Formulation – Algorithms for Constraint Graph Compaction – Partitioning – Placement – Placement Algorithms.					
Unit IV	**ALGORITHMS FOR FLOORPLANNING AND ROUTING**	9	0	0	9
Floorplanning – Problem Formulation – Floorplanning Algorithms – Routing – Area Routing – Global Routing – Detailed Routing.					
Unit V	**MODELLING, SIMULATION AND SYNTHESIS**	9	0	0	9
Simulation – Gate Level Modeling and Simulation – Logic Synthesis and Verification – Binary Decision Diagrams – High Level Synthesis					
					Total (45 L) = 45 Periods

Text Books:	
1	Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Second Edition, Wiley-India, 2017.
2	Naveed a. Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, Springer, 2017.

Reference Books:	
1	Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, "Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition
2	N.a. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
3	Andrew B Kahng and Jens Lienig, "VLSI Physical Design: From Graph Partitioning to Timing Closure".
4	Rolf Drechsler, "Evolutionary Algorithms for VLSI CAD".
E-Reference:	
1	https://archive.nptel.ac.in/courses/106/106/106106088/
2	https://gndec.ac.in/~librarian/web%20courses/IIT-MADRAS/CAD%20for%20VLSI%20DESIGN%20I/index1.html
3	https://archive.nptel.ac.in/courses/117/101/117101058/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use various VLSI design methodologies	Understanding
CO2	Understand different data structures and algorithms required for VLSI design.	Applying
CO3	Develop algorithms for partitioning and placement.	Applying
CO4	Develop algorithms for floorplanning and routing.	Applying
CO5	Design algorithms for modelling, simulation and synthesis.	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	1	1	-	-	-	-	-	-	-	1	2	1
CO2	1	1	1	1	1	1	-	-	-	-	1	-	1	2	1
CO3	1	1	1	1	1	1	-	-	-	-	1	-	1	2	1
CO4	1	1	1	1	1	1	-	-	-	-	2	1	1	2	1
CO5	1	1	1	1	1	-	-	-	-	-	2	1	1	2	1
Avg	1.2	1.2	1	1	1	1	-	-	-	-	1.5	1	1	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH201	**HIGH PERFORMANCE NETWORKS**			**Semester**			
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
		Hours/Week	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Objectives	
1	To Compare and contrast high throughput and low latency networking devices
2	To introduce the layered communication architectures of high performance network.
3	To apply various layer protocols and solve security issues

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Review of OSI, TCP/IP, Multiplexing, Modes of communication, Switching - Routing - SONET-DWDM-DSL-ISDN-BISDN - ATM-Features - Addressing signaling & Routing - Header structure - ATM adaptation layer - Management control - Interworking with ATM.

UNIT II	**MULTIMEDIA NETWORKING APPLICATIONS**	**9**	**0**	**0**	**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**	**0**	**0**	**9**

Architecture and performance - binary block codes - orthogonal - Biorthogonal - VPN-remote access VPN - site-to-site VPN - tunneling to PPP - security in VPN - MPLS-operation, routing, tunneling and use of FEC - traffic engineering - MPLS based VPN - overlay networks - P2P connections

UNIT IV	**TRAFFIC MODELLING**	**9**	**0**	**0**	**9**

Little’s theorem - Need for modeling - Poisson modeling and its failure - non-poisson models - Network performance evaluation - 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**	**0**	**0**	**9**

Network Architecture - SNMP basics - SNMP naming and OIDs, MIBs, SNMPv1 data types, SNMP operations, Authentication applications- Kerberos, X.509 authentication service, Electronic mail security-Pretty Good Privacy, IP Security-IP security overview, Firewalls- Firewall design principles.

Total (45L) = 45 Periods

Text Books:	
1	Warland, Pravin Varaiya, " High performance communication networks", Second Edition, Jean Harcourt Asia Pvt.Ltd, 2001.
2	William Stallings, " High speed networks and internets", Person Education, Second Edition, 2002.

Reference Books:	
1	James F.Kurose, Keith W.Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Person Education, Third Edition,2011
2	IrvanPepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 amd 2,2003.
3	Abhijit S. Pandya, Ercan Sea, "-ATM Technology for Board Band Telecommunication Networks", CRC Press, New-York, 2004.
4	Kaven Pahlavan And Prashant Krishnamoorthy, "Principles of Wireless Network", Prentice Hall of India, 2010.
E-Reference	
1	http://freevideolectures.com/course/2278/Data-Communication/30
2	http://nptel.ac.in/couses/106105082/30 3.http://nptel.ac.in/courses/106105183

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Recognize and differentiate concepts of ATM, SONET and ISDN.	Understanding
CO2	Understand various multimedia networking applications and services.	Understanding
CO3	Apply advanced networks concepts	Applying
CO4	Perform traffic based on the various models and theorems	Applying
CO5	Solve various networks security issues and understand management concepts	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	2	-	-	-	-	-	-	-	-	3	-	2
CO2	-	2	-	2	-	-	-	-	-	-	-	-	3	-	3
CO3	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
CO4	2	2	2	2	-	-	-	-	-	-	-	2	1	-	1
CO5	2	2	3	2	-	-	-	-	-	-	-	2	2	-	2
Avg	2	2	2.3	2	-	-	-	-	-	-	-	2	2.2	-	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH202	OPTICAL COMMUNICATION NETWORKS			Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
2	To learn the various optical source materials, LED structures, quantum efficiency and Laser diodes and its uses.
3	To understand the fiber optical network components, variety of networking aspects, SONET/SDH and operational principles WDM.

UNIT I	**OPTICAL FIBER COMMUNICATIONS**	**9**	**0**	**0**	**9**

Historical development - The general system - Advantages of optical fiber communication - Optical fiber wave guides: Ray theory transmission - Modes in planar guide - Phase and group velocity - Cylindrical fiber: Modes - Step index fibers - Graded index fibers - Single mode fibers - Cutoff wavelength - Mode field diameter - effective refractive index. Fiber Materials - Photonic crystal fibers.

UNIT II	**TRANSMISSION CHARACTERISTICS**	**9**	**0**	**0**	**9**

Transmission characteristics of optical fiber: Attenuation - Material absorption losses - Linear scattering losses - Nonlinear scattering losses - Fiber bend loss - Dispersion - Chromatic dispersion - Intermodal dispersion: Multimode step index fiber. Optical Fiber Connectors: Fiber alignment and joint loss - Fiber splices: Fusion Splices - Mechanical splices - Fiber connectors: Cylindrical ferrule connectors - Duplex and Multiple fiber connectors - Fiber couplers: three and four port couplers - star couplers - Optical Isolators and Circulators.

UNIT III	**OPTICAL SOURCES**	**9**	**0**	**0**	**9**

Optical sources: Light Emitting diodes: LED Structures - Light Source Materials - Quantum Efficiency and LED Power - Modulation. Laser Diodes: Modes and Threshold conditions - Rate equation - External Quantum Efficiency - Resonant Frequencies. Photodetectors: Physical principles of Photodiodes - Photo detector noise - Detector response time. Optical Receiver: Optical Receiver Operation: Error sources. Front End Amplifiers - Receiver sensitivity - Quantum Limit.

UNIT IV	**OPTICAL NETWORK ARCHITECTURES**	**9**	**0**	**0**	**9**

Introduction to Optical Networks; WDM networks - SONET / SDH - Metropolitan-Area Networks - Layered Architecture; Broadcast and Select Networks- Topologies for Broadcast Networks - Media Access Control Protocols - Wavelength Routing Architecture. WOBAN and OTDM networks. Introduction to ASON.

UNIT V	**PACKET SWITCHING AND ACCESS NETWORKS**	**9**	**0**	**0**	**9**

Photonic Packet Switching – OTDM - Multiplexing and Demultiplexing - Synchronisation - Broadcast OTDM networks - Switch-based networks; Access Networks – Network Architecture overview - OTDM networks; Optical Access Network Architectures; Future Access Networks

Total (45L) = 45 Periods

Text Books:

1	Gerd Keiser, Optical Fiber Communication, 5th Edition, Mc Graw Hill Education (India) Private Limited, 2015.ISBN:l-25-900687-5.
2	Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks : A Practical Perspective”, Harcourt Asia Pte Ltd., Second Edition 2004.

Reference Books:	
1	Optical Communication systems by John Gowar, 2nd Edition
2	Optical fiber Communications by John M. Senior, 3rd Edition
3	Biswanath Mukherjee, “Optical Communication Networks”, Mc-GrawHill ©1997, First Edition
4	C. Siva Ram Moorthy and Mohan Gurusamy, “WDM Optical Networks : Concept, Design and Algorithms”, Prentice Hall of India, Ist Edition, 2002.
E-Reference	
1	Optical Communications - Course (nptel.ac.in)
2	https://opg.optica.org/jocn/home.cfm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Recall the principles of operation of various optical fiber communication systems.	Remembering
CO2	Analyze the transmission characteristics of optical fiber and use	Applying
CO3	Recognize the type of optical sources	Remembering
CO4	Understand different types of optical network architectures and their applications	Understanding
CO5	Relate aspects of algorithms to connectivity and packet switching and queuing.	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	2	-	-	-	-	-	-	-	-	3	-	2
CO2	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
CO3	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
CO4	2	2	2	2	-	-	-	-	-	-	-	2	1	-	1
CO5	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
Avg	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH203	NETWORK SECURITY AND MANAGEMENT		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	Understand the need and concept of security
2	To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.
3	To understand Cryptography Theories, Algorithms and Systems

Unit	Title	L	T	P	TH
Unit I	**INTRODUCTION AND NUMBER THEORY**	**9**	**0**	**0**	**9**

Introduction to Information Security, Computer Security & Network Security. Need For Security. Security – Goals, Attacks, Security Services and Mechanisms, and Techniques - Number Theory and Mathematics for Cryptography

Unit	Title	L	T	P	TH
Unit II	**SYMMETRIC AND ASYMMETRIC CRYPTOSYSTEMS**	**9**	**0**	**0**	**9**

Number Theory and Mathematics for Symmetric Cryptography- Finite Arithmetic, Congruence Arithmetic-Linear Congruence and Quadratic Congruence – Basics for Asymmetric-Key Cryptography. Classical Symmetric-Key Ciphers –Substitution Ciphers, Transposition Ciphers

Unit	Title	L	T	P	TH
Unit III	**AUTHENTICATION, DIGITAL SIGNATURES AND CERTIFICATES**	**9**	**0**	**0**	**9**

Message Integrity & Message Authentication - Message Authentication Code (MAC), Cryptographic Hash Functions – Birthday Attacks, Digital Signatures - Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – Public Key Distribution – RSA schemes, Digital Certificates - PKI Certificates, PKI Life Cycle Management.

Unit	Title	L	T	P	TH
Unit IV	**SECURITY AT LAYERS**	**9**	**0**	**0**	**9**

Network Layer Security - IPSec, Transport Layer Security- SSL/TLS, SSH, Application Layer Security –PGP, S/MIME, Firewall - Concepts, Architecture, Packet Filtering, Proxy Services and Bastion Hosts.

Unit	Title	L	T	P	TH
Unit V	**NETWORK MANAGEMENT AND SNMP PROTOCOL MODEL**	**9**	**0**	**0**	**9**

Network and System management, Network management system platform; Current SNMP Broadband and TMN management, Network management standards. SNMPV1, SNMPV2 system architecture, SNMPV2, structure of management information. SNMPV2 – MIB – SNMPV2 protocol, SNMPV3-Architecture, Application, MIB, security user based security model, access control RMON.

Total (45L)= 45 Periods

Text Books:

1	Behrouz A.Forouzan, “Cryptography and Network Security”, Special Edition, Tata McGraw Hill, 2007
2	Mani Subramanian, “Network Management – Principles & Practice” – 2nd Edition Prentice Hall, 2012.

Reference Books:	
1	William Stallings “Cryptography and Network Security: Principles and Practice”, 3rd Edition, Pearson Education, 2002.
2	Bruce Scheneier, “Applied Cryptography”, John Wiley & Sons, 1994.
3	Charlie Kaufmann, Radia Perlman, Mike Speciner, "Network Security", Second Edition,
4	David M. Durton, “Elementary Number Theory”, Tata Mcgraw Hill, Sixth Edition, 2009.
E-References:	
1	https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2	https://nptel.ac.in/courses/106105031
3	https://www.udemy.com/courses/it-and-software/network-and-security/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Apply a structed approach of number theory to identify the need of security in the networks.	Applying
CO2	Able to apply the symmetric and asymmetric cryptosystems for the security issues in the network and resolve it.	Remembering
CO3	Have the knowledge of authentication, DSAs and certificates for security issues.	Analysing
CO4	Analyze the security at various layers in the networking..	Evaluating
CO5	Demonstrate various security applications, firewall, web security, Email security and malicious software, etc. and system management.	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	1	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	3	2	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	3	2	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH204	ARTIFICIAL NEURAL NETWORKS				Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To understand the biological neural network and to model equivalent neuron models.
2	To understand the architecture, learning algorithms
3	To know the issues of various feed forward and feedback neural networks.
4	To explore the Neuro dynamic models for various problems

UNIT I	INTRODUCTION	9	0	0	9

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning.

UNIT II	PERCEPTRONS	9	0	0	9

Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron – Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment. Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection

UNIT III	BACK PROPAGATION	9	0	0	9

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

UNIT IV	SELF-ORGANIZATION MAPS (SOM)	9	0	0	9

Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification

UNIT V	NEURO DYNAMICS AND HOPFIELD MODELS	9	0	0	9

Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, restricted boltzmen machine.

Total (45L) = 45 Periods

Text Books:

1	Artificial Neural Networks - B. Vegnanarayana Prentice Hall of India P Ltd 2005
2	Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Reference Books:	
1	Neural Networks in Computer Inteligance, Li Min Fu TMH 2003
2	Neural Networks a Comprehensive Foundations, Simon S Haykin, PHI Ed.
3	Neural Networks -James A Freeman David M S Kapura Pearson Ed., 2004.
4	Joao Luis Garcia Rosa, Artificial Neural Networks Models and Applications, IntechOpen,2016
E-Reference	
1	https://in.coursera.org/learn/neural-networks-deep-learninghttps://in.coursera.org/learn/neural-networks-deep-learning
2	https://nptel.ac.in/courses/117105084
3	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the similarity of biological networks and Neural networks	Understanding
CO2	Perform the training of neural networks using various learning rules.	Applying
CO3	Apply the concepts of forward and backward propagations.	Applying
CO4	Recognize mapping models and self-organizing map	Remembering
CO5	Understand and construct the Hopfield models.	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	2	-	-	-	-	-	-	-	-	3	-	2
CO2	2	2	3	2	-	-	-	-	-	-	-	2	2	-	3
CO3	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
CO4	2	2	2	2	-	-	-	-	-	-	-	2	-	-	-
CO5	-	2	3	2	-	-	-	-	-	-	-	2	2	-	2
Avg	2	2	2.5	2	-	-	-	-	-	-	-	2	2.25	-	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH205	5G COMMUNICATION NETWORKS			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives

1	To describe the evolution of mobile communication leading to the introduction of 5G
2	To identify the spectrum requirement
3	To explain the key innovations in radio and network

Unit I	**INTRODUCTION TO 5G**	**9**	**0**	**0**	**9**

3G and 4G(LTE) overview- Introduction to 5G – Use Cases – Evolving LTE to 5G Capability- 5G NR and 5G core network (5GCN) – 5G Standardization – 3GPP and IMT2020 – Spectrum for 5G – 5G deployment – Options, Challenges and Applications

Unit II	**5G WIRELESS PROPAGATION CHANNELS AND SPECTRUM**	**9**	**0**	**0**	**9**

Channel modeling requirements, propagation scenarios and challenges in the 5G modelling, Channel Models for mm Wave MIMO Systems. Spectrum for 4G – Spectrum Challenges in 5G- 5G Spectrum technologies- Value of spectrum for 5G.

Unit III	**TRANSMISSION AND DESIGN TECHNIQUES FOR 5G**	**9**	**0**	**0**	**9**

Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), nonorthogonal multiple accesses (NOMA).

Unit IV	**DEVICE-TO-DEVICE (D2D) COMMUNICATIONS**	**9**	**0**	**0**	**9**

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multihop and multi-operator D2D communications.

Unit V	**MILLIMETER WAVE COMMUNICATIONS**	**9**	**0**	**0**	**9**

Millimeter-wave Communications – spectrum regulations - deployment scenarios – beamforming - physical layer techniques - interference and mobility management - Massive MIMO propagation channel models - Channel Estimation in Massive MIMO - Massive MIMO with Imperfect CSI - Multi-Cell Massive MIMO - Pilot Contamination - Spatial Modulation (SM).

Total (45L)= 45 Periods

Text Books:

1	Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks” , Cambridge University Press
2	Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell

Reference Books:	
1	Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
2	Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.
3	Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.
4	Amitabha Ghosh and Rapeepat Ratasuk “Essentials of LTE and LTE-A”, Cambridge University Press.
E-References:	
1	https://nptel.ac.in/courses/112104181/
2	https://www.qualcomm.com
3	https://5glab.de

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the concepts and design of cognitive radios.	Understanding
CO2	Study about the SDR architecture and analysis.	Remembering
CO3	Analyse the various cognitive radio network architectures and network security.	Analysing
CO4	To analyse the performance of MAC and network layer design for cognitive radio.	Analysing
CO5	Able to improve the quality of video conferencing, improve the immersive learning experience and able to use AR and VR to design modules	Applying

COURSE ARTICULATION MATRIX

Cos/ Pos	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO3
CO1	2	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-	3	2	1
CO3	2	2	2	3	1	-	-	-	-	-	-	-	3	2	-
CO4	1	1	2	1	2	-	-	-	-	-	-	-	2	3	-
CO5	1	1	2	2	2	-	-	-	-	-	-	-	2	3	1
Avg	1.8	1.8	2	1.6	1.4	-	-	-	-	-	-	-	2.6	2.5	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH206	WIRELESS ADHOC AND SENSOR NETWORKS			Semester			
PREREQUISITES		**Category**	**PE**		**Credit**		**3**
		Hours/Week	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Objectives

1	To understand the basics of Ad-hoc & Sensor Networks.
2	To learn various fundamental and emerging protocols of all layers.
3	To understand the nature and applications of Ad-hoc and sensor networks.

Unit I	**MAC & TCP IN AD HOC NETWORKS**	**9**	**0**	**0**	**9**

Fundamentals of WLANs – IEEE 802.11 Architecture – Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols – TCP over Ad-Hoc networks-TCP protocol overview – TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

Unit II	**ROUTING IN AD HOC NETWORKS**	**9**	**0**	**0**	**9**

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services – DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

Unit III	**MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS**	**9**	**0**	**0**	**9**

Introduction – Architecture – Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues – Routing Protocols – Mobile Nodes and Mobile Robots – Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

Unit IV	**SENSOR MANAGEMENT**	**9**	**0**	**0**	**9**

Sensor Management – Topology Control Protocols and Sensing Mode Selection Protocols – Time synchronization – Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

Unit V	**SECURITY IN AD HOC AND SENSOR NETWORKS**	**9**	**0**	**0**	**9**

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks – Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

Total (45L)= 45 Periods

Text Books:

1	Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2	Carlos De Morais Cordeiro, Dharma Prakash Agrawal "Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011

Reference Books:	
1	C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.
2	C..K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
3	Erdal Çayırcı , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
4	Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.
E-References:	
1	https://nptel.ac.in/courses/106105183
2	https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09/
3	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Identify different issues in wireless ad hoc and sensor networks	Understanding
CO2	To analyze protocols developed for ad hoc and sensor networks.	Analysing
CO3	To design energy efficient Wireless Sensor Networks.	Understanding
CO4	Establish a Sensor network environment for different type of applications	Applying
CO5	Be familiar with the OS used in Wireless Sensor Networks and build basic modules	Remembering

COURSE ARTICULATION MATRIX														
Cos/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3	3	3	2	-	-	-	3	3	3	-	2
CO2	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
CO3	3	3	3	3	3	3	2	-	-	-	3	3	3	-	2
CO4	3	3	2	3	3	3	2	-	-	-	2	3	3	-	2
CO5	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
Avg	3	3	2	3	3	3	2	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH207	SOFTWARE DEFINED NETWORKS		Semester			
		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To differentiate between traditional networks and software defined networks
2.	To learn advanced and emerging networking technologies
3.	To obtain skills to do advanced networking research and programming
4.	To learn to use software programs to perform varying and complex networking tasks

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

SDN Origins and Evolution – Introduction – Why SDN? – Centralized and Distributed Control and Data Planes – The Genesis of SDN

UNIT II	**SDN ABSTRACTIONS**	**9**	**0**	**0**	**9**

How SDN Works – The Openflow Protocol – SDN Controllers: Introduction – General Concepts – Vmware – Nicira – Vmware/Nicira – OpenFlow-Related – Mininet – NOX/POX – Trema – Ryu – Big Switch Networks/Floodlight – Layer 3 Centric – Plexxi – Cisco OnePK

UNIT III	**PROGRAMMING SDN’S**	**9**	**0**	**0**	**9**

Network Programmability – Network Function Virtualization – NetApp Development, Network Slicing

UNIT IV	**SDN APPLICATIONS AND USE CASES**	**9**	**0**	**0**	**9**

SDN in the Data Center – SDN in Other Environments – SDN Applications – SDN Use Cases – The Open Network Operating System

UNIT V	**SDN’S FUTURE AND PERSPECTIVES**	**9**	**0**	**0**	**9**

SDN Open Source – SDN Futures – Final Thoughts and Conclusions

Total (45L) = 45 Periods

Text Books:

1.	Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014
2.	SDN – Software Defined Networks by Thomas D. Nadeau & Ken Gray, O’Reilly, 2013

Reference Books:

1.	Software Defined Networking with OpenFlow by SiamakAzodolmolky, Packt Publishing, 2013
2.	Feamster, Nick, Jennifer Rexford, and Ellen Zegura. “The road to SDN: an intellectual history of programmable networks.” ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.
3.	Kreutz, Diego, et al. “Software-defined networking: A comprehensive survey.” Proceedings of the IEEE 103.1 (2015): 14-76
4.	Vivek Tiwari, ―SDN and Open Flow for Beginners‖, Amazon Digital Services, Inc., 2013.

E-Reference

1	https://www.youtube.com/watch?v=CaukSKg_sI0
2	https://in.coursera.org/learn/sdn
3	https://nptel.ac.in/courses/108107107

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Differentiate between traditional networks and software defined networks	Understanding
CO2	:	Understand advanced and emerging networking technologies	Understanding
CO3	:	Obtain skills to do advanced networking research and programming	Applying
CO4	:	Learn how to use software programs to perform varying and complex networking tasks	Remembering
CO5	:	Expand upon the knowledge learned and apply it to solve real world problems	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	2	-	-	-	-	-	-	-	-	3	-	2
CO2	-	2	-	2	-	-	-	-	-	-	-	-	3	-	3
CO3	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
CO4	2	2	2	2	-	-	-	-	-	-	-	2	1	-	1
CO5	2	2	3	2	-	-	-	-	-	-	-	2	2	-	2
Avg	2	2	2.3	2	-	-	-	-	-	-	-	2	2.2	-	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH208	EMBEDDED SYSTEM FOR NETWORKING		Semester			
		CATEGORY	PE	Credit		C
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To learn embedded communication protocols and BUS
2.	To obtain skillset in basic and embedded ethernet
3.	To obtain skills to do advanced networking research and programming
4.	To specify, design, implement, and debug an embedded system project

UNIT I	EMBEDDED COMMUNICATION PROTOCOLS	9	0	0	9

Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming – ISA/PCI Bus protocols – Fire wire.

UNIT II	USB AND CAN BUS	9	0	0	9

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types –Enumeration –Descriptors –PIC 18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction – Frames –Bit stuffing –Types of errors – Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

UNIT III	ETHERNET BASICS	9	0	0	9

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol.

UNIT IV	EMBEDDED ETHERNET	9	0	0	9

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

UNIT V	WIRELESS EMBEDDED NETWORKING	9	0	0	9

Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization – Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing.

Total (45L) = 45 Periods

Text Books:

1.	Frank Vahid, Tony Givargis, “Embedded Systems Design: A Unified Hardware/Software Introduction”, John & Wiley Publications, 2002
2.	Jan Axelson, “Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port”, Penran Publications, 1996.

Reference Books:

1.	Dogan Ibrahim, “Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series”, Elsevier 2008.

2.	Jan Axelson, “Embedded Ethernet and Internet Complete”, Penram publications, 2003.
3.	Bhaskar Krishnamachari“, “Networking Wireless Sensors”, Cambridge press 2005.
E-Reference	
1	https://www.cisco.com/c/en/us/solutions/internet-of-things/iot-embedded-services.html
2	https://in.coursera.org/courses?query=embedded%20systems
3	https://www.coursera.org/lecture/iot/lecture-3-2-basic-equipment-UMLzi

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom’s Taxonomy Mapped
CO1	:	Understand different communication protocols	Understanding
CO2	:	Understand data flow in BUS and interfacing	Understanding
CO3	:	Obtain skills to use internet in local and wide communications	Applying
CO4	:	Differentiate UDP and TCP communication	Remembering
CO5	:	Expand upon the knowledge learned and apply it to solve real world problems	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	2	-	-	-	-	-	-	-	-	3	-	2
CO2	-	2	-	2	-	-	-	-	-	-	-	-	3	-	3
CO3	2	2	2	2	-	-	-	-	-	-	-	2	2	-	1
CO4	2	2	2	2	-	-	-	-	-	-	-	2	1	-	1
CO5	2	2	3	2	-	-	-	-	-	-	-	2	2	-	2
Avg	2	2	1.75	2	-	-	-	-	-	-	-	2	2.2	-	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH209	COGNITIVE RADIO NETWORKS			Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Objectives							
1	Understand the concepts of cognitive radio						
2	Learn spectrum sensing and dynamic spectrum access						
3	To introduce the student about fundamental concepts and applications of cognitive radio networks.						
Unit I	**INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO**			**9**	**0**	**0**	**9**
Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios - issues - enabling technologies - radio frequency spectrum and regulations.							
Unit II	**COGNITIVE RADIO ARCHITECTURE**			**9**	**0**	**0**	**9**
Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases - Inference Hierarchy - Architecture maps - Building the Cognitive Radio Architecture on Software defined Radio Architecture - Overview of IEEE 802.22 standard for broadband wireless access in TV bands.							
Unit III	**SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS**			**9**	**0**	**0**	**9**
Introduction – Primary user detection techniques – energy detection - feature detection - matched filtering - cooperative detection - Bayesian Approach - Neyman Pearson fusion rule for spectrum sensing - Optimum spectrum sensing - Kullback Leibler Divergence and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.							
Unit IV	**MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO**			**9**	**0**	**0**	**9**
MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.							
Unit V	**ADVANCED TOPICS IN COGNITIVE RADIO**			**9**	**0**	**0**	**9**
Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques – Requirement and challenges of IoT – Energy efficiency– MIMO Cognitive Radio – Power allocation algorithms.							
							Total (45L)= 45 Periods

Text Books:	
1	Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, “Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2	Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006

Reference Books:	
1	Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
2	Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
3	S..Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017.
E-References:	
1	https://www.youtube.com/watch?v=FCDZV2U6xxE
2	https://www.youtube.com/watch?v=oFon8h68RtM
3	https://www.udemy.com/course/cognitive-radio-networks/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Able to understand the fundamental concept of cognitive radio networks	Understanding
CO2	Understand technologies to allow and efficient use of TV bands for radio communication based on two spectrum sharing business models	Understanding
CO3	Understand the fundamental issues regarding dynamic spectrum access.	Understanding
CO4	Develop the cognitive radio as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.	Applying
CO5	Use the Cognitive Radio for IoT and MIMO systems.	Understanding

COURSE ARTICULATION MATRIX															
COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-	3	2	1
CO3	2	2	2	3	1	-	-	-	-	-	-	-	3	2	-
CO4	1	1	2	1	2	-	-	-	-	-	-	-	2	3	-
CO5	1	1	2	2	2	-	-	-	-	-	-	-	2	3	1
Avg	1.8	1.8	2	1.6	1.4	-	-	-	-	-	-	-	2.6	2.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH210	NEXT GENERATION NETWORKS			Semester		
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives

1	To learn Wireless technologies and Ad-hoc Network.
2	To explore NGN architecture and management activities.
3	To gain the knowledge of Cooperation for Next Generation Wireless Networks

Unit	Title	L	T	P	TH
Unit I	BASIC HISTORY OF MOBILE COMPUTING	9	0	0	9
Architecture for mobile computing - Three tier architecture - design considerations for mobile computing, mobile computing through internet - Wireless network architecture – Applications - Security, Concerns and Standards – Benefits - Future Evolution of mobile computing.					
Unit II	OVERVIEW OF WIRELESS NETWORK AND TECHNOLOGIES	9	0	0	9
Introduction to different generations – Bluetooth - RFID, Mobile IP: Introduction, Advertisement, Registration, TCP connections, two level addressing, abstract mobility management model, performance issue, routing in mobile host, Adhoc networks – Mobile transport layer - Wireless network topologies, Cell fundamentals and topologies - Global system for mobile communication - GSM architecture.					
Unit III	GENERAL PACKET RADIO SERVICE(GPRS)	9	0	0	9
GPRS and packet data network - GPRS network architecture – GPRS network operation - Data services in GPRS - Applications of GPRS - Billing and charging in GPRS.					
Unit IV	INFRASTRUCTURE AND AD-HOC NETWORK	9	0	0	9
System Architecture - Protocol Architecture - Medium Access Control layer - MAC Management - Wireless LAN advantages - IEEE 802.11a - 802.11b standards -Wireless LAN architecture - Mobility in Wireless LAN - Deploying Wireless LAN - Mobile ad hoc networks and sensor networks - Wireless LAN security.					
Unit V	WIRELESS APPLICATION PROTOCOL(WAP), MMS, GPRS APPLICATION CDMA AND 3G	9	0	0	9
Spread-spectrum Technology – FHSS – DSSS - CDMA versus GSM - Wireless data - Third generation networks - Applications in 3G Wireless LAN - WiFi v/s 3G Voice over Internet protocol and convergence - Convergence technologies - Security issues in mobile Information security - Security techniques and algorithms - Security framework for mobile environment.					
					Total (45L)= 45 Periods

Text Books:	
1	Jingming Li Salina, Pascal Salina "Next Generation Networks-perspectives and potentials Wiley, January 2008.
2	Madhusanga Liyanage, Andrei Gurtov, Mika Ylianttila, “Software Defined Mobile Networks beyond LTE Network Architecture”, Wiley, June 2015.

Reference Books:	
1	Martin Sauter,"3G,4G and Beyond bringing networks, devices and web together", Wiley, Second edition-2013
2	Savo G Glisic," Advanced Wireless Networks- Technology and Business models", Wiley, 3rd edition- 2016
3	Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
4	Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis Takis Mathiopoulos, "New Directions in Wireless communications Systems: From Mobile to 5G", CRC Press, 2017.
E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://www.coursera.org/lecture/smart-device-mobile-emerging-technologies/4-5-lte-advanced-part-2-A4XMD
3.	https://www.coursera.org/lecture/network-transformation-101/yet-another-next-generation-yang-data-modeling-language-NXxPA

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	To understand concept of mobile computing.	Understanding
CO2	Have the knowledge of different generation mobile communication systems.	Analysing
CO3	Analyze various protocols of all layers for mobile and adhoc wireless communication networks	Analysing
CO4	Analyze and examine new generation of mobile technology.	Analysing
CO5	Recognize and understand cellular technology using long term evolution.	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	1	2	1	-	-	-	-	-	-	-	1	2	1
CO2	2	1	2	2	1	-	-	-	-	-	-	-	1	2	2
CO3	1	1	1	1	1	-	-	-	-	-	-	-	1	2	1
CO4	1	1	2	1	1	-	-	-	-	-	-	-	1	2	1
CO5	1	1	1	1	1	-	-	-	-	-	-	-	1	2	1
Avg	1.25	1	1.4	1.4	1	-	-	-	-	-	-	-	1	2	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH301	STATISTICAL THEORY OF COMMUNICATION			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
		Hours/Week		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives	
1	To introduce various decision making system, filtering techniques and statistical operations.
2	To impart knowledge on Estimation theory.
3	To gain knowledge on Information theory.

Unit I	**INFORMATION MEASURE**	**9**	**0**	**0**	**9**
Fundamental problem of Communication - Definition and properties of Discrete Entropy - Joint and conditional entropies - Entropy in the continuous case - Noiseless coding: problem of unique decipherability - instantaneous codes - Kraft-McMillan inequality - The noiseless coding theorem. Construction of optimal codes (Huffman's method).					
Unit II	**NOISY CODING**	**9**	**0**	**0**	**9**
The discrete memoryless channel - Mutual information and channel capacity - Classification of channels - Calculation of channel capacity - Decoding schemes - Shannon's fundamental theorem - Capacity of a band limited Gaussian channel.					
Unit III	**OPTIMIMUM LINEAR SYSTEMS**	**9**	**0**	**0**	**9**
Digital communication in presence of additive white Gaussian noise - Correlation receiver - Matched filter for additive non-white Gaussian noise - Linear estimation using least mean square error criterion - Wiener filters.					
Unit IV	**TESTING OF STATISTICAL HYPOTHESIS**	**9**	**0**	**0**	**9**
Likelihood ratio tests - Bayes, Neyman Pearson and Mini-max tests - Probability of error - Receiver operating characteristics - Optimum reception of known binary signals in Gaussian noise.					
Unit V	**PARAMETER ESTIMATION**	**9**	**0**	**0**	**9**
Estimation of unknown parameters random and deterministic: ML, MSE and MAP estimates - Application to Radar - Block diagram of a pulsed radar system - The radar equation detection of steady point targets - Estimation of the range and velocity of steady point targets.					
					Total (45L)= 45 Periods

Text Books:	
1	Yuk Wing Lee, Statistical Theory of Communication, Literary Licensing, LLC 2013
2	S.P. Eugene Xavier, Statistical Theory of Communication, New Age International, 1997

Reference Books:	
1	Willis W. Harman, Principles of the Statistical Theory of Communication, McGraw-Hill, 1963
2	Barbara R. Levin, Statistical Communication Theory and Its Applications, Imported Publication 1982
3	I. Ravi Kumar, Compr. Statistical Theory of Communication, Firewall Media, 2001
4	Yuk Wing Lee, Statistical Theory of Communication Hardcover – 1, John Wiley & Sons Inc 1960
E-References:	
1	http://www.spec.gmu.edu/~pparis/classes/notes_630/handouts.pdf
2	https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee53/
3	http://drolet.segfaults.net/EE501/CourseNotesEE501.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Characterize and apply probabilistic techniques in modern decision systems.	Applying
CO2	Demonstrate and compare various Estimation techniques	Understanding
CO3	Apply various source coding techniques to data	Applying
CO4	Apply appropriate model for estimation and signal modeling for the given problem	Applying
CO5	Analyze non-parametric and parametric methods for parameter estimation	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	-	-	-	-	-	-	-	3	-	2
CO2	3	1	1	2	1	-	-	-	-	-	-	-	3	1	2
CO3	3	1	2	2	2	-	-	-	-	-	-	-	3	1	2
CO4	3	2	2	1	1	-	-	-	-	-	-	-	3	-	1
CO5	3	1	2	2	1	-	-	-	-	-	-	-	3	2	2
Avg	3	1.4	1.6	1.8	1.2	-	-	-	-	-	-	-	3	1.3	1.8

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH302	**INFORMATION THEORY AND CODING**			**Semester**			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To study the basic concepts of information theory.
2	To understand the concepts of error control coding.
3	To Learn various applications of coding theory.

Unit I	**INFORMATION THEORY**	9	0	0	9

Information – Entropy, Information rate - classification of codes - Kraft McMillan inequality - Source coding theorem - Shannon-Fano coding - Huffman coding - Extended Huffman coding - Joint and conditional entropies - Mutual information - Discrete memoryless channels – BSC, BEC – Channel capacity - Shannon limit.

Unit II	**BLOCK CODES**	9	0	0	9

Definitions and Principles: Hamming weight - Hamming distance - Minimum distance decoding - Single parity codes - Hamming codes - Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder – CRC.

Unit III	**BCH CODES**	9	0	0	9

Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non –binary BCH codes: q –ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non –Binary BCH and RS codes: The Berlekamp – Massey Algorithm.

Unit IV	**CONVOLUTIONAL CODES**	9	0	0	9

Encoding of Convolutional codes - Structural properties - Distance properties - Viterbi Decoding Algorithm for decoding - Soft –output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms - Majority logic decoding.

Unit V	**CONCATENATED CODES**	9	0	0	9

Single level Concatenated codes - Multilevel Concatenated codes - Soft decision Multistage decoding - Concatenated coding schemes with Convolutional Inner codes - Introduction to Turbo coding and their distance properties - Design of Turbo codes.

Total (45 L) = 45 Periods

Text Books:

1	Shu Lin &Daniel J. Costello, Jr. “Error Control Coding "Pearson / Prentice Hall, Second Edition, 2011.
2	R Bose, “Information Theory, Coding and Cryptography”, TMH 2016.

Reference Books:	
1	S. Gravano, “Introduction to Error Control Codes”, Oxford University Press 2007.
2	Amitabha Bhattacharya, “Digital Communication”, TMH 2017.
3	Simon Haykin, “Digital Communication Systems”, Wiley, 2021.
4	Todd K Moon, “Error Correction Coding”, Wiley, Second Edition, 2020.

e-Reference:	
1	https://nptel.ac.in/courses/117101053
2	https://nptel.ac.in/courses/108102117
3	https://nptel.ac.in/courses/117108097

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Use algebraic techniques to construct efficient codes	Applying
CO2	Identify the parameters of a given code	Analysing
CO3	State and prove the limits on achievable code performance	Understanding
CO4	Understand practical aspects of data compression and error-control coding	Understanding
CO5	Design the encoding and decoding circuits for block codes, convolutional codes, BCH and concatenated codes.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	2	1	-	-	-	-	-	-	-	2	1	1
CO2	2	-	-	2	1	-	-	-	-	-	-	-	1	1	1
CO3	3	-	-	3	1	-	-	-	-	-	-	-	2	1	1
CO4	3	-	-	2	1	-	-	-	-	-	-	-	2	2	1
CO5	2	-	-	2	1	-	-	-	-	-	-	-	1	1	-
Avg	2.6	-	-	2.2	1	-	-	-	-	-	-	-	1.6	1.2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH303	MILLIMETER WAVE COMMUNICATION			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
1. Analog and Digital Communication, 2. Digital System Design 3. Signals and Systems		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To understand the fundamentals of Millimeter wave devices and circuits.
2	To understand the various components of Millimeter wave Communications system.
3	To know the antenna design at Millimeter wave frequencies.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**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	**MILLIMETER WAVE DEVICES AND CIRCUITS**	**9**	**0**	**0**	**9**

Millimeter wave generation and amplification: Peniotrons – Ubitrons - Gyrotrons and Free electron lasers – HEMT - models for mm wave Transistors - transistor configurations - Analog mm wave components: Amplifiers – Mixers – VCO – PLL - Metrics for analog mm wave devices - Consumption factor theory - Trends and architectures for mm wave wireless - ADC’s and DAC’s.

Unit III	**MILLIMETER WAVE COMMUNICATION SYSTEMS**	**9**	**0**	**0**	**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	**MILLIMETER WAVE MIMO SYSTEMS**	**9**	**0**	**0**	**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**	**0**	**0**	**9**

Antenna beamwidth – Polarization - Advanced beam steering and beam forming - mm wave design consideration - On-chip and In package mm wave antennas - Techniques to improve gain of on-chip antennas - Implementation for mm wave in adaptive antenna arrays - Device to Device communications over 5G systems - Design techniques of 5G mobile.

Total (45L) = 45 Periods

Text Books:

1	Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
2	K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.

Reference Books:	
1	Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.
2	Manuel García Sanchez, “Millimeter-Wave (mmWave) Communications”, MDPI Books, March 2020.
3	John S. Seybold “Introduction to RF propagation,”John Wiley and Sons, 2005.
4	Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, “Millimeter – Wave Wireless Communication Systems: Theory and Applications,” Hindawi Publishing Corporation, 2007.
E-References:	
1	https://onlinecourses.nptel.ac.in/noc23_ee69/preview
2	https://onlinecourses.nptel.ac.in/noc22_ee102/preview
3	https://www.classcentral.com/course/swayam-millimeter-wave-technology-7903

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand wave propagation models for millimeter wave.	Understanding
CO2	Understand Millimeter devices and circuits.	Understanding
CO3	Understand Millimeter-wave based communication systems.	Understanding
CO4	Understand Millimeter-wave based MIMO systems	Understanding
CO5	Design antenna for Millimeter wave frequencies	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO2	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO3	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO4	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO5	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
Avg	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH304	SPREAD SPECTRUM COMMUNICATION			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
Analog and Digital Communication		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives

1	To understand the basics of spread spectrum communication systems.
2	To learn about the performance of spread spectrum in multipath environment.
3	To understand the performance analysis of spread spectrum systems.

Unit I	**SPREADING CODES**	9	0	0	9
Finite-Field Arithmetic- Sequence Generator Fundamentals-State - Machine Representation of Shift Register Generators-Generation and Properties of m-Sequences Gold Codes - Kasami Sequences (Small Set) - Quaternary Sequences - Complementary Code Keying - Walsh–Hadamard Sequences.					
Unit II	**SPREAD SPECTRUM SYSTEMS**	9	0	0	9
Direct Sequence Spread Spectrum (DSSS) - Processing Gain- Frequency Hop Spread Spectrum (FHSS)- Coherent and Noncoherent Slow FHSS – Coherent and Noncoherent Fast FHSS- Hybrid DS/FH Spread Spectrum.					
Unit III	**SYNCHRONIZATION IN SPREAD SPECTRUM**	9	0	0	9
Baseband Recovery - Carrier Synchronization - Code Synchronization – Pseudonoise Acquisition in Direct Sequence Receivers- Pseudonoise Tracking in Direct Sequence Receivers.					
Unit IV	**SPREAD SPECTRUM IN MULTIPATH ENVIRONMENT**	9	0	0	9
Spread Spectrum Communication System Model - Performance of Spread Spectrum Systems without Coding - Performance of Spread Spectrum Systems with Forward Error Correction: Elementary Block Coding Concepts- Optimum Decoding Rule-Calculation of Error Probability - Elementary Convolution Coding Concepts - Decoding and Bit-Error Rate.					
Unit V	**PERFORMANCE ANALYSIS OF SPREAD SPECTRUM SYSTEM**	9	0	0	9
Performance of spread spectrum system under AWGN - multi-user Interference - Jamming and narrow band interferences Low probability of intercept methods - Optimum intercept receiver for direct sequence spread spectrum - Error probability of DS-CDMA system under AWGN and fading channels - RAKE receiver.					
					Total (45L) = 45 Periods

Text Books:	
1	Rodger E. Ziemer, "Fundamentals of Spread Spectrum Modulation", Morgan & Claypool, Publishers series, 2007.
2	Bernard Sklar & Pabitra Kumar Ray, "Digital Communications Fundamentals and Applications", Third Edition, Pearson Education, Inc, 2021.

Reference Books:	
1	Don Torrieri, "Principles of Spread-Spectrum Communication Systems", Springer, 3rd Edition, 2015.
2	L. Peterson, R. E. Ziemer, and D. E. Borth, "Introduction to Spread Spectrum Communications", Upper Saddle River, NJ: Prentice Hall, 1995
3	M.K. Simon, J.K. Omura, R.A. Scholtz, and B.K. Levitt, "Spread Spectrum Communications Handbook", Electronic Edition, McGraw-Hill, 2002
4	Robert C.Dixon, "Spread Spectrum Systems with Commercial Applications", 3rd Edition, John Wiley & Sons, Ins, 1994..
E-Reference:	
1	https://nptel.ac.in/courses/117105077/
2	http://www.rgcetpdy.ac.in/Notes/IT/III %20 YEAR/COMMUNICATION % 20 ENGINEERING -II / Unit % 202. pdf
3	https://www.tutorialspoint.com/digital_communication/digital_communication_spread_spectrum_modulation.htm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the spread spectrum codes.	Understanding
CO2	Arrive at detailed specifications of the spread spectrum systems.	Remembering
CO3	Design systems based on spread spectrum synchronization.	Applying
CO4	Design the spread spectrum in multipath environment.	Applying
CO5	Know the concept of Performance analysis of spread spectrum system.	Remembering

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	2	1	-	-	-	-	-	-	-	1	-	1
CO2	2	-	2	2	1	-	-	-	-	-	-	-	2	-	1
CO3	2	-	2	2	1	-	-	-	-	-	-	-	2	1	1
CO4	2	-	2	2	1	-	-	-	-	-	-	-	2	1	1
CO5	2	-	2	2	1	-	-	-	-	-	-	-	2	1	1
Avg	2	-	2	2	1	-	-	-	-	-	-	-	1.8	1	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH305	MIMO COMMUNICATION			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
Analog and Digital Communication		**Hours/Week**	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Objectives

1	To give comprehensive coverage of coding techniques for Multiple Input Multiple Output (MIMO) communication systems.
2	To analyze about MIMO communication systems, Space-time block codes, Space-time trellis codes
3	To gain knowledge on MIMO systems for frequency-selective (FS) fading channels.

Unit I	**FADING CHANNELS AND DIVERSITY TECHNIQUES**	9	0	0	9

Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

Unit II	**CAPACITY AND INFORMATION RATES OF MIMO CHANNELS**	9	0	0	9

Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signalling for MIMO communications.

Unit III	**SPACE-TIME BLOCK AND TRELLIS CODES**	9	0	0	9

Transmit diversity with two antennas: The Alamouti scheme – Orthogonal and Quasi-orthogonal space-time block codes – Linear dispersion codes – Generic space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes.

Unit IV	**CONCATENATED CODES AND ITERATIVE DECODING**	9	0	0	9

Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding.

Unit V	**SPACE-TIME CODING FOR FREQUENCY SELECTIVE FADING CHANNELS**	9	0	0	9

MIMO frequency-selective channels – Capacity and Information rates of MIMO FS fading channels – Space-time coding and Channel detection for MIMO FS channels – challenges in MIMO OFDM systems – Antenna selection for MIMO systems.

Total (45L) = 45 Periods

Text Books:

1	Tolga M. Duman and Ali Ghrayeb, “Coding for MIMO Communication systems”, John Wiley & Sons, West Sussex, England, 2007
2	A.B. Gershman and N.D. Sidiropoulus, “Space-time processing for MIMO communications”, Wiley, Hoboken, NJ, USA, 2005.

Reference Books:	
1	E.G. Larsson and P. Stoica, "Space-time block coding for Wireless communications", Cambridge University Press, 2003.
2	Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 1st Edition, McGraw-Hill Education, India, 2015.
3	H. Jafarkhani, "Space-time coding: Theory & Practice", Cambridge University Press, 2005.
4	Huaibei Zhou" Advance MIMO systems" Scientific Research Publishing; 1st edition, 2009.
E-Reference:	
1	https://nptel.ac.in/noc/individual_course.php?id=noc17-cs37
2	https://nptel.ac.in/courses/117104115/34
3	https://nptel.ac.in/noc/individual_course.php?id=noc16-ec11

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the diversity techniques and design the MIMO channels.	Understanding
CO2	Understand the capacity of MIMO channels.	Remembering
CO3	Analyse the performance of Space time Trellis code.	Analysing
CO4	Design concatenated codes.	Applying
CO5	Understand Frequency selective channels to estimate the capacity of MIMO channels.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	1	1	-	-	-	-	-	-	-	2	1	1
CO2	1	-	1	1	1	-	-	-	-	-	-	-	2	-	1
CO3	2	-	2	2	1	-	-	-	-	-	-	-	2	-	1
CO4	2	-	2	2	1	-	-	-	-	-	-	-	2	1	1
CO5	2	-	2	2	1	-	-	-	-	-	-	-	2	-	1
Avg	1.8	-	1.6	1.6	1	-	-	-	-	-	-	-	2	1	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH306	SMART ANTENNAS			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
Antenna and wave propagation		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To gain basic knowledge on smart antennas.
2	To understand adaptive beam forming.
3	To acquire insight about space-time processing.

Unit	Title	L	T	P	TH
Unit I	**INTRODUCTION TO SMART ANTENNAS**	**9**	**0**	**0**	**9**
Need for Smart Antennas- Smart Antenna Configurations- Switched-Beam Antennas- Adaptive Antenna Approach- Space Division Multiple Access (SDMA) - Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits, Drawbacks and Applications of Smart Antennas System.					
Unit II	**DOA ESTIMATION FUNDAMENTALS**	**9**	**0**	**0**	**9**
Array Response Vector, Received Signal Model - Subspace-Based Data Model - Signal Autocovariance - Conventional DOA Estimation Methods - Conventional Beamforming Method - Capon's Minimum Variance Method - Subspace Approach to DOA Estimation - MUSIC Algorithm - ESPRIT Algorithm - Uniqueness of DOA Estimates.					
Unit III	**BEAM FORMING FUNDAMENTALS**	**9**	**0**	**0**	**9**
Classical Beam former - Statistically Optimum Beamforming Weight Vectors - Maximum SNR Beam former - Multiple Sidelobe Canceller and Maximum - SINR Beam former - Minimum Mean Square Error (MMSE) - Direct Matrix Inversion (DMI) - Linearly Constrained Minimum Variance (LCMV).					
Unit IV	**INTEGRATION AND SIMULATION OF SMART ANTENNAS**	**9**	**0**	**0**	**9**
Antenna Design, Mutual Coupling - Adaptive Signal Processing Algorithms – DOA - Adaptive Beam forming - Beam forming and Diversity Combining for Rayleigh-Fading Channel - Trellis-Coded Modulation (TCM) for Adaptive Arrays - Smart Antenna Systems for Mobile Adhoc Networks (MANETs), Protocol, Simulations, Discussion.					
Unit V	**SPACE-TIME PROCESSING**	**9**	**0**	**0**	**9**
Discrete Space–Time Channel and Signal Models, Space– Time Beamforming, Inter-symbol and Co-Channel Suppression, Space–Time Processing for DSCDMA, Capacity, and Data Rates in MIMO Systems.					
					Total (45L)= 45 Periods

Text Books:	
1	Constantine A. Balanis & Panayiotis I. Ioannides, "Introduction to Smart Antennas", Morgan & Claypool Publishers' series-2007
2	Joseph C. Liberti Jr., Theodore S Rappaport, "Smart Antennas for Wireless CommunicationsIS-95 and Third Generation CDMA Applications", PTR – PH publishers, 1st Edition, 1989.

Reference Books:	
1	T.S Rappaport, "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE press 1998, PTR – PH publishers 1999.
2	Lal Chand Godara, "Smart Antennas", CRC Press, LLC-20.
3	Frank B. Gross, Smart Antennas with MATLAB®, 2nd Edition, 2015 McGraw-Hill Education.
4	T. K. Sarkar, Michael C. Wicks, Magdalena Salazar-Palma, Robert J. Bonneau, Smart Antennas: 143 (Wiley Series in Microwave and Optical Engineering), Wiley-IEEE Press; 1st edition (20 May 2003).
E-References:	
1	https://onlinecourses.nptel.ac.in/noc20_ee20/preview
2	https://nptel.ac.in/courses/108101092
3	https://archive.nptel.ac.in/courses/117/107/117107035/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand various types of smart antenna and its configurations.	Understanding
CO2	Analyse various estimation methods.	Analysing
CO3	Understand and analyse beamforming in smart antennas.	Analysing
CO4	Integrate and simulate algorithms related to smart antennas.	Applying
CO5	Analyse and understand space-time processing techniques.	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO2	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO3	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO4	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO5	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
Avg	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH307	RF IC AND MICROWAVE MEMS				Semester		
PREREQUISITES			**Category**		**PE**	**Credit**	**3**
1. Transmission lines 2. Microwave Engineering			**Hours/Week**		**L**	**T**	**P**	**TH**

	L	**T**	**P**	**TH**
Hours/Week	**3**	**0**	**0**	**3**

Course Objectives

1	Familiarize the students with different types of MEMS devices and fabrication methods of passive and active MEMS devices.
2	Design micro machined passive components, Transmission lines and Antennas.
3	Analyse Packaging and reliability issues in MEMS structures.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction to MMIC - Processing & Layers - Passive MMIC Elements & Models - Active MMIC Elements & Models Biasing – Amplifiers - Introduction to MMICs Technologies: GaAs/Si/InP: MESFET HEMT BJT HBT – Applications - Circuit basics - Fabrication Technology - MMIC components - Active devices - Passive lumped elements - Microstrip elements - Introduction: RF MEMS for microwave applications - MEMS technology and fabrication - Mechanical modelling of MEMS devices - MEMS materials and fabrication techniques.

Unit II	**TRANSMISSION LINES AND ANTENNAS**	**9**	**0**	**0**	**9**

Transmission Lines and Antennas: Micromachined transmission lines - losses in transmission lines - coplanar transmission lines - micromachined waveguide components - Micromachined antennas: Micromachining techniques to improve antenna performance - reconfigurable antennas.

Unit III	**RF FILTERS AND PHASE SHIFTERS**	**9**	**0**	**0**	**9**

RF Filters and Phase Shifters: Modeling of mechanical filters - micromachined filters - surface acoustic wave filters - micromachined filters for millimeter wave frequencies - Various types of MEMS phase shifters - Ferroelectric phase shifters.

Unit IV	**MEMs SWITCHES**	**9**	**0**	**0**	**9**

MEMS Switches: Introduction to MEMS switches - Capacitive shunt and series switches: Physical description - Circuit model and electromagnetic modelling - Techniques of MEMS switch fabrication and packaging - Design of MEMS switches.

Unit V	**INTEGRATION AND PACKAGING**	**9**	**0**	**0**	**9**

Integration and Packaging: Role of MEMS packages - types of MEMS packages - module packaging - packaging materials and reliability issues.

Total (45L)= 45 Periods

Text Books:

1	Varadan, V.K., Vinoy, K.J. and Jose, K.J., “RF MEMS and their Applications”, John Wiley & Sons. 2002.
2	Rebeiz, G.M., “MEMS: Theory Design and Technology”, John Wiley & Sons. 1999.

Reference Books:	
1	De Los Santos, H.J, “RF MEMS Circuit Design for Wireless Communications”, Artech House. 1999.
2	Trimmer, W., “Micromechanics & MEMS”, IEEE Press. 1996.
3	Madou, M., “Fundamentals of Microfabrication”, CRC Press. 1997.
4	Sze, S.M., “Semiconductor Sensors”, John Wiley & Sons. 1994.
E-References:	
1	https://onlinecourses.nptel.ac.in/noc19_ee57/preview
2	https://www.surrey.ac.uk/cpd-and-short-courses/microwave-circuits-and-systems
3	RF and millimeter-Wave Circuit Design | Coursera

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Identify various types of MMIC and MEMS devices, fabrication methods and packaging standards.	Understanding
CO2	Design MEMS tuneable capacitors and switches using micromachining techniques.	Applying
CO3	Model MEMS filters and Phase shifters for various types of RF applications.	Applying
CO4	Design and analysis of Micro machined Transmission lines and Antennas for wireless applications	Applying
CO5	Analyse the reliability and design related issues in MEMS structures.	Analysing

COURSE ARTICULATION MATRIX															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO2	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO3	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO4	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
CO5	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
Avg	3	2	1	2	2	1	-	-	-	-	2	-	2	2	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH308	COGNITIVE RADIO			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
		Hours/Week		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To enable the student to understand the requirements in designing software defined radios and cognitive radio and its functionalities
2	To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation
3	To analyse the spectrum management functions using cognitive radio systems and cognitive radio networks.

Unit I	**INTRODUCTION TO COGNITIVE RADIOS**	**9**	**0**	**0**	**9**
Digital dividend, cognitive radio (CR) architecture - functions of cognitive radio - dynamic spectrum access (DSA) - components of cognitive radio - spectrum sensing - spectrum analysis and decision - potential applications of cognitive radio.					
Unit II	**SPECTRUM SENSING**	**9**	**0**	**0**	**9**
Spectrum sensing - Detection of spectrum holes (TVWS) - collaborative sensing - geo-location database and spectrum sharing business models.					
Unit III	**OPTIMIZATION TECHNIQUES OF DYNAMIC SPECTRUM ALLOCATION**	**9**	**0**	**0**	**9**
Linear programming - convex programming - non-linear programming - integer programming - dynamic programming and stochastic programming.					
Unit IV	**DYNAMIC SPECTRUM ACCESS AND MANAGEMENT**	**9**	**0**	**0**	**9**
Spectrum broker - cognitive radio architectures - centralized dynamic spectrum access - distributed dynamic spectrum access.					
Unit V	**SPECTRUM TRADING**	**9**	**0**	**0**	**9**
Introduction to spectrum trading - classification to spectrum trading - radio resource pricing - brief discussion on economics theories in DSA - classification of auctions (single auctions, double auctions, concurrent, sequential).					
Total (45L)= 45 Periods					

Text Books:

1	Ekram Hossain, DusitNiyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press 2009.
2	E. Biglieri, A.J. Goldsmith., L.J. Greenstein, N.B. Mandayam, H.V. Poor, "Principles of Cognitive Radio", Cambridge University Press, 2013.

Reference Books:	
1	Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
2	Cognitive Radio Hardbound by Budati Anil Kumar , Peter Ho Chiung Ching , Shuichi Torii , CRC Press 1st Edition 2021
3	Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, "Cognitive RadioCommunications And Networks - Principles And Practice", Elsevier Inc. , 2010.
4	Handbook of Cognitive Radio Editor: Wei Zhang, Springer 2020
E-References:	
1	http://www.xgtechnology.com/innovations/cognitive-radio-networks/
2	https://snscourseware.org/snscenew/notes.php?cw=CW_5d09f853e42f6
3	https://www.techtarget.com/searchnetworking/definition/cognitive-radio

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the fundamental concepts of cognitive radio networks	Understanding
CO2	Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.	Applying
CO3	Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.	Understanding
CO4	Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.	Understanding
CO5	Understanding of the applications of auction theory as an economic approach to enable the emerging cognitive radio systems very useful.	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	-	-	-	-	-	-	3	3	-
CO2	3	2	3	3	1	1	-	-	-	-	-	-	3	2	-
CO3	3	2	2	3	1	1	-	-	-	-	-	-	2	3	3
CO4	3	2	3	3	2	1	-	-	-	-	-	-	2	-	3
CO5	3	3	3	3	1	1	-	-	-	-	-	-	2	-	3
Avg	2.8	2.2	2.6	2.8	1.4	1	-	-	-	-	-	-	2.4	2.7	3

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH309	SATELLITE POSITIONING AND NAVIGATION SYSTEMS			Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To learn about the science behind the orbiting satellites and various multiplexing schemes
2	To impart knowledge on earth station parameters used for satellite communication.
3	To gain knowledge of navigation systems especially GPS in detail.

Unit I	**ORBITS, PROPAGATION IMPAIRMENTS AND SPACE LINK**	9	0	0	9

Introduction, Satellite orbits - Kepler 's three laws - Orbital Elements - Eclipse effect - Orbit determination - Look angle determination - Satellite subsystems: Attitude and Orbital Control System (AOCS) - Telemetry Tracking and Command (TT&C) - Power System - Communications System - Satellite transponder - Space Craft Antennas - Frequency Reuse Antennas - Communication link design: Basic transmission theory – EIRP - Completion Link design with and without frequency reuse - System noise temperature G/T ratio - Noise figure and Noise temperature.

Unit II	**SATELLITE MULTIPLE ACCESSES: SATELLITE MOBILE AND SPECIALIZED SERVICES**	9	0	0	9

Frequency Division Multiple Access (FDMA) – Intermodulation - Calculation of C/N - Time Division Multiple Access (TDMA) - Satellite Switched TDMA - Demand Assignment Multiple Access (DAMA) - CDMA Spread Spectrum Transmission and Reception - Message Transmission by FDMA: M/G/1 Queue - Message Transmission by TDMA - PURE ALOHA - Satellite Packet Switching - Slotted Aloha - Packet Reservation - Tree Algorithm - VSAT Technologies - Network Configurations - Polling VSAT Networks - Mobile Satellite Networks - CDMA MSAT Network.

Unit III	**EARTH STATION TECHNOLOGY**	9	0	0	9

Transmitters, Receivers, Antennas - Tracking Systems – Transponders - Small earth station Antennas -Equipment for earth station, Lower Orbit Considerations, Coverage and frequency considerations, Direct broadcasting satellite Television and Radio, Satellite Navigation.

Unit IV	**INTRODUCTION TO GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSSs)**	9	0	0	9

The History of GPS, The Evolution of GPS - Development of NAVSTAR GPS - GPS working principle - Trilateration - Determining the receiver position in 2D or XY Plane, Determining the receiver position in 3D or X-Y-Z Plane.

Unit V	**GPS ORBITS AND SATELLITE POSITION DETERMINATION**	9	0	0	9

GPS system segments - Space segment - Control segment - User segment - GPS Signals - Pseudorandom noise (PRN) code - C/A code - P code Navigation data and Signal structure of GPS - Anti-spoofing (AS) - selective availability GPS orbital parameters - description of receiver independent exchange format (RINEX) – Observation data and navigation message data parameters - GPS position determination, least squares

Total (45 L) = 45 Periods

Text Books:

1	Timothy Pratt, Jeremy Allnutt, "Satellite Communications", 3rd Edition, Wiley, 2019.
2	G S RAO, "Global Navigation Satellite Systems", McGraw-Hill publications, New Delhi, 2010.

Reference Books:	
1	D.C.Agarwal. R Anand, “Satellite Communications”, Khanna Publishers, 2021.
2	M. Richcharia, “Satellite Communications: Design Principles” 2nd Ed., BSP, 2003.
3	James Ba, Yen Tsui, “Fundamentals of GPS receivers – A software approach”, John Wiley & Sons, 2001.
4	Gunter Seeber, “Satellite Geodesy Foundations-Methods and Applications”, 2003.
e-Reference:	
1	https://nptel.ac.in/courses/117105131
2	https://www.youtube.com/watch?v=H00_PVX2bRw
3	https://youtube.com/playlist?list=PLLy_2iUCG87A55NPtEwWoWPiKs0-9NNT1

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Architect appropriate technologies for the implementation of specified satellite communication systems.	Applying
CO2	Understand the various multiple access techniques for satellite services.	Understanding
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.	Analysing
CO4	Summarize the working principle of GPS and its history.	Remembering
CO5	Develop new navigation solutions for determining accurate user position.	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	2	1	1	1	1	-	-	-	-	-	2	1	1
CO2	1	-	1	1	1	1	1	-	-	-	-	-	1	-	1
CO3	2	-	2	1	1	1	1	-	-	-	-	-	2	1	1
CO4	1	-	1	1	1	1	-	-	-	-	-	-	1	-	1
CO5	2	-	2	1	1	1	1	-	-	-	-	-	2	2	1
Avg	1.4	-	1.6	1	1	1	1	-	-	-	-	-	1.6	1.3	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

<table>
<tr><td>22ECH310</td><td colspan="5">REMOTE SENSING</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="4">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="3">Credit</td><td>3</td></tr>
<tr><td colspan="4" rowspan="2"></td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">3</td></tr>
<tr><td colspan="10">Course Objectives</td></tr>
<tr><td>1</td><td colspan="9">To familiarize about the basic principles of remote sensing</td></tr>
<tr><td>2</td><td colspan="9">To acquire knowledge about the motion of remote sensing satellites in the space</td></tr>
<tr><td>3</td><td colspan="9">To expose the various types of sensors used for remote sensing</td></tr>
<tr><td>4</td><td colspan="9">To gain knowledge about the generation of satellite data products</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="4">PHYSICS OF REMOTE SENSING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Remote Sensing - Definition - Components - Electro Magnetic Spectrum – Basic wave theory – Particle theory – Stefan Boltzman law - Wiens-Displacement Law - Radiometric quantities - Effects of Atmosphere- Scattering – Different types –Absorption-Atmospheric window- Energy interaction with surface features – Spectral reflectance of vegetation, soil and water –atmospheric influence on spectral response patterns- multi concept in Remote sensing -</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="4">REMOTE SENSING PLATFORMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Orbit elements – Types of orbits – Motions of planets and satellites – Launch of space vehicle – Orbit perturbations and maneuvers – escape velocity - Types and characteristics of different remote sensing platforms – sun synchronous and geo synchronous satellites.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="4">REMOTE SENSING SENSORS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Classification of remote sensors – selection of sensor parameters - resolution concept - Spectral, Radiometric and temporal resolution – Quality of images – imaging mode – photographic camera – opto-mechanical scanners – pushbroom and whiskbroom cameras – Panchromatic, multi spectral , thermal,hyperspectral scanners and microwave sensors – geometric characteristics of scanner imagery – Operational Earth resource satellites - Landsat, SPOT, IRS, WorldView, hyperion and hysis, ERS, ENVISAT,Sentinel.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="4">DATA RECEPTION AND DATA PRODUCTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Ground segment organization – Data product generation – sources of errors in received data – referencing scheme – data product output medium – Digital products – Super structure, Fast,GeoTIFF, Hierarchical and HDF formats – Indian and International Satellite Data Products – ordering of data</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="4">DATA ANALYSIS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Data products and their characteristics – Elements of visual interpretation – interpretation keys – Digital image processing – Preprocessing – Image rectification – Image enhancement techniques– Image classification – Supervised and unsupervised classification algorithms for multispectral and hyperspectral images – Accuracy assessment.- hybrid classification techniques – Knowledge based classification, Neural Network Classification, Fuzzy Classification.</td></tr>
<tr><td colspan="10" align="right">Total (45L)= 45 Periods</td></tr>
</table>

Text Books:	
1	John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition, 2017.
2	Lillesand T.M., and Kiefer,R.W. Remote Sensing and Image interpretation, VI edition of John Wiley & Sons-2015.

Reference Books:	
1	Beniamino Cipriani, Remote Sensing and Image Interpretation, Scitus, 2016
2	John A.Richards, Springer – Verlag, Remate Sensing Digital Image Analysis 5th edition, 2013.
3	George Joseph, Fundamentals of Remote Sensing, Third Edition, Universities Press (India) Pvt Ltd, Hyderabad, 2018
4	Shunlin Liang , Jindi Wang, Acad Pr " Advanced Remote Sensing ", Acad Pr , 2nd Edition, 2019.
E-References:	
1	https://nptel.ac.in/courses/105108077
2	https://ncert.nic.in/textbook/pdf/kegy307.pdf
3	https://www.uotechnology.edu.iq/appsciences/Laser/Lacture_laser/thrid_class/Remote_Sensing/3-Remote_Sensing.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts and laws related to remote sensing	Understanding
CO2	Acquire knowledge about various remote sensing platforms	Remembering
CO3	Understand the characteristics of different types of remote sensors	Understanding
CO4	Gain knowledge about reception, product generation, storage and ordering of satellite data	Remembering
CO5	Understand the concept of different image processing techniques and interpretation of satellite data	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-	3	2	1
CO3	2	2	2	3	1	-	-	-	-	-	-	-	3	2	-
CO4	1	1	2	1	2	-	-	-	-	-	-	-	2	3	-
CO5	1	1	2	2	2	-	-	-	-	-	-	-	2	3	1
Avg	1.8	1.8	2	1.6	1.4	-	-	-	-	-	-	-	2.6	2.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH401	ADVANCED DIGITAL SIGNAL PROCESSING				Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
Digital Signal Processing			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To learn and understand the concepts of stationary and non-stationary random signals and analysis & characterization of discrete-time random processes
2	To enunciate the significance of estimation of power spectral density of random processes
3	To introduce the principles of optimum filters such as Wiener and Kalman filters
4	To introduce the principles of adaptive filters and their applications to communication engineering
5	To introduce the concepts of multi-resolution analysis

Unit I	**DISCRETE-TIME RANDOM PROCESSES**	9	0	0	9

Random variables - ensemble averages - random processes - autocorrelation and autocovariance matrices, ergodic random process, white noise, filtering random processes, spectral factorization, special types of random processes - AR, MA, ARMA

Unit II	**SPECTRUM ESTIMATION**	9	0	0	9

Bias and consistency, Non-parametric methods - Periodogram, modified-Periodogram - performance analysis. Bartlett's method, Welch's method, Blackman-Tukey method. Performance comparison. Parametric methods - autoregressive (AR) spectrum estimation – autocorrelation method, Prony's method, solution using Levinson Durbin recursion

Unit III	**OPTIMUM FILTERS**	9	0	0	9

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications - filtering, linear prediction. IIR Wiener filter - causal and non-causal filters. Recursive estimators - discrete Kalman filter.

Unit IV	**ADAPTIVE FILTERS**	9	0	0	9

Principles and properties of adaptive filters - FIR adaptive filters. Adaptive algorithms – steepest descent algorithm, the LMS algorithm - convergence. Applications of adaptive filtering – noise cancellation, channel equalization

Unit V	**MULTIRESOLUTION ANALYSIS**	9	0	0	9

Short-time Fourier transform - Heisenberg uncertainty principle. Principles of multi-resolution analysis - sub-band coding, the continuous and discrete wavelet transform - properties. Applications of wavelet transform - noise reduction, image compression

Total (45 L) = 45 Periods

Text Books:

1	Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2	P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc.

Reference Books:	
1	John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education / Prentice Hall, 2007
2	Sophoncles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000.
3	Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, 5th Edition, 2014.
4	S. Kay,” Modern spectrum Estimation theory and application”, Pearson India, 2009.
E-Reference:	
1	https://ekeeda.com/degree-courses/electrical-engineering/advanced-digital-signal-processing
2	https://www.classcentral.com/course/youtube-advanced-digital-signal-processing-course-97386
3	https://nptel.ac.in/courses/117101001

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Articulate and apply the concepts of special random processes in practical applications	Analysing
CO2	Choose appropriate spectrum estimation techniques for a given random process	Applying
CO3	Apply optimum filters appropriately for a given communication application	Understanding
CO4	Apply appropriate adaptive algorithm for processing non-stationary signals	Applying
CO5	Apply and analyse wavelet transforms for signal and image processing based applications	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	2	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH402	SPEECH PROCESSING				Semester		
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
DIGITAL SIGNAL PROCESSING			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To understand the speech production mechanism and the various speech analysis techniques and speech models
2	To understand the speech compression techniques
3	To understand the speech recognition techniques
4	To know the speaker recognition and text to speech synthesis techniques

Unit	Title	L	T	P	TH
Unit I	**SPEECH SIGNAL CHARACTERISTICS & ANALYSIS**	9	0	0	9

Speech production process - speech sounds and features- - Phonetic Representation of Speech - representing speech in time and frequency domains - Short-Time Analysis of Speech - Short- Time Energy and Zero-Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception

Unit	Title	L	T	P	TH
Unit II	**SPEECH COMPRESSION**	9	0	0	9

Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Vector Quantization- Linear predictive coding (LPC) - Code excited Linear predictive Coding (CELP)

Unit	Title	L	T	P	TH
Unit III	**SPEECH RECOGNITION**	9	0	0	9

LPC for speech recognition- Hidden Markov Model (HMM)- training procedure for HMM- subword unit model based on HMM- language models for large vocabulary speech recognition – Overall recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition.

Unit	Title	L	T	P	TH
Unit IV	**SPEAKER RECOGNITION**	9	0	0	9

Acoustic parameters for speaker verification- Feature space for speaker recognition-similarity measures- Text dependent speaker verification-Text independent speaker verification techniques

Unit	Title	L	T	P	TH
Unit V	**SPEAKER RECOGNITION AND TEXT TO SPEECH SYNTHESIS**	9	0	0	9

Text to speech synthesis(TTS)-Concatenative and waveform synthesis methods - sub-word units for TTS, intelligibility and naturalness-role of prosody

Total (45 L) = 45 Periods

Text Books:

1	L. R. Rabiner and R. W. Schafer, Introduction to Digital Signal Processing, Foundations and Trends in Signal Processing Vol. 1, Nos. 1–2 (2007) 1–194
2	Ben Gold and Nelson Morgan “Speech and Audio signal processing- processing and perception of speech and music”, John Wiley and sons 2006

Reference Books:	
1	Lawrence Rabiner, Biiing and– Hwang Juang and B.Yegnanarayana "Fundamentals of Speech Recognition", Pearson Education, 2009
2	Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999
3	Donglos O shanhnessy "Speech Communication: Human and Machine ", 2nd Ed. University press 2001.
4	Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education
E-Reference:	
1	https://www.udemy.com/course/speech-recognition-a-z-with-hands-on-learnkarts/
2	https://onlinecourses.nptel.ac.in/noc22_ee117/preview
3	https://archive.nptel.ac.in/courses/108/108/108108185/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Analyse the speech signal	Analysing
CO2	Design speech compression techniques	Analysing
CO3	Configure speech recognition techniques	Applying
CO4	Understand speaker recognition systems	Understanding
CO5	Design text to speech synthesis systems	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	1	2	2	1	-	-	-	-	-	-	-	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
CO3	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
CO4	2	1	2	2	1	-	-	-	-	-	-	-	2	2	2
CO5	2	1	2	2	1	-	-	-	-	-	-	-	2	2	2
Avg	2	1	2	1.6	1	-	-	-	-	-	-	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH403	SOFTWARE DEFINED RADIO			Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	To understand the evolving software defined radio and cognitive radio techniques and their essential functionalities
2	To study the basic architecture and standard for SDR
3	To understand the physical, MAC and Network layer design of SDR
4	To expose the student to evolving applications and advanced features of SDR

Unit I	**INTRODUCTION TO SOFTWARE DEFINED RADIO**	9	0	0	9
Brief history – SDR – Networking and SDR – RF architectures for SDR – Processing architectures for SDR – Software environments for SDR.					
Unit II	**RECEIVE AND TRANSMIT TECHNIQUES FOR SDR**	9	0	0	9
Receive techniques for SDR: Nyquist zones – Fixed point quantization – Design trade-offs for number of bits, cost, power and so forth – Sigma-Delta Analog-Digital converters. Transmit techniques for SDR: Analog reconstruction filters – DACs – Digital pulse shaping filters – Nyquist pulse shaping theory – Two Nyquist pulses.					
Unit III	**UNDERSTANDING SDR HARDWARE**	9	0	0	9
Components of communication system: Components of an SDR – AD9363 details – Zynq details – Linux industrial input/output details – MATLAB as an IIO client – Strategies for development in MATLAB: Radio I/O basics – Continuous transmit – Latency and data delays – Receive spectrum – Automatic gain control – Common issues - Example: Loopback with real data – Noise figure.					
Unit IV	**ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING**	9	0	0	9
Rationale of MCM: Dispersive channel environments – General OFDM model – Common OFDM waveform structure – Packet detection – CFO estimation – Symbol timing estimation – Equalization – Bit and power allocation.					
Unit V	**APPLICATIONS FOR SOFTWARE DEFINED RADIO**	9	0	0	9
Cognitive Radio: Bumblebee behavioural model – Reinforcement model – Vehicular networking – Case study: Cognitive radio using SDR – Vehicular networking using SDR.					
					Total (45 L) = 45 Periods

Text Books:	
1	Travis F.Collins, Robin Getz, DI PU, Alexander M.Wyglinski, “Software-Defined Radio for Engineers”, Mobile communication series, 2018.
2	Qasim Chaudhari, “Wireless communications from the ground up – An SDR Perspective”, 2018.

Reference Books:	
1	Jeffrey H. Reed ,"Software Radio: A Modern Approach to Radio Engineering", Pearson Education Low Price Edition,2002
2	Kwang-Cheng Chen, Ramjee Prasad, "Cognitive Radio Networks", John Wiley and Sons, 2009.
3	Ezio Biglieri, Professor Andrea J. Goldsmith, Dr Larry J. Greenstein, Narayan B. Mandayam, H. Vincent Poor, "Principles of Cognitive Radio" , Cambridge University Press, 2012.
4	Travis F. Collins, Robin Getz, Di Pu, Alexander M. Wyglinski, "Software-Defined Radio for Engineers", mobile communication series, 2018.
E-Reference:	
1	https://onlinecourses.nptel.ac.in/noc22_ee78/preview
2	https://www.udemy.com/topic/software-defined-radio-sdr/
3	https://commtech-academy.com/sdr/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Gain knowledge about Software Defined Radio	Understanding
CO2	Understand the concepts of receiving and transmitting techniques for SDR	Understanding
CO3	Familiar with the available SDR hardware	Remembering
CO4	Understand the concept of Orthogonal Frequency Division Multiplexing in SDR perspective	Understanding
CO5	Know the various applications of SDR.	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	1	-	1	2	-	-	-	1	-	-	-	-	1	-	-
CO2	-	1	-	-	-	2	-	-	-	-	-	-	-	2	-
CO3	2	-	-	1	-	-	-	-	-	-	-	-	1	-	-
CO4	-	-	-	-	-	-	2		-	-	-	-	2	1	1
CO5	2	-	1	-	-	1	-	2	-	-	-	-	1	-	-
Avg	1.7	1	1	1.5	-	1.5	2	1.5	-	-	-	-	1.25	1.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH404	WAVELET SIGNAL PROCESSING			Semester			
PREREQUISITES			Category	PE	Credit		3
			Hours/Week	L	T	P	TH
				3	0	0	3

Course Objectives

1	To study the basics of signal representation and Fourier theory
2	To understand Multi Resolution Analysis and Wavelet concepts
3	To study the wavelet transform in both continuous and discrete domain
4	To understand the design of wavelets using Lifting scheme
5	To understand the applications of Wavelet transform

Unit I	**FUNDAMENTALS**	9	0	0	9
Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion,Fourier transform, Short time Fourier transform, Time-frequency analysis					
Unit II	**MULTI RESOLUTION ANALYSIS**	9	0	0	9
Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.					
Unit III	**CONTINUOUS WAVELET TRANSFORMS**	9	0	0	9
Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions (Daubechies Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal)– Tiling of Time – Scale Plane for CWT.					
Unit IV	**DISCRETE WAVELET TRANSFORMS**	9	0	0	9
Filter Bank and Sub Band Coding Principles – Wavelet Filters – Inverse DWT Computation by Filter Banks – Basic Properties of Filter Coefficients – Choice of Wavelet Function Coefficients – Derivations of Daubechies Wavelets – Mallat's Algorithm for DWT – Multi Band Wavelet Transforms Lifting Scheme- Wavelet Transform Using Polyphase Matrix Factorization – Geometrical Foundations of Lifting Scheme – Lifting Scheme in Z –Domain.					
Unit V	**APPLICATIONS**	9	0	0	9
Wavelet methods for signal processing- Image Compression Techniques: EZW–SPHIT Coding– Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions –Edge Detection and Object Isolation, Image Fusion, and Object Detection.					
Total (45 L) = 45 Periods					

Text Books:	
1	Rao R M and A S Bopardikar, “Wavelet Transforms Introduction to theory and Applications”, Pearson Education, Asia, 2000.
2	L.Prasad & S.S.Iyengar, “Wavelet Analysis with Applications to Image Processing”, CRC Press, 1997.

Reference Books:	
1	J. C. Goswami and A. K. Chan, “Fundamentals of wavelets: Theory, Algorithms and Applications" WileyInterscience Publication,John Wiley & Sons Inc., 1999.
2	M. Vetterli, J. Kovacevic, “Wavelets and subband coding" Prentice Hall Inc, 1995.
3	Stephen G. Mallat, “A wavelet tour of signal processing" 2 nd Edition Academic Press, 2000.
4	Soman K P and Ramachandran K I, ―Insight into Wavelets From Theory to practice, Prentice Hall, 2004.
E-Reference:	
1	https://ocw.mit.edu/courses/18-327-wavelets-filter-banks-and-applications-spring-2003/
2	https://nptel.ac.in/courses/108101093
3	https://archive.nptel.ac.in/courses/117/101/117101123/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use Fourier tools to analyse signals	Understanding
CO2	Gain knowledge about MRA and representation using wavelet bases	Understanding
CO3	Acquire knowledge about continuous wavelet transforms	Understanding
CO4	Acquire knowledge about discrete wavelet transforms	Evaluating
CO5	Apply wavelet transform for various signal & image processing applications	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
CO3	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
CO4	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
CO5	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2
Avg	2	1	2	1	1	-	-	-	-	-	-	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH405	PATTERN RECOGNITION AND MACHINE LEARNING			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
		Hours/Week		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives

1	Understand the in-depth concept of Pattern Recognition , Bayes Decision Theory Perception and related Concepts
2	To enable the student to understand the working concepts of RF active components and amplifiers
3	Understand the concept of ML Pattern Classification and the concept of DL Pattern Recognition
4	To Understand the basics concepts of machine learning, CNN and RNN to model for real world applications.

Unit I	INTRODUCTION TO PATTERN RECOGNITION	9	0	0	9

Basic concepts, Applications, Fundamental problems in pattern Recognition system design, Design concepts and methodologies, Simple pattern recognition model.

Unit II	STATISTICAL DECISION MAKING	9	0	0	9

Introduction, Baye's theorem, Multiple features, Conditionally independent features, Decision boundaries, Unequal cost of error, estimation of error rates, the leaving-one-out-techniques, characteristic curves, estimating the composition of populations.

Unit III	NON PARAMETRIC DECISION MAKING	9	0	0	9

Histogram, kernel and window estimation, nearest neighbour classification techniques. Adaptive decision boundaries, adaptive discriminant functions, Minimum squared error discriminant functions, choosing a decision making techniques

Unit IV	INTRODUCTION TO MACHINE LEARNING	9	0	0	9

Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm. Feed forward Networks: Multilayer Perceptron, Backpropagation, Radial basis function networks.

Unit V	CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS	9	0	0	9

Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function -Structured Outputs - Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- LeNet, AlexNet.Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks - The Long Short-Term Memory and Gated RNNs, Autoencoders.

Total (45 L) = 45 Periods

Text Books:

1	Pattern Classification, 2nd Edition, Richard O. Duda, Peter E. Hart, and David G. Stork. Wiley, 2000
2	Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, September 2014, ISBN 978-0-262-02818-9

Reference Books:	
1	“Pattern Recognition and Machine Learning”, Christopher M. Bishop. Springer, 2010
2	Practical Machine Learning and Image Processing, Himanshu Singh. Apress, 2019
3	MehryarMohri, AfshinRostamizadeh, AmeetTalwalkar, "Foundations of Machine Learning",MIT Press (MA) 2012.
4	Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, now publishers Inc.,2009.
e-Reference:	
1	https://www.geeksforgeeks.org/pattern-recognition-introduction/
2	https://viso.ai/deep-learning/pattern-recognition/
3	https://nptel.ac.in/courses/117108048

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Outline basic concepts of pattern recognition	Understanding
CO2	Classify decision-making algorithms in pattern recognition.	Understanding
CO3	Understand the concept of Non parametric decision making	Applying
CO4	Understand the basics of machine learning	Understanding
CO5	Apply the concept of CNN and RNN to model applications	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	2	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH406	ADAPTIVE/ARRAY SIGNAL PROCESSING		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To analyze and to design signal processing algorithms both in the temporal and spatial domain
2	To develop a mathematical theory of linear adaptive filters
3	To design optimum and linear filter

Unit	Title	L	T	P	TH
Unit I	**INTRODUCTION**	9	0	0	9

Adaptive Filters - Single channel adaptive equalization (temporal filter) - multi-channel adaptive beamforming (spatial filter) Stochastic Processes - Stationary processes, Time averages - Ergodic processes - Correlation matrices - Linear Algebra - Eigenvalue decomposition - Eigen filter.

Unit	Title	L	T	P	TH
Unit II	**ADAPTIVE FILTERS**	9	0	0	9

Linear Optimum Filtering (Wiener Filters) - Principle of Orthogonality - Wiener-Hopf equations - Error-performance surface - MMSE (minimum mean-squared error) - Canonical form of the error-performance surface - MMSE filtering in case of linear Models - Generalized Sidelobe Canceler - Iterative Solution of the Normal Equations-Steepest descent algorithm - Stability of the algorithm - Optimization of the step-size - Least Mean Square (LMS) Algorithm - Recursive Least Squares (RLS) Algorithm

Unit	Title	L	T	P	TH
Unit III	**HIGH-RESOLUTION PARAMETER ESTIMATION**	9	0	0	9

Data model (DOA estimation) - Eigen decomposition of the spatial correlation matrix at the receive array - Subspace estimates - Estimation of the model order - Spectral MUSIC-DOA estimation – Periodogram - Standard ESPRIT - Selection matrices - Shift invariance property - Signal Reconstruction - Spatial smoothing.

Unit	Title	L	T	P	TH
Unit IV	**TENSOR-BASED SIGNAL PROCESSING**	9	0	0	9

Introduction and Motivation - Fundamental Concepts of Tensor Algebra - Elementary Tensor Decompositions - Higher Order SVD (HOSVD) - CANDECOMP / PARAFAC (CP) Decomposition - Tensors in Selected Signal Processing Applications.

Unit	Title	L	T	P	TH
Unit V	**MAXIMUM LIKELIHOOD ESTIMATORS**	9	0	0	9

Maximum Likelihood Principle - The Fisher Information Matrix and the Cramer Rao Lower Bound (CRLB) – Efficiency - CRLB for 1-D direction finding applications - Asymptotic CRLB.

Total (45 L) = 45 Periods

Text Books:

1	A. H. Sayed, Fundamentals of Adaptive Filtering. John Wiley & Sons, Inc., New York, NY, 2003.
2	T. K. Moon and W. C. Stirling, Mathematical Methods and Algorithms for Signal Processing.

Reference Books:

1	S. Haykin, AdaptiveFilterTheory.Prentice-Hall, 4th edition, 2002.
2	H. L. V.Trees, OptimumArrayProcessing.John Wiley & Sons, Inc., New York, NY, 2002.
3	Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.
4	Adaptive Filtering: Algorithms and Practical Implementation, P. Diniz, Kluwer, 1997.

E-Reference:	
1	https://nptel.ac.in/courses/117105075
2	http://www.infocobuild.com/education/audio-video-courses/electronics/AdaptiveSignalProcessing-IIT-Kharagpur/lecture-30.html
3	https://www.ce.cit.tum.de/msv/courses/master-lectures/adaptive-and-array-signal-processing/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts of temporal and spatial filtering.	Understanding
CO2	Designing, implementing, and analyzing adaptive filters applied to system identification	Analysing
CO3	Identify tensors for selected signal processing application	Applying
CO4	Apply various techniques to retrieve high resolution parameter estimation	Applying
CO5	Understand the concepts of Maximum likelihood estimators	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	-	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	-	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	-	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	-	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	-	1.6	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH407	MULTIMEDIA PROCESSING			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives	
1	To get familiarity with gamut of multimedia and its significance
2	To acquire knowledge in multimedia components.
3	To acquire knowledge about multimedia tools and authoring
4	To acquire knowledge in the development of multimedia applications.
5	To explore the latest trends and technologies in multimedia

Unit I	INTRODUCTION	9	0	0	9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Unit II	ELEMENTS OF MULTIMEDIA	9	0	0	9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Unit III	MULTIMEDIA TOOLS	9	0	0	9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Unit IV	MULTIMEDIA SYSTEMS	9	0	0	9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Unit V	MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS	9	0	0	9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval

Total (45 L) = 45 Periods

Text Books:	
1	Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2	Prabhat K.Andleigh, Kiran Thakrar, “Multimedia Systems Design”, Pearson Education, 2015.

Reference Books:	
1	Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018.
2	Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017
3	Multimedia Signal Processing - Theory And Applications In Speech, Music And Communications by Vaseghi, John Wiley And Sons
4	Jan Vozer, “Video Compression for Multimedia”, AP Press, New York, 1995.

e-Reference:	
1	https://www.aonlinetraining.com/
2	https://gb.coursera.org/lecture/android-programming-2/multimedia-part-1-NW4wT
3	https://onlinecourses.nptel.ac.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Handle the multimedia elements effectively.	Understanding
CO2	Articulate the concepts and techniques used in multimedia applications.	Understanding
CO3	Develop effective strategies to deliver Quality of Experience in multimedia applications	Applying
CO4	Design and implement algorithms and techniques applied to multimedia objects.	Evaluating
CO5	Design and develop multimedia applications following software engineering models.	Evaluating

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH408	BIOMEDICAL SIGNAL AND IMAGE PROCESSING			Semester			
PREREQUISITES		Category		PE	Credit		3
		Hours/Week		L	T	P	TH
				3	0	0	3

Course Objectives

1	To learn the image fundamentals and mathematical transforms necessary for signal and image processing.
2	To study the various image enhancement techniques.
3	To apply various image restoration procedures in medical images.
4	To gain knowledge about the basic concepts of image compression procedures.
5	To study about the various segmentation techniques applied to Medical Images.

Unit I	BIOMEDICAL SIGNALS AND IMAGES	9	0	0	9

CG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events - clinical applications. Speech Signals: The source-filter model of speech production - spectrographic analysis of speech. Speech Coding: Analysis-synthesis systems - channel vocoders - linear prediction of speech - linear prediction vocoders- Imaging Modalities: Survey of major modalities for medical imaging: ultrasound - X-ray - CT - MRI - PET - and SPECT-MRI: Physics and signal processing for magnetic resonance imaging.

Unit II	FUNDAMENTALS OF DETERMINISTIC SIGNAL AND IMAGE PROCESSING	9	0	0	9

Data Acquisition: Sampling in time - aliasing, interpolation, and quantization- Digital Filtering: Difference equations - FIR and IIR filters - basic properties of discrete-time systems - convolution. DTFT: The discrete-time Fourier transform and its properties. FIR filter design using windows. DFT: The discrete Fourier transform and its properties- the fast Fourier transform (FFT) - the overlap-save algorithm- digital filtering of continuous-time signals. Sampling Revisited: Sampling and aliasing in time and frequency- spectral analysis. Image processing- I: Extension of filtering and Fourier methods to 2-D signals and systems. Image processing II: Interpolation- noise reduction methods- edge detection- homomorphic filtering.

Unit III	IMAGE SEGMENTATION AND OBJECT RECOGNITION	9	0	0	9

Edge detection- Marr Hidreth edge detector - Canny edge detector- Thresholding foundation - Basic global thresholding - Basic Adaptive thresholding - Region Based segmentation - Watershed segmentation algorithm - Patterns and pattern classes - Recognition based on decision theoretic methods-matching - Optimum statistical classifiers.

Unit IV	IMAGE COMPRESSION	9	0	0	9

Image compression- Fundamentals - Image compression standards- Coding: Run length- - Huffman- Arithmetic - Bit plane- - Transform- and Lossy- and lossless predictive coding.

Unit V	IMAGE RESTORATION AND RECONSTRUCTION OF MEDICAL IMAGES	9	0	0	9

Image degradation models - Algebraic approach to restoration - inverse filtering - Least mean square filter - Image reconstruction from projections - Radon transforms - Filter back projection algorithm - Fourier reconstruction of MRI Images.

Total (45 L) = 45 Periods

Text Books:	
1	Rabiner. L. R., and R. W. Schafer. Digital Processing of Speech Signals. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.
2	Rafael C, Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education Asia, Third Edition, 2007.
Reference Books:	
1	William K Pratt, "Digital Image Processing", John Wiley NJ, 4th Edition, 2007
2	Albert Macouski, "Medical Imaging systems", Prentice Hall, New Jersey 2nd edition 1997.
3	Lim, J. S. Two-Dimensional Signal and Image Processing. Upper Saddle River, NJ: Prentice Hall, 1989.
4	Macovski, A. Medical Imaging Systems. Upper Saddle River, NJ: Prentice Hall, 1983.
e-Reference:	
1	https://onlinecourses.nptel.ac.in/noc20_ee41
2	https://onlinecourses.nptel.ac.in/noc21_bt50
3	https://onlinecourses.nptel.ac.in/noc20_ee40

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Identify the equipment used in the analysis of biomedical signal and image processing	Analysing
CO2	Understand the filtering concepts applied to signal and images.	Understanding
CO3	Understand how to apply the image processing techniques for various medical images.	Applying
CO4	Learn the fundamental concepts of medical image acquisition	Understanding
CO5	Understand the concepts of image compression and restoration	Understanding

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	-	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	-	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	-	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	-	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	-	1.6	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

<table>
<tr><td>22ECH409</td><td colspan="4">VLSI IN SIGNAL PROCESSING</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td colspan="2">PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">VLSI design</td><td rowspan="2">Hours/Week</td><td colspan="2">L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td colspan="2">3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Course Objectives</td></tr>
<tr><td>1</td><td colspan="8">To review VLSI design methods.</td></tr>
<tr><td>2</td><td colspan="8">To explore VLSI architecture</td></tr>
<tr><td>3</td><td colspan="8">To implement DSP algorithms onto digital hardware</td></tr>
<tr><td>4</td><td colspan="8">Applications of parallel processing and pipelining.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="3">PIPELINING AND PARALLEL PROCESSING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Introduction - Pipelining of FIR Digital Filters - Parallel Processing - Pipelining and Parallel Processing for Low Power - Retiming: Introduction - Definition and Properties - Solving System of Inequalities - Retiming Techniques.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="3">FOLDING AND UNFOLDING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Folding: Introduction -Folding Transform – Register minimization Techniques – Register minimization in folded architectures – folding of multirate systems Unfolding: Introduction – An Algorithm for Unfolding – Properties of Unfolding – critical Path - Unfolding and Retiming – Applications of Unfolding.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="3">SYSTOLIC ARCHITECTURE DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Introduction - Systolic Array Design Methodology - FIR Systolic Arrays - Selection of Scheduling Vector - Matrix Multiplication and 2D Systolic Array Design - Systolic Design for Space Representations Containing Delays.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="3">FAST CONVOLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Introduction - Cook, Toom Algorithm - Winogard Algorithm - Iterated Convolution - Cyclic Convolution - Design of Fast Convolution Algorithm by Inspection.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="3">LOW POWER DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Scaling Vs Power Consumption –Power Analysis - Power Reduction techniques – Power Estimation Approaches. Programmable DSP: Evaluation of Programmable Digital Signal Processors - DSP Processors for Mobile and Wireless Communications - Processors for Multimedia Signal Processing</td></tr>
<tr><td colspan="9" align="right">Total (45 L) = 45 Periods</td></tr>
</table>

Text Books:	
1	Keshab K. Parhi. “VLSI Digital Signal Processing Systems”, Wiley-Inter Sciences, 1999
2	Kung S. Y, H. J. While House, T. Kailath, “VLSI and Modern Signal processing”, 1985, Prentice Hall.
Reference Books:	
1	Mohammed Ismail, Terri, Fiez, “Analog VLSI Signal and Information Processing”, McGraw Hill, 1994.
2	Kung. S.Y., H.J. While house T.Kailath, “VLSI and Modern signal processing”, Prentice Hall, 1985.
3	Jose E. France, Yannis Tsividls, “Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing”, Prentice Hall, 1994.
4	Medisetti V. K, “VLSI Digital Signal Processing”, 1995, IEEE Press (NY), USA.
E-Reference:	
1	https://archive.nptel.ac.in/courses/108/105/108105157/
2	https://www.classcentral.com/course/swayam-vlsi-signal-processing-17837
3	https://nptel.ac.in/courses/108106149

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand VLSI design methodology for signal processing systems.	Understanding
CO2	Design and analysis of FIR digital filters using pipelined and parallel processing architecture	Analysing
CO3	Be familiar with VLSI algorithms and architectures for DSP.	Understanding
CO4	Implementing Cook, Toom Algorithm, Winogard Algorithms.	Applying
CO5	Gain knowledge on DSP for mobile and wireless communication	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	1	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	1	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2.4	2	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH410	RADAR SIGNAL PROCESSING			Semester			
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
Digital signal Processing			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Objectives							
1	To study about different radar signal processing techniques						
2	To learn about radar signal model						
3	To study about radar signal detection						
Unit I	**INTRODUCTION TO RADAR SYSTEMS**			9	0	0	9
History and application of radar - basic radar function - elements of pulsed radar - review of signal processing concepts and operations - A preview of basic radar signal processing - radar system components - advanced radar signal processing.							
Unit II	**SIGNAL MODELS**			9	0	0	9
Components of a radar signal - amplitude models - types of clutters - noise model and signal-to noise ratio - jamming - frequency models: the doppler shift - spatial models - spectral model.							
Unit III	**SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS**			9	0	0	9
Domains and criteria for sampling radar signals - Sampling in the fast time dimension - Sampling in slow time: selecting the pulse repetition interval - sampling the doppler spectrum - Sampling in the spatial and angle dimension - Quantization - I/Q Imbalance and Digital I/Q.							
Unit IV	**RADAR WAVEFORMS**			9	0	0	9
Introduction - the waveform matched filter - Matched filtering of moving targets - the ambiguity function - the pulse burst waveform - frequency-modulated pulse compression waveforms - Range sidelobe control for FM waveforms - the stepped frequency waveform - Phase-modulated pulse compression waveforms - COSTAS Frequency Codes.							
Unit V	**DOPPLER PROCESSING:**			9	0	0	9
Alternate forms of the Doppler spectrum - moving target indication (MTI) - Pulse Doppler processing - dwell-to-dwell stagger - Pulse pair processing - additional Doppler processing issues - clutter mapping and the moving target detector - MTI for moving platforms: adaptive displaced phase centre antenna processing.							
							Total (45L) = 45 Periods

Text Books:	
1	Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, New York, 2005
2	Francois Le Chevalier, "Principles of Radar and Sonar Signal Processing", Artech House

Reference Books:	
1	Ramon Nitzberg, “Radar Signal Processing and Adaptive Systems”, Artech House, 1999.
2	Michael O Kolawole, “ Radar systems, Peak Detection and Tracking”,Elseveir, 2010.
3	August. W Rihaczek, “Principles of High Resolution Radar”, Artech House, 1996.
4	Peyton Z. Peebles, “ Radar Principles”, Wiley India, 2009
E-Reference:	
1	https://onlinecourses.nptel.ac.in/noc19_ee58/preview
2	https://nptel.ac.in/courses/108105154
3	https://abrarhashmi.files.wordpress.com/2020/02/lecture_1_make_radar-fundamentals_final.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Demonstrate the basic operation of Radar concepts.	Understanding
CO2	Classify the various types of Radars.	Understanding
CO3	Design and analyze the radar signals and processing.	Analysing
CO4	Learn advanced signal processing technics for Radar applications	Remembering
CO5	Process the data received from radar.	Applying

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	2	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

ELECTIVES FOR MINOR

MINOR DEGREE - VERTICALS

22CEM01	**CONSTRUCTION MATERIALS**			**Semester**			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	To study the characteristics and Properties of Stones and Brick
2	To impart knowledge on Cement, Aggregate and Mortar
3	To understand the behaviour of concrete and seasoning timber
4	To study the Parts and types of flooring and roofing
5	To study carpentry, arches, lintels and finishing works.

Unit I	**STONES, BRICKS**	**9**	**0**	**0**	**9**

Building Stone –classification of rocks-characteristics of good building stone – deterioration and preservation of stone work – tests on stones - Bricks- manufacture of clay bricks -classification - tests on bricks- bricks for special use- refractory bricks.

Unit II	**CEMENT, AGGREGATES, MORTAR**	**9**	**0**	**0**	**9**

Cement- composition- manufacturing process-wet and dry processes. Aggregates –coarse and fine aggregates-characteristics and function. Mortar- properties- uses- types of mortars- selection of mortars for various Civil Engineering construction.

Unit III	**CONCRETE, TIMBER AND OTHER MATERIALS**	**9**	**0**	**0**	**9**

Concrete- ingredients - principles of hardened concrete- Special concrete- types.
Timber- characteristics- seasoning-preservation- Panels of laminates. Glass- properties- uses. Steel- Uses - market forms. Aluminum and other metallic materials for construction.
Paints, Varnishes and Distempers-types-properties.

Unit IV	**FLOORING AND ROOFING**	**9**	**0**	**0**	**9**

Components of floor- selection of flooring materials- suitability of floors for various applications. damp proof course, causes of dampness- effect of dampness - requirements of good stairs - classification of stairs -Roofs - types of roofs- requirements - pitched roof - lean to roof-gable roof-hip roof-flat roof-RCC roof.

Unit V	**CARPENTARY, ARCHES, LINTELS AND FINISHING WORKS**	**9**	**0**	**0**	**9**

Location of doors and windows - size of doors - types of doors - fixture and fastenings for doors and windows - arches - classification - stability of an arch - lintels - classification of lintels - steel lintel. scaffolding - component parts - shoring - methods of plastering - defects in plastering - pointing - objectives- methods of pointing

Total= 45 Periods

Text Books:	
1	B.C. Punmia, Building Construction, Laxmi Publications; Eleventh edition -2021
2	S.C.Rangwala, Building Construction,CharotarPublishing House Pvt. Ltd, 34th Edition - 2022
3	P. Purushothama Raj., Building Construction Materials and Techniques, Pearson Education India, First Edition - 2017

Reference Books:	
1	Shetty M.S., Concrete Technology (Theory and Practice), S.Chand& Company Ltd.,2021.
2	Rangwala S.C., Engineering Materials (Material Science) revised and enlarged by Rangwala K.S. and Rangwala P.S., Charotar Publishing House, 2010.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify and characterize and properties of Stone and brick	Remember
CO2	Understand the manufacturing process of cement and functions of mortar	Understand
CO3	Identify the age of timber and preservation methods of timber	Remember
CO4	Differentiate the types of roofing and flooring	Understand
CO5	Understand the miscellaneous works such as carpentry, lintels, Arch, etc.	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	2	3	-	-	-	-	-	-	-	-
CO3	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO4	1	-	2	-	2	3	2	-	-	-	-	-	-	-	-
CO5	1	-	-	-	3	-	2	-	-	-	-	-	-	-	-
Avg	1	2	2	-	2	3	2	-	-	-	-	-	-	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEM02	BUILDING CONSTRUCTION & EQUIPMENT			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	Able to gain basic knowledge in construction methods.
2	Able to gain basic knowledge in equipment.
3	Able to gain basic knowledge in machineries.
4	Able to gain basic knowledge in fire safety principles.
5	Able to gain basic knowledge in green technology.

Unit I	**CLASSIFICATION OF BUILDINGS, FOUNDATIONS AND TYPES OF MASONRY**	**9**	**0**	**0**	**9**

Component parts of a building -Their functions. Classification of buildings according to National building code.
Site investigation for foundation as per N.B.C, Types of foundation and prevention of dampness at basement level,Classification of stone masonry

Unit II	**DOORS, WINDOWS, LINTELS, SCAFFOLDING AND STAIRCASES**	**9**	**0**	**0**	**9**

Doors and windows – parts of door and window – Types of Door and windows–Ventilators – fixed, swinging type and louvered. Lintels – Functions, Scaffolding – Purpose and types –Location of stairs.Types of stairs

Unit III	**ROOFS, FLOORINGS, PROTECTIVE AND DECORATIVE FINISHES**	**9**	**0**	**0**	**9**

Roof Beams and Roof Slabs – Types of Roofing Systems – Methods of Termite Proofing – Methods of Damp proofing.
Types of floors- Plastering (Interior and Exterior) – Pointing for Walls and Floors using Grouts – White Washing, Color Washing with different Color Shades available in the Markets – Painting – Types of Painting for Interior and Exterior application.

Unit IV	**CONSTRUCTION EQUIPMENTS**	**9**	**0**	**0**	**9**

Selection of equipment for earthwork excavation, drilling, blasting, tunnelling, erection and dewatering and pumping, concreting, material handling and erection of structures

Unit V	**GREEN BUILDING TECHNOLOGY**	**9**	**0**	**0**	**9**

Introduction to green technology – types and importance; zero waste and r concept, green materials – green concrete (purpose and limitations), green buildings, green engineering.

Total= 45 Periods

Text Books:

1	Building Construction by S.C.Rangawala
2	Construction Technology by Sarkar Oxford University Press
3	Building Material & Construction by S.P. Arora& S. P. Bindra

Reference Books:	
1	Hopkinson And Kay J.D., The Lighting of Building, Faber and Faber, London.
2	Koerner, R.M, Construction & Geotechnical Methods in Foundations Engineering, McGraw Hill, 1984
3	Varna M., Construction Equipment and Its Planning & Applications, Metropolitan Books Co, 1979

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Organize the construction technique to be followed in brick and stone masonry, concreting, flooring, roofing and plastering etc.	Create
CO2	Select safe practices in building construction activities	Evaluate
CO3	Clarify the different types of roofs, floor and productive materials of buildings	understand
CO4	Select the relevant equipment for building construction	Evaluate
CO5	Apply the Principles of green building technology.	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	3	2	2	2	1	1	-	-	-	-	1
CO2	-	-	-	-	3	2	2	2	2	2	-	-	-	-	1
CO3	-	-	-	-	2	3	2	2	2	1	-	-	-	-	1
CO4	-	-	-	-	2	2	3	1	1	2	-	-	-	-	1
CO5	-	-	-	-	2	3	2	2	2	2	-	-	-	-	1
Avg	-	-	-	-	2.4	2.4	2.2	1.8	1.6	1.6	-	-	-	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEM03	CONCRETE TECHNOLOGY				Semester		
PREREQUISITES		Category	OE	Credit			3
NIL		Hours/Week	L	T	P		TH
			3	0	0		3

Course Learning Objectives

1	To understand the properties of ingredients of concrete.
2	To study the behavior of concrete at its fresh and hardened state.
3	To study about the concrete design mix.
4	To know about the procedures in concrete at different stage.
5	To understand special concrete and their uses.

Unit	Title	L	T	P	TH
Unit I	INTRODUCTION	9	0	0	9
Concrete materials, Cement: Field and laboratory tests on cement, Types of cement and their uses, different tests for aggregates. Methods for manufacturing of cement- Wet and dry process. Hydration of cement, Bogue's compound.					
Unit II	ADMIXTURES	9	0	0	9
Accelerating admixtures, Retarding admixtures, water reducing admixtures, Air entraining admixtures, coloring agent, Plasticizers. Batching, Mixing, Transportation, placing of concrete, curing of Concrete					
Unit III	MIX DESIGN	9	0	0	9
Factors influencing mix proportion, Mix design by ACI method and I.S. code method, Design of high strength concrete.					
Unit IV	BEHAVIOUR OF CONCRETE	9	0	0	9
Strength of concrete, Shrinkage and temperature effects, creep of concrete, permeability of concrete, durability of concrete, Corrosion, Causes and effects, remedial measures, Thermal properties of concrete, Micro cracking of concrete.					
Unit V	SPECIAL CONCRETE	9	0	0	9
Light-weight concrete, Fibre reinforced concrete, Polymer modified concrete, Ferro cement, Mass concrete, Ready-mix concrete, Self-compacting concrete, Quality control, Sampling and testing, Acceptance criteria.					
					Total= 45 Periods

Text Books:

1	Neville A.M Properties of Concrete, Pearson publication, 2012.
2	Shetty M.S Concrete technology, S.Chand and Company Ltd, New Delhi 2022.
3	Santha Kumar A.R Concrete Technology, Oxford university Press, NewDelhi, 2022.
4	Mehta K.P Concrete Technology, Chand & Co, NewDelhi, 2006.
5	Robert RatayForensic Structural Engineering Handbook, McGraw Hill LLC, 2009

Reference Books:	
1	Indian Standard Recommended Guide lines for Concrete Mix Design, IS:10262 – 2019, Bureau of Indian Standards, NewDelhi.
2	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete IS:383-1970 R2011, Bureau of Indian Standards, NewDelhi.
3	Gambhir.M.L,Concrete Technology, Volume I & II, Tata McGraw-HillBookCompany,Third print, 2003
4	Krishna Raju N. Design of Concrete Mixes, CBS publishers. NewDelhi, 2002.
5	Stephen E. Petty,Forensic Engineering: Damage Assessments for Residential and Commercial Structures,CRCpress,Taylor& Francis,2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To identify suitable materials to be used in the cement concrete by conducting various tests as per BIS code.	Evaluate
CO2	To know about the specific applications and uses of admixtures.	Understand
CO3	Design the concrete mix using ACI and BIS code methods.	Create
CO4	Determine the properties of fresh and hardened of concrete.	Evaluate
CO5	Design special concretes and to Ensure quality control while testing/ sampling and acceptance criteria for pre and post construction work.	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	3	-	1	1	1	2	1	1	1	-	1
CO2	-	-	-	-	3	-	3	-	1	1	-	-	2	-	1
CO3	-	-	-	-	3	-	3	-	-	1	-	-	1	-	1
CO4	-	-	-	-	3	2	1	-	-	-	-	-	-	-	1
CO5	-	-	-	-	3	3	3	1	1	3	1		3	-	1
Avg	-	-	-	-	3	2.5	2.2	1	1	1.75	1	1	1.75	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEM04	ENVIRONMENTAL ENGINEERING			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	To evaluate the sources of water and analyse its characteristics and processes in water treatment, express the analysis of distribution network
2	To design sewer system, basic design of the biological treatment processes, gain knowledge on sludge treatment and its disposal
3	To predict the sources, effects, dispersion of air pollutants air quality management and its control measures
4	To identify the characteristics and sources of municipal solid wastes, its collection methods, off-site processing of municipal solid wastes and its recovery, disposal methods
5	To assess the sources, effects and control measures of noise pollution

Unit I	**WATER TREATMENT**	**9**	**0**	**0**	**9**

Water Quality and its Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment.

Unit II	**WASTEWATER TREATMENT**	**9**	**0**	**0**	**9**

Sewerage system design, quantity and quality of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.

Unit III	**AIR POLLUTION**	**9**	**0**	**0**	**9**

Air Pollution: Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality Index and limits.

Unit IV	**SOLID WASTE MANAGEMENT**	**9**	**0**	**0**	**9**

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Unit V	**NOISE POLLUTION**	**9**	**0**	**0**	**9**

Noise pollution: Sources; Health effects; Standards; Measurement and control methods

Total= 45 Periods

Text Books:

1	Garg, S.K. Water supply Engineering, Khanna Publishers, New Delhi, 2010.
2	Garg, S.K. Sewage water disposal and Air pollution, Khanna Publishers, New Delhi, 2010.
3	George Tchobanoglous et.al., Integrated Solid Waste Management, McGraw-Hill, Publishers, 1993.
4	Rao, C.S., Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.

Reference Books:	
1	Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2	Peavy S.W., Rowe D.R. and Tchobanoglous G. Environmental Engineering, McGraw Hill, NewDelhi, 1985.
3	Metcalf and Eddy,M.C., Wastewater Engineering – Treatment &Reuse,TataMcGraw-Hill Publications, New Delhi,2003.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the sources of water supply, analyze the characteristics of water with its standards and various unit operations and processes in water treatment, express the analysis of distribution network	Remember
CO2	Expertise design sewer system, basic design of the biological treatment processes, gain knowledge on sludge treatment and disposal and justify the methods for disposal of sewage	Analyze
CO3	Predict the sources, effects, dispersion of air pollutants air quality management and its control measures	Apply
CO4	Aware about the characteristics, types and sources of municipal solid wastes, Learn the collection methods, Know about off-site processing of municipal solid wastes and its recovery, disposal methods	Remember
CO5	Understand the sources, effects and control methods of noise pollution	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	2	1	3	2	1	1	2	1	1	3	-	2
CO2	2	1	3	1	1	3	1	-	1	2	2	1	3	-	2
CO3	2	1	3	1	1	3	1	-	1	2	2	1	3	-	2
CO4	2	1	3	1	1	3	1	-	-	2	2	1	3	-	2
CO5	2	-	3	-	-	3	-	-	-	2	1	1	3	-	2
Avg	2	1	3	1.3	1	3	1.3	1	1	2	1.6	1	3	-	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEM05	BASICS OF TRANSPORTATION ENGINEERING			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives

1	The objective of the course is to educate the students on various components of highway engineering.
2	To educate the geometric design concepts of highway engineering
3	To develop skills on construction and maintenance of highway.
4	Ability to plan various civil engineering aspects of railways and educate various components of railways
5	The course enables the students to develop skill on evaluation and maintenance of railway track.

Unit I	**CROSS SECTIONAL ELEMENTS OF HIGHWAYS**	**9**	**0**	**0**	**9**

Classification of Highways - Classification and Cross Section of Urban and Rural Roads (IRC), Highway Cross Sectional Elements- Right of Way, Carriage Way, Camber, Kerbs, Shoulders and Footpaths (IRC Standards), Sight Distances - Stopping Sight Distance (SSD), Overtaking Sight Distance (OSD), Sight Distance at Intersections, Intermediate Sight Distance and Illumination Sight Distance - Cross Sections of Different Class of Roads -

Unit II	**GEOMETRIC DESIGN OF HIGHWAYS**	**9**	**0**	**0**	**9**

Horizontal Alignments – Superelevation, Widening of Pavements on Horizontal Curves, Vertical Alignments - Rolling. Limiting, Exceptional and Minimum Gradients, Summit and Valley Curves -Geometric Design of Hill Roads (IRC Standards Only)

Unit III	**CONSTRUCTION AND MAINTENANCE OF HIGHWAY**	**9**	**0**	**0**	**9**

Construction of Flexible and Rigid Pavements – Defects in Flexible and Rigid Pavements -Highway Drainage – Evaluation and Maintenance of Pavements.

Unit IV	**RAILWAY PLANNING AND DESIGN**	**9**	**0**	**0**	**9**

Permanent Way, its Components and Functions of Each Component: Rails - Types of Rails, Rail Fastenings, Concept of Gauges, Coning of Wheels, Creeps Sleepers - Functions, Materials, Density. Ballasts - Functions, Materials, Ballast less Tracks Geometric Design of Railway Tracks Gradients and Grade Compensation, Super-Elevation, Widening of Gauges in Curves, Transition Curves, Horizontal and Vertical Curves.

Unit V	**RAILWAY TRACK CONSTRUCTION MAINTENANCE AND OPERATION**	**9**	**0**	**0**	**9**

Points and Crossings – Turnouts, Track circuiting, Signaling, Interlocking, Lay Outs of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance, Level Crossings.

Total= 45 Periods

Text Books:

1	Khanna K., Justo C.E.G., Highway Engineering Revised 10th Edition Khanna Publishers, Roorkee, 2014
2	Kadiyalil. R, Engineering Traffic and Transport Planning, Khanna Publishers, New Delhi, 2019.
3	Chandola S.P. Transportation Engineering-2019

Reference Books:	
1	Sharma S.K., Principles Practice and Design of Highway Engineering, S. Chand & Co Ltd. New Delhi, 2006
2	Guidelines Of Ministry of Road Transport and Highways, Government of India.
3	Agarwal M.M., Indian Railway Track, 14th Edition, Prabha and Co., New Delhi, 2002.
4	Saxena S.C. Highway & Traffic Engineering, 2014.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify roads as per Indian Road Congress and describe the principles of highway alignment	Understand
CO2	Determine the highway geometric elements	Analyse
CO3	Differentiate between types of pavements, their construction and design principles	Analyse
CO4	Explain the functions of components of Railways	Understand
CO5	Carry out the various methods for track alignment & procedure for construction of railway & maintenance of track	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	2	2	3	1	2	-	-	-	1	-	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	2	2	3	1	3	-	-	-	1	-	-
CO4	-	-	-	-	2	2	3	1	2	-	-	-	-	-	-
CO5	-	-	-	-	2	2	3	1	2	-	-	-	1	-	-
Avg	2	3	2	2	2	2	3	1	2.25	-	-	-	1	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEM06	REPAIR AND REHABILITATION OF STRUCTURES				Semester		
PREREQUISITES		Category		OE	Credit		3
NIL		Hours/Week		L	T	P	TH
				3	0	0	3

Course Learning Objectives	
1	Study the various types and properties of repair materials
2	Learn various distress and damages to concrete structures
3	Understand the importance of maintenance of structures
4	Assess the damage to structures using various tests
5	Learn various repair techniques of damaged structures, corroded structures

Unit I	MAINTENANCE AND REPAIR STRATEGIES	9	0	0	9
Maintenance, repair and rehabilitation, Facts of Maintenance, importance of Maintenance various aspects of inspection, assessment procedure for evaluating a damaged structure, causes of deterioration.					
Unit II	**SERVICEABILITY AND DURABILITY OF CONCRETE**	**9**	**0**	**0**	**9**
Quality assurance for concrete construction, concrete properties- strength, permeability, thermal properties and cracking-effects due to climate, temperature, chemical, corrosion- Design and construction errors-effects of cover thickness and cracking.					
Unit III	**MATERIALS AND TECHNIQUES FOR REPAIR**	**9**	**0**	**0**	**9**
Special concretes and mortar, concrete chemical, special elements for accelerated strength gain, expansive cement, polymer concrete, Sulphur infiltrated concrete, ferro cement, fibre reinforced concrete, rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, gunite and shotcrete, epoxy injection, mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings and cathodic protection.					
Unit IV	**REPAIRS, REHABILITATION AND RETROFITTING OF STRUCTURES**	**9**	**0**	**0**	**9**
Strengthening of Structural elements, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure.					
Unit V	**DEMOLITION TECHNIQUES**	**9**	**0**	**0**	**9**
Demolition methods by machines, explosives, Advanced techniques-Demolition sequences, dismantling techniques, safety precautions in dismantling and demolition, Engineered demolition techniques for dilapidated structures- case studies					
					Total= 45 Periods

Text Books:	
1	Shetty, M.S, Concrete Technology- Theory and Practice, S. Chand and company, New Delhi,2019
2	Repair and protection of concrete structures by Noel P. Mailvaganam, CRC Press,1991.
3	CPWD: Handbook on Repair & Rehabilitation of R.C.C. Buildings, CPWD, Govt. of India, 2002, updated reprint 2011

Reference Books:	
1	Santhakumar A.R, Training Course notes on Damage Assessment and Repair in Low-cost housing, "RHDC.NBO" Anna University, July 1992.
2	Raikar R.N.,Learning from failures- deficiencies in design, construction and services – R&D Centre (SDCPL), Raikar bhavan, Bombay,1987
3	Palaniyappan, N., Estate management, Anna Institute of Management, Chennai,1992.
4	Lakshmipathy, M. etal., Lecture notes of workshop on Repairs and Rehabilitation of structures, 29-30th October 1999.
5	https://nptel.ac.in/courses/114106035/38

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the condition of structures	Understand
CO2	Inspect and evaluate the damaged structure	Analyze
CO3	Implement the repairing techniques of a structure	Analyze
CO4	Identify and Use different materials for repairing works	Apply
CO5	Demonstrate the dismantling and demolishing structures	Apply

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO2	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO3	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO4	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO5	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
Avg	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEM07	GREEN BUILDING TECHNOLOGY			Semester			
PREREQUISITES		Category		OE	Credit		3
NIL		Hours/Week		L	T	P	TH
				3	0	0	3

Course Learning Objectives

1	To Know various aspects of green buildings
2	To Learn the principles of planning and orientation of buildings.
3	To Relate the construction of green building with prevailing energy conservation policy and regulations.
4	To Know and identify different green building construction materials.
5	To Learn different rating systems and their criteria

Unit I	INTRODUCTION TO GREEN BUILDING	9	0	0	9

Introduction, Necessity, Definition & concept of Green Building, Issues and strategies of Green Building, Principles and Benefits of Green Building, Components/ features of Green Building, Energy Efficiency, Water efficiency, Material Efficiency, Indoor Air Quality.

Unit II	SITE SELECTION AND PLANNING	9	0	0	9

Site selection, Site selection strategies, Landscaping, building form, orientation, building envelope and fenestration, material and construction techniques, roofs, walls, fenestration and shaded finishes, Environmental design (ED) strategies for building construction, Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, recycle and reuse systems, Waste Management.

Unit III	ENERGY AND ENERGY CONSERVATION	9	0	0	9

Introduction, Environmental impact of building constructions, present scenario, Need of energy conservation, Concepts of embodied energy,

operational energy and life cycle energy, Methods to reduce operational energy, Energy efficient building, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

Unit IV	BUILDING MATERIALS	9	0	0	9

Green building materials and products- Bamboo, Rice husk ash concrete, plastic bricks, Bagasse particle board, Insulated concrete forms. use of materials with recycled content such as blended cements, pozzolana cements, flyash bricks, vitrified tiles, materials from agro and industrial waste, reuse of waste material-Plastic, rubber, Newspaper wood, Nontoxic paint, green roofing.

Unit V	RATING SYSTEM	9	0	0	9

Introduction to Leadership in Energy and Environmental Design (LEED) criteria, Indian Green Building council (IGBC) Green rating, Green Rating for Integrated Habitat Assessment. (GRIHA) criteria, National Productivity council (NPC) Ministry of New and Renewable Energy (MNRE) Bureau of Energy efficiency (BEE) -BER (Building Energy Rating) – Certificates.

Total= 45 Periods

Text Books:

1	Kibert, C.J., Sustainable construction: Green Building design and Delivery, John Wiley Hobouken, NewJersey, 3rd Edition, 2012.
2	Chauhan, D S Sreevasthava, S K., Non-conventional Energy Resources, New Age International Publishers, NewDelhi, 4th Edition, 2021

Reference Books:	
1	O.P. Gupta, Energy Technology, Khanna Publishing House, NewDelhi
2	Jagadeesh, K S, Reddy Venkatta Rama &Nanjunda Rao, K S., Alternative Building Materials and Technologies, New Age International Publishers,Delhi.
3	Sam Kubba., Handbook of Green Building Design and Construction, Butterworth- Heinemann.
4	Means R S, Green Building - Project Planning and Cost Estimating, John Wiley &Sons
5	Sharma K V, Venkataseshaiah P., Energy Management and Conservation, IK International.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the concepts of Green Building	Understand
CO2	Discuss the Planning of Green Building.	Understand
CO3	Explain the concept of Energy and Energy Conservation.	Understand
CO4	Select appropriate green building material and technique.	Understand
CO5	Summarize the Green Building Functions in various organizations.	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	1	-	2	3	-	-	-	2	1	2	-	-
CO2	1	1	1	2	1	-	-	-	-	-	-	-	2	-	-
CO3	-	1	3	-	2	-	-	-	-	-	-	-	2	-	-
CO4	-	1	2	-	3	-	-	-	-	-	2	-	2	-	-
CO5	1	1	2	3	2	-	-	-	-	-	2	-	2	-	-
Avg	1	1	2	2	2	2	3	-	-	-	2	1	2	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CSM01	PROGRAMMING IN C++					
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand and develop the object oriented programming concepts.
2	To familiarize and design the template functions and classes
3	To disseminate and apply exception handling mechanisms.
4	To learn and exploit stream classes.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Procedure oriented programming paradigm - Object oriented programming paradigm - Basic concepts of object oriented programming, benefits of OOP, application of OOP - C++ fundamentals –structure of C++ program, tokens, data types - Operators and expressions - Control structures - Functions.					
Unit II	**INHERITANCE AND VIRTUAL FUNCTIONS**	**9**	**0**	**0**	**9**
Classes and objects - friend functions- constructors and destructors- Operator overloading – binary and unary operator overloading using member function and friend function - Type conversions.					
Unit III	**INHERITANCE AND VIRTUAL FUNCTIONS**	**9**	**0**	**0**	**9**
Inheritance – defining derived classes, types, virtual base classes, abstract classes, constructor in derived classes - Pointers-pointers to objects, this pointer, pointer to derived classes - Virtual functions.					
Unit IV	**TEMPLATES AND EXCEPTION HANDLING**	**9**	**0**	**0**	**9**
Generic Classes – class template, class templates with multiple parameters - Generic Functions - function templates, function templates with multiple parameters, member function templates - Exception handling – basics, exception handling mechanism, rethrowing an exception – Exception handling options – understanding terminate() and unexpected() – the uncaught_exception() function – bad_exception().					
Unit V	**CONSOLE I/O AND FILE HANDLING**	**9**	**0**	**0**	**9**
C++ Stream Classes – unformatted I/O operations, formatted console I/O operations, manipulators - Files-classes for file operation, opening and closing a file, detecting end of file, files modes, sequential file operations, random file operations.					
					Total (45 L) =45 Periods

Text Books:

1	E. Balagurusamy "Object –Oriented Programming with C++" Sixth Edition Tata McGraw-Hill

Reference Books:

1	Herbert Schildt, "The Complete Reference C++", Fifth Edition, Tata McGraw Hill
2	Bjarne Stroustrup, "The C++ programming language", Fourth Edition Addison Wesley
3	K.R.Venugopal, Rajkumar Buyya, T.Ravishankar , Mastering in C++, Second Edition, Tata McGraw Hill

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Build the object oriented programming concepts.	Apply
CO2	Familiarize and build the template functions and classes	Understand
CO3	Disseminate and apply exception handling mechanisms.	Apply
CO4	Depict and exploit steam classes.	Understand

22CSM02	ADVANCED DATA STRUCTURES AND ALGORITHMS						
PREREQUISITES		**Category**	**OE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives

1	To understand the concepts of ADTs
2	To Learn linear data structures – lists, stacks, and queues
3	To have knowledge about non-linear data structures like trees and graphs
4	To understand concepts about searching and sorting and hashing techniques

Unit I	**LINEAR DATA STRUCTURES – LIST**	**9**	**0**	**0**	**9**

Abstract Data Types (ADTs) – List ADT - Array based Implementation - Linked List Implementation – Singly Linked Lists - Circularly Linked Lists - Doubly-Linked Lists - Applications of Lists – Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).

Unit II	**LINEAR DATA STRUCTURES –STACKS AND QUEUES**	**9**	**0**	**0**	**9**

Stack ADT - Operations - Applications of Stacks - Evaluating Arithmetic Expression - Conversion of infix to postfix Expression - Queue ADT - Operations - Circular Queue - DeQueue - Applications of Queue

Unit III	**NON LINEAR DATA STRUCTURES – TREES**	**9**	**0**	**0**	**9**

Tree ADT – Tree traversals – Binary Tree ADT – Expression Trees – Applications of Trees – Binary Search Tree ADT – Threaded Binary Trees- AVL Trees – B-Tree – Heaps - Operations of Heaps - Priority Queues - Binary Heap - Max Heap - Min Heap - Applications of Heap.

Unit IV	**NON LINEAR DATA STRUCTURES – GRAPHS**	**9**	**0**	**0**	**9**

Definition – Representation of Graphs –Types of Graphs - Graph Traversals - Breadth First Search - Depth First Search - Application of Graph Structures: Shortest Path Problem: Dijkstra's Algorithm - Minimum Spanning Trees: Prim's Algorithm - Kruskal's Algorithms

Unit V	**SEARCHING, SORTING AND HASHING TECHNIQUES**	**9**	**0**	**0**	**9**

Searching: Linear Search - Binary Search - Sorting Algorithms - Insertion Sort - Selection Sort - Shell Sort - Bubble Sort - Quick Sort - Merge Sort - Radix Sort - Hashing: Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

Total (45 L) =45 Periods

Text Books:

1	Mark Allen Weiss, " Data Structures and Algorithm Analysis in C ", 4/E Pearson Education, 2013.

Reference Books:

1	Seymour Lipschutz, "Data Structures With C ",(Schaum`s Outline Series) Published by Tata McGraw-Hill Education Pvt. Ltd., 2015
2	Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, "Fundamentals of Data Structures In C", Second Edition, Silicon Press, 2008.
3	Richard F.Gilberg & Behrouz A.Forouzan, "Data Structures: A Pseudo code Approach With C", Second Edition, Cengage Learning Publishers,2005.

4	Classic Data Structures", Second Edition by Debasis Samanta, PHI Learning, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Implement various abstract data types to solve real time problems by using Linear Data Structures	Apply
CO2	Apply the different Non-Linear Data Structures to solve problems	Apply
CO3	Analyze and implement graph data structures to solve various computing problems.	Analyze
CO4	Critically analyze the various sorting and searching algorithms	Analyze

22CSM03	COMPUTER ORGANIZATION AND DESIGN					
PREREQUISITES		Category	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the basic structure and operations of digital computer
2	To learn the working of different arithmetic operations
3	To understand the different types of control and the concept of pipelining
4	To study the hierarchical memory system including cache memory and virtual memory
5	To understand the different ways of communication with I/O devices and standard I/O interfaces

UNIT I	INTRODUCTION	9	0	0	9

Functional units ,Basic Operational Concepts, Bus Structure ,Memory Locations and Addresses, MemoryOperations, Instruction and Instruction Sequencing, Addressing modes.

UNIT II	ARITHMETIC UNIT	9	0	0	9

Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, BoothAlgorithm, Fast Multiplication, Integer Division, Floating point number operations.

UNIT III	PROCESSOR UNIT AND PIPELINING	9	0	0	9

Fundamental Concepts, Execution of Instruction, Multi Bus Organization, Hardwired control, Micro programmed control, Basic Concepts of pipelining, Data Hazards, Instruction Hazards ,Data path & Control Considerations.

UNIT IV	MEMORY SYSTEMS	9	0	0	9

Basic Concepts, Semiconductor RAM, ROM, Cache memory, Improving Cache Performance, Virtual memory,Memory Management requirements, Secondary Storage Device.

UNIT V	INPUT AND OUTPUT ORGANIZATION	9	0	0	9

Accessing I/O devices, Programmed I/O, Interrupts, Direct Memory Access, Interface circuits, Standard I/O Interfaces (PCI, SCSI, USB).

Total (45 L) =45 Periods

Text Books:

1	Carl Hamacher V.,Zvonko G.Vranesic, Safwat G. Zaky, " Computer organization ", Tata McGraw Hill,5th Edition, 200

Reference Books:

1	Patterson and Hennessey, "Computer Organization and Design ". The Hardware/Software interface,Harcourt Asia Morgan Kaufmann, 3rd Edition, 2007
2	Hayes, "Computer Architecture and Organization ", 3rd edition,Tata McGraw Hill, 2006
3	Heuring V.P., Jordan H.F., " Computer System Design and Architecture ", 6th edition ,Addison Wesley,2008

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the working principles of computer componets	Understand
CO2	Design the arithmetic and processing units	Create
CO3	Analyze the various computer components	Analyze

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22CSM04	ADVANCED OPERATING SYSTEMS			Semester		
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To understand the structure and functions of Operating systems
2	To understand the process concepts and scheduling algorithms
3	To understand the concept of process synchronization and deadlocks
4	To learn various memory management schemes
5	To illustrate various file systems and disk management strategies

UNIT I	**INTRODUCTION AND OPERATING SYSTEM STRUCTURES**	**9**	**0**	**0**	**9**
Main frame Systems, Desktop Systems, Multiprocessor Systems, Distributed Systems, Clustered Systems, Real Time systems, Hand held Systems; Operating Systems Structures - System Components, Operating System Services, System calls, System Programs, System Design and Implementation.					
UNIT II	**PROCESS MANAGEMENT**	**9**	**0**	**0**	**9**
Processes-Process Concepts, Process Scheduling, Operation on Processes, Co-Operating Processes, InterProcess Communication; Threads- Multithreading Models, Threading Issues; CPU Scheduling-Basic Concepts, Scheduling Criteria, Scheduling Algorithms.					
UNIT III	**PROCESS SYNCHRONIZATION AND DEADLOCKS**	**9**	**0**	**0**	**9**
Process Synchronization- The Critical Section Problem, Synchronization Hardware, Semaphores, Classical Problem of Synchronization, Monitors; Deadlocks- Deadlock Characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance ,Deadlock Detection, Recovery from Deadlock.					
UNIT IV	**MEMORY MANAGEMENT AND VIRTUAL MEMORY**	**9**	**0**	**0**	**9**
Memory Management- Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging; Virtual Memory - Demand paging, Page Replacement, Thrashing.					
UNIT V	**FILE SYSTEM AND MASS-STORAGE STRUCTURE**	**9**	**0**	**0**	**9**
File System Interface - File Concepts, Access methods, Directory Structure, File Sharing, File Protection; File System Implementation- File System Structure and Implementation, Directory Implementation, Allocation Methods, Free Space Management; Mass-Storage Structure - Disk Structure, Disk scheduling, Disk Management, RAID Structure; Case study: Linux system.					
					Total (45 L) =45 Periods

Text Books:	
1	Abraham Silberschatz, P.B.Galvin, G.Gagne —Operating System Concepts 6th edition, John Wiley & Sons, 2003.
Reference Books:	
1	Andrew S. Tanenbaum, —Modern Operating Systems, PHI , 2nd edition, 2001

2	D.M.Dhamdhere, “Systems Programming and Operating Systems ", 2nd edition, Tata McGraw Hill Company, 1999.
3	Maurice J. Bach, ―The Design of the Unix Operating System, 1st edition, PHI, 2004.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Identify the components and their functionalities in the operating system	Apply
CO2	Apply various CPU scheduling algorithms to solve problems	Apply
CO3	Analyze the needs and applications of process synchronization and deadlocks	Analyze
CO4	Apply the concepts of memory management including virtual memory and page replacement to the issues that occur in real time applications	Apply
CO5	Solve issues related to file system implementation and disk management	Apply

22CSM05	DATA COMMUNICATION AND COMPUTER NETWORKS				Semester		
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
		Hours/Week	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Learning Objectives

1	To study the concepts of data communications and functions of different ISO/OSI reference architecture
2	To understand the error detection and correction methods and also the types of LAN
3	To study the concepts of subnetting and routing mechanisms
4	To understand the different types of protocols and congestion control
5	To study the application protocols and network security

UNIT I	**DATA COMMUNICATIONS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**

Data Communication; Networks- Physical Structures (Types of Connections, Physical Topology),Categories of Networks, Interconnection of Networks: Internetwork; Protocols and Standards; Network Models-The OSI Model, Layers in the OSI Model, Addressing; Transmission media-Guided Media, Unguided Media.

UNIT II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**

Introduction-Types of errors, Redundancy, Detection versus Correction, Modular Arithmetic; Block Coding-Error Detection and Correction (VRC,LRC,CRC, Checksum, Hamming Code);Data link Control- Flow Control (Stop- and-Wait, Sliding Window),Error Control (Automatic Repeat Request, Stop-and-wait ARQ, Sliding Window ARQ), HDLC; Local Area Networks-Ethernet, Token Bus, Token Ring, FDDI.

UNIT III	**NETWORK LAYER**	**9**	**0**	**0**	**9**

Network Layer services-Packet Switching-Network Layer Performance-IPv4 addresses-IPv6 addressing- Subnetting-Bridges-Gateways- Routers-Routing Algorithm-Distance Vector Routing, Link State Routing.

UNIT IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**

Duties of the Transport layer-User Datagram Protocol-Transmission Control Protocol- Congestion Control and Quality of Service-Congestion, Congestion Control, Quality of Service, Techniques to improve QoS, Integrated Services.

UNIT V	**PRESENTATION LAYER AND APPLICATION LAYER**	**9**	**0**	**0**	**9**

Domain Name System - Domain Name Space, DNS in the Internet; Electronic Mail-FTP- HTTP- World Wide Web.

Total (45 L) =45 Periods

Text Books:

1	Behrouz A.Ferouzan, "Data Communications and Networking", 4th Edition, Tata McGraw-Hill, 2007.

Reference Books:

1	Andrew S. Tanenbaum, "Computer networks "PHI, 4th edition 2008
2	William Stallings," Data and computer communications", 10th edition,PHI, 2012

3	Douglas E. comer," Internetworking with TCP/IP-Volume-I", 6th edition,PHI, 2008

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Classify the fundamentals of data communications and functions of layered architecture	Understand
CO2	Apply the error detection and correction methods and also identify the different network technologies	Apply
CO3	Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and routing technologies	Analyze
CO4	Illustrate the transport layer principles and reliable data transfer using protocols	Apply
CO5	Analyze the application layer protocols and also the use of network security	Analyze

22CSM06	PROGRAMMING ESSENTIALS IN PYTHON				Semester		
PREREQUISITES			**Category**	**OE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Learning Objectives							
1	To learn Python data structures, conditional and control structures and files						
2	To study Python Modules, packages, Functions and Exceptions.						
3	To describe Object oriented programming features and Regular Expressions.						
4	To learn about Web programming, GUI Programming and Database programming						
UNIT I	**INTRODUCTION**			**9**	**0**	**0**	**9**
Python: Features - The Basics-Python Objects-Numbers-Sequences-Mapping and set types- Conditionals and loops-if statement-else statement-elif-Conditional Expressions-while statement-for statement-break-continue.							
UNIT II	**FUNCTIONS, MODULES AND PACKAGES**			**9**	**0**	**0**	**9**
Functions-Calling functions-Creating functions-Passing Functions-Formal Arguments-Variable length arguments-variable scope-Recursion, Modules-Packages.							
UNIT III	**FILES AND EXCEPTIONS**			**9**	**0**	**0**	**9**
Files and Input/ Output –Errors and Exceptions-Introduction-Detecting and handling Exceptions-Context Management-Raising Exceptions-Assertions-Standard Exceptions.							
UNIT IV	**OBJECT ORIENTED PROGRAMMING AND REGULAR EXPRESSIONS**			**9**	**0**	**0**	**9**
Object Oriented Programming Introduction-Classes-class Attributes-Instances-Instances attributes-Building and Method Invocation-Static methods and class Methods-Inheritance-Operator overloading - Regular Expressions-Network Programming – Multithreaded Programming							
UNIT V	**ADVANCED TOPICS**			**9**	**0**	**0**	**9**
GUI Programming- Web Programming-Database Programming							
Total (45 L) =45 Periods							

Text Books:	
1	Wesley J.Chun-"Core Python Programming" –Prentice Hall, Second Edition, 2006.
Reference Books:	
1	Swaroop C N, " A Byte of Python ", ebshelf Inc., 1st Edition, 2013
2	"A Practical Introduction to python programming", Brian Heinold,Mount St.Mary's University,2012
3	Learning to Program with Python," Richard L. Halterman"., Southern Adventist University

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Develop programs using control structures and files. .	Create
CO2	Create own Python Modules, packages, functions and Exceptions. .	Create
CO3	Illustrate Object oriented Programming features and Regular Expressions.	Apply
CO4	Create own Web programs, GUI and database programs.	Create

22CSM07	ADVANCED DATABASE SYSTEM CONCEPTS			Semester		
PREREQUISITES		Category	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the fundamentals of data models ,SQL queries and relational databases
2	To make a study of database design using ER Diagram and normalize
3	To impart knowledge in transaction processing.
4	To make the students to understand the file operations and indexing
5	To familiarize the students with advanced databases

UNIT I	RELATIONAL DATABASES	9	0	0	9

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL.

UNIT II	DATABASE DESIGN	9	0	0	9

Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

UNIT III	TRANSACTION	9	0	0	9

Transaction Concepts – ACID Properties – Schedules – Serializability – Concurrency Control – Need for Concurrency – Locking Protocols – Two Phase Locking – Deadlock – Transaction Recovery – Save Points – Isolation Levels – SQL Facilities for Concurrency and Recovery.

UNIT IV	IMPLEMENTATION TECHNIQUES	9	0	0	9

RAID – File Organization – Organization of Records in Files – Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for SELECT and JOIN operations – Query optimization using Heuristics and Cost Estimation.

UNIT V	ADVANCED TOPICS	9	0	0	9

Distributed Databases: Architecture, Data Storage, Transaction Processing – Object-based Databases: Object Database Concepts, Object-Relational features, ODMG Object Model, ODL, OQL – XML Databases: XML Hierarchical Model, DTD, XML Schema, XQuery – Data Warehousing and Data Mining - information Retrieval:
IR Concepts, Retrieval Models, Queries in IR systems.

Total (45 L) =45 Periods

Text Books:

1	Abraham Silberschatz, Henry F.Korth and S.Sundarshan "Database System Concepts", Sixth Edition,Tata McGraw Hi 2011.

Reference Books:

1	Ramez Elamassri and Shankant B-Navathe, "Fundamentals of Database Systems", Sixth Edition,Pearson Education, 2011.
2	C.J. Date, "An Introduction to Database Systems", Eighth Edition, Pearson Education Delhi, 2008.
3	Raghu Ramakrishnan, —Database Management Systems, Fourth Edition, McGraw-Hill CollegePublications, 2015.
4	G.K.Gupta,"Database Management Systems", Tata McGraw Hill, 2011.

E-References:	
1.	Lecture Series on Database Management System by Dr.S.Srinath, IIIT Bangalore, nptl

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the basic concepts of the database and data models.	Understand
CO2	Design a database using ER diagrams and map ER into Relations and normalize the relations.	Create
CO3	Develop a simple database for applications	Create

<table>
<tr><td>22CSM08</td><td colspan="4">VIRTUALIZATION AND CLOUD COMPUTING</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td colspan="2">Category</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2"></td><td colspan="2" rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To introduce the broad perceptive of Parallel Computing, Distributed Computing and Cloud Computing.</td></tr>
<tr><td>2</td><td colspan="8">To understand the concept of Virtualization</td></tr>
<tr><td>3</td><td colspan="8">To identify the approaches of SLA and programming model in Cloud</td></tr>
<tr><td>4</td><td colspan="8">To understand the Cloud Platforms in Industry and Software Environments.</td></tr>
<tr><td>5</td><td colspan="8">To learn to design the trusted Cloud Computing system</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Principles of Parallel and Distributed Computing – Elements of Parallel and Distributed Computing, Technologies for Distributed Computing; Vision of Cloud, Defining a Cloud, characteristics and benefits; Cloud Computing Architecture- Cloud Reference Model, Types of Clouds, Open Challenges.</td></tr>
<tr><td>UNIT II</td><td colspan="4">VIRTUALIZATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Introduction, Characteristics of Virtualized environments, Virtualization techniques-Machine Reference Model, Hardware-Level Virtualization, Programming Language-Level Virtualization, Application-Level Virtualization ,Other types of Virtualization, Virtualization and Cloud computing, Pros and cons of Virtualization, Technology examples-Xen: Para virtualization, VMware: Full Virtualization.</td></tr>
<tr><td>UNIT III</td><td colspan="4">SLA MANAGEMENT IN CLOUD COMPUTING AND PROGRAMMING MODEL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Traditional Approaches to SLA Management, Types of SLA, Life Cycle of SLA, SLA Management in Cloud; Data Intensive Computing - Technologies for Data Intensive Computing, MapReduce Programming Model.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">CLOUD INDUSTRIAL PLATFORMS AND SOFTWARE ENVIRONMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Cloud Platforms in Industry - Amazon Web Service, Google App Engine; Cloud Software Environments –Eucalyptus, OpenNebula; Aneka Cloud Application Platform-Aneka Framework Overview, Anatomy of Aneka Container.</td></tr>
<tr><td>UNIT V</td><td colspan="4">CLOUD SECURITY AND APPLICATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">An Introduction to the Idea of Data Security, The Current State of Data Security in the Cloud, Cloud Computing and Data Security Risk, Cloud Computing and Identity; The Cloud, Digital Identity, and Data Security, Content Level Security, Pros and Cons; Cloud Scientific Applications.</td></tr>
<tr><td colspan="9">Total (45L) = 45 Periods</td></tr>
</table>

Text Books:	
1	Rajkumar Buyya, Christian Vecchiola, S.Tamarai Selvi, ‘Mastering Cloud Computing-Foundations and Applications Programming”, TMGH,2013.(Unit- I,II & IV)
2	RajKumar Buyya, James Broberg, Andrezei M.Goscinski, “Cloud Computing: Principles and paradigms”,2011(Unit-III & V)
Reference Books:	

1	Kai Hwang.GeoffreyC.Fox.JackJ.Dongarra, “ Distributed and Cloud Computing ,From Parallel Processing to The Internet of Things”, 2012 Elsevier
2	Barrie Sosinsky, “Cloud Computing Bible”, Wiley Publisher, 2011

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Explain the main concepts and architecture of Parallel computing, Distributed Computing and Cloud Computing.	Understand
CO2	Analyze the concept of Virtualization	Analyze
CO3	Identify the approaches of SLA and programming model in Cloud	Apply
CO4	Analyze the Cloud Platforms in Industry and Software Environments.	Analyze
CO5	Identify the security issues in scientific and real time applications.	Apply

22ECM01	ELECTRON DEVICES					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce components such as diodes, BJTs and FETs, their characteristics and applications
2.	To understand, analyse and design of simple diode and transistor circuits.
3.	To know the switching characteristics of components and the concept of rectifiers and power supplies

Unit I	**EXTRINSIC SEMICONDUCTOR AND PN JUCTIONS**	**9**	**0**	**0**	**9**
N and P type semiconductor and their energy band structures- Law of electrical neutrality-calculation of location of Fermi level and free electron and hole densities in extrinsic semiconductors-Mobility, drift current and conductivity-diffusion current-continuity equation- Hall effect and its applications. Band structure of PN junction – current component in a PN junction- derivation of diode equation-temperature dependence of diode characteristics and equivalent models.					
Unit II	**SWITCHING CHARACTERISTICS OF PN JUNTION AND SPECIAL DIODES**	**9**	**0**	**0**	**9**
Calculation of transition and diffusion capacitance- varactor diode-charge control description of diode-switching characteristics of diode- mechanism of avalanche and Zener breakdown-temperature dependence of breakdown voltages-backward diode-tunneling effect in thin barriers - tunnel diode-photo diode-light emitting diodes.					
Unit III	**BIPOLAR JUNCTION TRANSISTORS**	**9**	**0**	**0**	**9**
Construction of PNP and NPN transistors- BJT current components-emitter to collector and base to collector current gains-base width modulation CB, CE and CC characteristics- breakdown characteristics- Ebers-Moll model - transistor switching times- Photo translator.					
Unit IV	**FIELD EFFECT TRANSISTORS**	**9**	**0**	**0**	**9**
Construction and characteristics of JFET-relation between pinch off voltage and drain current derivation. MOSFETS - enhancement and depletion types. CMOS circuits. MOS capacitance, BICMOS, SOI CMOS.					
Unit V	**RECTIFIERS AND POWER SUPPLIES**	**9**	**0**	**0**	**9**
Half-wave, full-wave and bridge rectifiers with resistive load. Analysis for Vdc and ripple voltage with C, CL, L-C and C-L-C filters. Voltage multipliers Zener diode regulator. Electronically regulated d.c power supplies. Line regulation, output resistance and temperature coefficient.					
	Total (45L)= 45 Periods				

Text Books:

1.	JaconMillman& Christos C. Halkias, " Electronic Devices and Circuits" Tata McGraw-Hill, 1991.
2.	Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory 8th edition.", PHI, 2002

Reference Books:

1.	Donald A. Neaman. " Semiconductor Physics and Devices" 3rd Ed., Tata McGraw-Hill 2002
2.	S. Salivahanan, N. Suresh kumar and A. Vallavaraj, Electronic Devices and Circuits, TMH, 1998.
3.	Ben, G. Streetman and Sanjay Banerjee, Solid State Electronic Devices, Pearson Education 2000
4.	Floyd, "Electronic Devices", Sixth edition, Pearson Education, 2003.

E-References:

1.	https://archive.nptel.ac.in/courses/108/108/108108122/
2.	https://www.youtube.com/watch?v=qqQ8wO-lNmI
3.	https://slideplayer.com/slide/12438044/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Interpret various applications of diode.	Applying
CO2	Classify various configurations and biasing technique of BJT	Applying
CO3	Apply the knowledge of using special devices for various applications	Understanding
CO4	Discuss operation, biasing and applications of JFET.	Analysing
CO5	Design power supplies and rectifiers	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	2	2	1
CO5	2	2	1	-	-	-	-	-	-	-	-	-	3	2	2
Avg	2	2	1	-	-	-	-	-	-	-	-	-	2.2	2	1.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM02	DIGITAL ELECTRONICS					
PREREQUISITES		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives

1	To introduce basic postulates of boolean algebra and show the correlation between expressions
2	To Introduce the methods for Simplifying Boolean expressions
3	To Outline the formal procedures for the analysis and design of combinational circuits and sequential circuits
4	To introduce the Concept of Memories and programmable logic devices
5	To illustrate the concept of synchronous and Asynchronous sequential circuits

Unit	Title	L	T	P	TH
Unit I	**NUMBER SYSTEMS AND LOGIC GATES**	**9**	**0**	**0**	**9**

Number Systems - signed Binary numbers - Binary Arithmetic - Binary codes -conversion from one code to another - Boolean Algebra and Minimization Techniques - Canonical forms – Conversion between canonical forms – Simplifications of Boolean expressions using Karnaugh map - LOGIC GATES - Implementations of Logic Functions using gates.

Unit	Title	L	T	P	TH
Unit II	**COMBINATIONAL CIRCUITS**	**9**	**0**	**0**	**9**

Design procedure – Adders/Subtractor – Serial adder/ Subtractor - Parallel adder/ Subtractor- BCD adder- Multiplexer/ Demultiplexer - encoder / decoder – code converters.

Unit	Title	L	T	P	TH
Unit III	**SEQUENTIAL CIRCUITS**	**9**	**0**	**0**	**9**

Design Procedure - Flip flops: SR, JK, T, D and JKMS – Triggering of Flip-flop - Realization of flip flops – Moore and Mealy – Counters: Asynchronous / Ripple counters – Synchronous counters – Modulo n counter. Register: shift registers- Universal shift register.

Unit	Title	L	T	P	TH
Unit IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS**	**9**	**0**	**0**	**9**

Design of fundamental mode circuits – primitive state / flow table – Minimization of primitive state table –state assignment. Problems in Asynchronous Circuits: Cycles – Races – Hazards. Design of Hazard Free Circuits: Static, Dynamic Hazards elimination

Unit	Title	L	T	P	TH
Unit V	**PLD AND MEMORY DEVICES**	**9**	**0**	**0**	**9**

Classification of memories –RAM organization –ROM organization. Programmable Logic Devices: Programmable Logic Array (PLA) - Programmable Array Logic (PAL). Implementation of combinational logic using MUX, ROM, PAL and PLA.

Total (45 L) = 45 Periods

Text Books:

1	M. Morris Mano, Digital Design, 4.ed.,Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2008
2	R.P.Jain, Modern Digital Electronics, 4th edition, TMH, 2010.

Reference Books:

1	S. Salivahanan and S. Arivazhagan, Digital Circuits and Design, 2nd ed., Vikas Publishing House Pvt. Ltd, New Delhi, 2004
2	Charles H.Roth. “Fundamentals of Logic Design”, Thomson Publication Company, 2003.
3	Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, 5 ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
4	John F.Wakerly, Digital Design: Principles and practices, PHI, 2006

E-Reference:	
1	http://nptel.ac.in/noc/individual_course.php?id=noc15-ec01
2	https://nptel.ac.in/courses/117105080/6
3	https://nptel.ac.in/courses/117105080/12

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Minimize Boolean expressions and implement using logic gates	Applying
CO2	Design and analyse combinational logic circuits.	Analysing
CO3	Design and analyse synchronous and asynchronous sequential logic circuits	Analysing
CO4	Understand the concepts of memories and PLDs	Understanding
CO5	Implement circuits using memory and PLDs.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	2	3	2	-	-	-	-	2	1	-
CO2	3	3	2	2	3	3	2	1	1	-	-	-	3	2	-
CO3	2	2	3	3	2	1	2	1	1	-	-	-	2	2	-
CO4	2	1	2	1	2	2	3	1	-	-	-	-	2	1	-
CO5	2	1	2	1	3	2	1	2	-	-	-	-	3	2	-
Avg	2.4	1.8	2.2	1.8	2.6	2	2.2	1.4	1	-	-	-	2.4	1.6	-
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM03	ELECTRONIC CIRCUITS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
Electron Devices		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To perform analysis on Small signal amplifiers and large signal amplifiers.
2	To give a comprehensive exposure to all types of discrete amplifiers and oscillators.
3	To understand the various linear and non-linear applications of op-amp

Unit I	**MIDBAND ANALYSIS OF SMALL SIGNAL AMPLIFIERS**	**9**	**0**	**0**	**9**

BJT – Need for biasing - Fixed bias circuit - Load line and quiescent point. Different types of biasing circuits. Use of Self bias circuit as a constant current circuit. CE, CB and CC amplifiers. Method of drawing small-signal equivalent circuit. Mid-band analysis of various types of single stage amplifiers to obtain gain - input impedance and output impedance. Miller's theorem. Darlington connection using similar and Complementary transistors. Methods of increasing input impedance using Darlington connection and bootstrapping. CS, CG and CD (FET) amplifiers. Multistage amplifiers-Basic emitter coupled differential amplifier circuit. Differential gain - CMRR. Use of constant current circuit to improve CMRR.

Unit II	**LARGE SIGNAL AMPLIFIERS**	**9**	**0**	**0**	**9**

Low frequency & High frequency analysis of amplifiers -Hybrid – pi equivalent circuit of BJTs.-High frequency equivalent circuit of FETs. Gain-bandwidth product of FETs. General expression for frequency response of multistage amplifiers. Calculation of overall upper and lower cut off frequencies of multistage amplifiers. Amplifier rise time and sag time and their relation to cut off frequencies. Classification of amplifiers (Class A, B, AB, C&D), Efficiency of class A, RC coupled and transformer-coupled power amplifiers. Class B complementary-symmetry, push-pull power amplifiers. Calculation of power output, efficiency and power dissipation. Crossover distortion and methods of eliminating it. Calculation of actual power handling capacity of transistors with and without heat sink. Heat sink design.

Unit III	**OSCILLATORS**	**9**	**0**	**0**	**9**

Feedback Amplifier: Block diagram - Gain with feedback - Barkhausen Criterion - Mechanism for start of oscillation and stabilization of amplitude - Analysis of Oscillator using Cascade connection of RC and LC filters - RC phase shift Oscillator - Wien bridge Oscillator and Twin-T Oscillators - Analysis of LC Oscillators: Colpitts – Hartley – Clapp - Miller and Pierce oscillators - Frequency range of RC Oscillators - Electrical equivalent circuit of Crystal.

Unit IV	**TUNED AMPLIFIERS AND MULTIVIBRATORS**	**9**	**0**	**0**	**9**

Analysis of single tuned and synchronously tuned amplifiers - Class C tuned amplifiers and their applications - Efficiency of Class C tuned Amplifier- Collector coupled and Emitter coupled Astable Multi vibrator – Mono stable Multi vibrator – Bistable Multi vibrator - Triggering methods – Mono stable and Astable Blocking Oscillators using Emitter and base timing.

Unit V	**OPERATIONAL AMPLIFIERS AND ITS APPLICATIONS**	**9**	**0**	**0**	**9**

Basic structure and principle of operation - Calculation of differential gain - Common Mode gain, CMRR - OP-AMP design - DC and AC characteristics of OP-AMP. Applications: Inverting and non-inverting amplifiers - Integrator and Differentiator - Summing amplifier - Precision rectifier - Schmitt trigger and its applications - Active filters: Low pass, high pass, band pass and band stop filters - Sine wave oscillators – Comparator – Multi vibrator.

Total (45 L) = 45 Periods

Text Books:	
1	B.Visvesvara Rao, K.Raja Rajeswari, P.Chalam Raju Pantulu, K.Bhaskara Rama Murthy, "Electronic Circuits-II", Pearson Education,2012
2	D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2011.
Reference Books:	

1	Millman J. and Taub H., "Pulse Digital and Switching waveform", 3rd Edition, McGraw-Hill International , 2011.
2	Sedera& Smith, “Micro Electronic Circuits”, 4 th Edition, Oxford University Press, Chennai.
3	Michael Jacob, ‘Applications and Design with Analog Integrated Circuits’, Prentice Hall of India, 1996.
4	K.R.Botkar, ‘Integrated Circuits’, 10th edition, Khanna Publishers, 2010.
e-Reference:	
1	http://nptel.ac.in/courses/117105080/40
2	http://nptel.ac.in/courses/117108038/1
3	https://freevideolectures.com/course/2915/linear-integrated-circuits

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	To analyze small signal amplifiers and Large signal Amplifiers.	Applying
CO2	Analyze the frequency response characteristics of amplifiers	Applying
CO3	Develop insight of on oscillator design.	Applying
CO4	Construct and analyse tuned amplifiers and multivibrators.	Applying
CO5	Develop competence in linear and nonlinear Op amp circuit analysis.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	-	-	-	-	-	-	-	-	1	2	1
CO2	3	2	1	2	-	-	-	-	-	-	-	-	1	2	1
CO3	3	2	1	2	-	-	-	-	-	-	-	-	1	2	1
CO4	3	2	1	2	-	-	-	-	-	-	-	-	1	2	1
CO5	1	2	1	2	-	-	-	-	-	-	-	-	1	2	1
Avg	2.4	2	1	2	-	-	-	-	-	-	-	-	1	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM04	SIGNAL PROCESSING						
PREREQUISITES		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:	
1.	To understand and perform Fourier and Laplace analysis on signals and systems respectively.
2.	To analyse the Discrete Fourier Transform, Fast Fourier Transform algorithms.
3.	To design and realize IIR, FIR filters.

Unit I	**INTRODUCTION TO SIGNALS AND SYSTEMS**	**9**	**0**	**0**	**9**
Classification of Signals: Even and Odd Signal - Energy and power signals - Continuous time (CT) and Discrete time (DT) signals - Continuous and Discrete amplitude signal -. System properties and representation: linearity - Tme-invariance – Causality – Stability - Realizability. - Linear Time-Invariant (LTI) systems: Impulse response and step response – Convolution – Correlation - System representation through differential equations and difference equations.					
Unit II	**ANALYSIS OF SIGNAL AND SYSTEMS**	**9**	**0**	**0**	**9**
Introduction to Fourier Transform, Fourier Series, Relating the Laplace Transform to Fourier Transform, Frequency response of continuous time systems. Introduction to z- Transform.					
Unit III	**DISCRETE FOURIER TRANSFORM**	**9**	**0**	**0**	**9**
Introduction to DFT – Properties of DFT - Circular convolution - FFT algorithms – Radix-2 FFT algorithms – Decimation in Time and Decimation in Frequency algorithms.					
Unit IV	**INFINITE IMPULSE RESPONSE FILTER DESIGN**	**9**	**0**	**0**	**9**
Characteristics of Analog Butterworth filter - Chebyshev filter - Low pass filter, High pass filter, Band pass filter and Band stop filter - Transformation of analog filters in to equivalent digital filters using bilinear transformation method - Realization structure for IIR filters-Direct form - Cascade form - Parallel form.					
Unit V	**FINITE IMPULSE RESPONSE FILTER DESIGN**	**9**	**0**	**0**	**9**
Linear phase response of FIR filter - FIR design using window method: Rectangular, Hamming, Hanning and Blackmann Windows - Park-McClellan's method - Realization structures for FIR filters - Linear phase structures and Direct form structure - Comparison of FIR and IIR filters.					
					Total (45L)= 45 Periods

Text Books:	
1.	A.Anand Kumar, “Signals and Systems” , 3rd Edition, PHI, 2013.
2.	John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, 4th Edition, Pearson Education, 2009.
Reference Books:	
1.	Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, “Signals and Systems”, 2nd edition, PHI Learning Private Limited, New Delhi, 2010.
2.	B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2009.
3.	Emmanuel C. Ifeacher, Barry W. Jervis, “Digital Signal Processing: A Practical Approach”, 2nd Edition, Pearson Education, 2004.
4.	S.K. Mitra, “Digital Signal Processing, A Computer Based approach”, 4th Edition, McGraw-Hill, 2010.
E-References:	
1.	http://nptel.ac.in/courses/117104074/
2.	https://www.coursera.org/learn/dsp
3.	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse and understands different types of signals.	Analysing
CO2	Represent continuous signals and systems in time and frequency domain using different transforms.	Analysing
CO3	Analyse the need for Discrete Fourier Transform, Fast Fourier Transform algorithms in digital signals & systems.	Analysing
CO4	Design and realize IIR filters.	Applying
CO5	Design and realize FIR filters.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	-	-	-	-	-	-	-	2	2	2
CO2	3	2	2	3	3	2	-	-	-	-	-	-	2	2	2
CO3	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO4	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO5	1	1	1	1	1	-	-	-	-	-	-	-	2	2	1
Avg	2.6	1.8	2	2.2	1.8	2	1						1.6	1.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM05	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To familiarise with 8086 and 8051 architectures.
2.	To interface 8086 microprocessor and 8051 microcontrollers with peripherals by programming.
3.	To gain basic knowledge of PIC microcontrollers.

Unit I	**8086 MICROPROCESSOR ARCHITECTURE**	9	0	9
Overview of Microcomputer systems-8086 Architecture – Pin Assignments – Internal Architecture – Addressing modes-Instruction Formats- Directives and Operators-Assembly process.				
Unit II	**PROGRAMMING AND INTERFACING OF 8086**	9	0	9
Fundamental I/O considerations- Programmed I/O- Interrupt I/O- Basic 8086 Configurations- Minimum Mode-Maximum Mode-System Bus timing- I/O Interfaces-Peripheral Interfacing using 8255 PPI - 8279 Keyboard/Display controller - 8251 USART.				
Unit III	**8051 ARCHITECTURE**	9	0	9
8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization - Instruction set — Addressing modes				
Unit IV	**PROGRAMMING AND INTERFACING OF 8051**	9	0	9
Assembly language programming.8051Timers - Serial Port Programming - Interrupts Programming - LCD and Keyboard Interfacing - ADC, DAC and Sensor Interfacing - Motor Control.				
Unit V	**PIC MICROCONTROLLERS**	9	0	9
Main characteristics of PIC microcontrollers – PIC microcontroller families-Memory-Program Memory – RAM Data Memory - Instruction set and timers in PIC				
				Total (L+T) = 45 periods

Text Books:	
1.	Yu-Cheng Liu, Glenn A. Gibson,” Microcomputer Systems, The 8086/8088 Family”, Pearson, 2e, 2019.
2.	Muhammad Ali Mazidi, Janice GillispieMazidi, RolinD.McKinlay, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, 2e, 2022.
Reference Books:	
1.	Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, 2nd Edition, Pearson education, 2011.
2.	Martin Bates,”PIC Microcontrollers-An Introduction to Microelectronics”, 3e, Elsevier, 2011.
3.	Mathur Sunil,”Microprocessor 8086: Architecture, Programming and Interfacing” PHI Learning Pvt. Ltd. 2011.
4.	Salvador PinillosGimenez,” 8051 Microcontrollers Fundamental Concepts, Hardware, Software and Applications in Electronics”, Springer 2019.
E-References:	
1.	Ashraf Almadhoun,”A Detailed Look Into PIC Microcontroller and Its Architecture”, Amazon 2020.
2.	https://nptel.ac.in/courses/108105102
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe and analyse the architecture of 8086 microprocessor and 8051 architectures.	Remembering
CO2	Develop assembly language programs and Interface peripherals with 8086.	Applying

CO3	Develop assembly language programs and Interface peripherals with 8051.	Applying
CO4	Determine application specific circuit for real-time applications.	Understanding
CO5	Associate appropriate PIC microcontroller for a given application.	Understanding

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	2	-	1	-	-
CO2	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO3	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	-	2	-	-	-	-	-	-	-	-	2	2	-
Avg	2	2	2	2	-	-	-	-	-	-	2	-	1.8	2	2

22ECM06	ANALOG AND DIGITAL COMMUNICATION					
PREREQUISITES		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	Understand analog and digital communication techniques.
2.	Learn data and pulse communication techniques.
3.	Be familiarized with source and Error control coding.

Unit I	INFORMATION THEORY	9	0	0	9
Uncertainty, information and entropy – Source coding theorem – Shannon Fano coding – Huffman coding – Discrete memoryless channels – Mutual information – Channel capacity – Channel coding theorem.					
Unit II	**ANALOG COMMUNICATION**	**9**	**0**	**0**	**9**
Noise: Source of Noise – External Noise- Internal Noise- Noise Calculation. Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).					
Unit III	**DIGITAL COMMUNICATION**	**9**	**0**	**0**	**9**
Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).					
Unit IV	**PULSE COMMUNICATION AND MULTIPLE ACCESS TECHNIQUES**	**9**	**0**	**0**	**9**
Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication System (PAM – PTM – PCM). Multiple access techniques: FDMA, CDMA, TDMA, SDMA.					
Unit V	**ERROR CONTROL CODING**	**9**	**0**	**0**	**9**
Linear block codes - Cyclic codes - Convolution codes – Maximum likelihood decoding of convolutional codes – Sequential decoding of convolutional codes – Trellis codes – Applications.					
					Total (45L)= 45 Periods

Text Books:	
1.	Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2014.
2.	J.G.Proakis, M.Salehi, ―Fundamentals of Communication Systems‖, Pearson Education 2014.
Reference Books:	
1.	B.P.Lathi, ―Modern Digital and Analog Communication Systems‖, 4th Edition, Oxford University Press, 2013.
2.	D.Roody, J.Coolen, ―Electronic Communications, 4th edition PHI 2015.
3.	B.Sklar, ―Digital Communications Fundamentals and Applications‖, 5th Edition Pearson Education 2017
4.	H P Hsu, Schaum Outline Series - ―Analog and Digital Communications‖ TMH, 5th edition 2006
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc21_ee74/preview
2.	https://nptel.ac.in/courses/117101051
3.	https://www.digimat.in/nptel/courses/video/117105143/L51.html

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO	:	Apply the concepts of Random Process to the design of Communication	Applying
CO	:	Apply analog and digital communication techniques.	Applying
CO	:	Understand the use of data and pulse communication techniques.	Understanding
CO	:	Analyze Source and Error control coding.	Analysing
CO	:	Design AM communication systems and Angle modulated communication	Applying

COURSE ARTICULATION MATRIX															
COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-	3	2	1
CO3	2	2	2	3	1	-	-	-	-	-	-	-	3	2	-
CO4	1	1	2	1	2	-	-	-	-	-	-	-	2	3	-
CO5	1	1	2	2	2	-	-	-	-	-	-	-	2	3	1
Avg	1.8	1.8	2	1.6	1.4	-	-	-	-	-	-	-	2.6	2.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM07	COMMUNICATION NETWORKS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	Understand the division of network functionalities into layers.
2.	Be familiar with the components required to build different types of networks
3.	Be exposed to the required functionality at each layer
4.	Learn the flow control and congestion control algorithms

Unit I	**FUNDAMENTALS & LINK LAYER**	9	0	0	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	0	0	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	0	0	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	0	0	9
Introduction to Transport layer –Protocols- User Datagram Protocols (UDP) and Transmiision 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	0	0	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 forCryptography and Network Security – Firewalls.					
Total (45L)= 45 Periods					

Text Books:	
1.	Behrouz A Forouzan, Data Communications and Networking, 4th Edition, 2020
2.	James F. Kurose, Keith W. Ross, Computer Networking - A Top-Down Approach Featuring the Internet, Seventh Edition, Pearson Education, 2016.
Reference Books:	
1.	Nader. F. Mir,“ Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2nd Edition, 2014.
2.	Alberto Leon-Garcia, IndraWidjajaCommunication Networks 2nd Edition McGraw-Hill Education, 2003
3.	Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, McGraw Hill Publisher, 2011.
4.	Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers, 2011.
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee61/preview
2.	https://www.ee.iitb.ac.in/~sarva/courses/EE706/2012/EE706LecNotes.pdf
3.	http://www.cs.kent.edu/~farrell/net01/lectures/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basic concept in modern data communication and different level of layers in the protocol	Understanding
CO2	Analyse the functions and services of data link layer	Analysing
CO3	Categorize the functions and services of network layer	Understanding
CO4	Examine the basic functions of transport layer and congestion in networks	Understanding
CO5	Analyse the concepts of various network applications and data security	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	-	1	-	-	-	-	-	-	-	2	-	1
CO2	2	1	2	-	1	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	3	1	2
CO4	3	2	1	-	2	-	-	-	-	-	-	-	2	-	2
CO5	2	1	1	-	1	-	-	-	-	-	-	-	1	1	1
Avg	2.2	1.2	1.2	-	1.25	-	-	-	-	-	-	-	2	1	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM08	FUNDAMENTALS OF IoT					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives	
1	To understand Smart Objects and IoT Architectures
2	To learn about various IOT-related protocols
3	To build simple IoT Systems using Arduino and Raspberry Pi
4	To understand data analytics and cloud in the context of IoT
5	To develop IoT infrastructure for popular applications

Unit I	**FUNDAMENTALS OF IOT**	**9**	**0**	**0**	**9**
	Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects				
Unit II	**IoT PROTOCOLS**	**9**	**0**	**0**	**9**
	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				
Unit III	**DESIGN AND DEVELOPMENT**	**9**	**0**	**0**	**9**
	Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.				
Unit IV	**DATA ANALYTICS AND SUPPORTING SERVICES**	**9**	**0**	**0**	**9**
	Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG				
Unit V	**CASE STUDIES/INDUSTRIAL APPLICATIONS**	**9**	**0**	**0**	**9**
	Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – Grid Blocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control				
	Total (45 L) = 45 Periods				

Text Books:	
1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2	ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015
Reference Books:	

1	Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2).
2	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
3	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.
4	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
E-References:	
1	https://online.stanford.edu/courses/xee100-introduction-internet-things
2	https://www.udemy.com/topic/internet-of-things/
3	https://www.netacad.com/courses/iot

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of IoT.	Understanding
CO2	Analyze various protocols for IoT.	Applying
CO3	Design a PoC of an IoT system using Rasperry Pi/Arduino	Applying
CO4	Apply data analytics and use cloud offerings related to IoT.	Applying
CO5	Analyze applications of IoT in real time scenario	Analysing

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM09	WIRELESS SENSORS AND NETWORKING					
PREREQUISITE:		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	Learn fundamental of Ad hoc network and architecture
2.	Understand the MAC and routing protocols.
3.	Have an in-depth knowledge on QoS, security and sensor network platforms

Unit I	ROUTING PROTOCOLS	9	0	0	9

Elements of Ad hoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Ad hoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).

Unit II	ARCHITECTURES OF WSN	9	0	0	9

WSN application examples, Types of applications, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Single-Node Architecture: Hardware Components, Energy Consumption of Sensor Nodes, Operating systems and execution environments

Network Architecture: Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, gateway concepts.

Unit III	MAC PROTOCOLS AND ROUTING PROTOCOLS	9	0	0	9

Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262 - ITU-T Recommendation H.263.

Unit IV	QUALITY OF SERVICE AND ADVANCED APPLICATION SUPPORT	9	0	0	9

Quality of Service: Coverage and deployment, Reliable data transport, Single packet delivery, Block delivery, Congestion control and rate control - Advanced application support: Advanced in-network processing, Security and Application-specific support.

Unit V	SENSOR NETWORK PLATFORMS AND TOOLS	9	0	0	9

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.

Total (45L) = 45 Periods

Text Books:

1.	C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008
2.	Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.

Reference Books:

1.	Feng Zhao and LeonidesGuibas, "Wireless sensor networks ", Elsevier publication - 2004.
2.	Charles E. Perkins, ―Ad Hoc Networking‖, Addison Wesley, 2000.
3.	William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004
4.	I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, Computer Networks, Elsevier, 2002, 394 - 422.

E-References:

1.	https://nptel.ac.in/courses/106105183
2.	https://nptel.ac.in/courses/106105183
3.	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Know the basics of Ad hoc networks and Wireless Sensor Networks	Understanding
CO2	Have a knowledge on architecture of Wireless Sensor Networks	Applying
CO3	Apply the knowledge to identify MAC and routing protocols	Applying
CO4	Understand the transport layer and security issues possible in Ad hoc and sensor networks	Understanding
CO5	Be familiar with the OS used in Wireless Sensor Networks and build basic modules	Remembering

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	3	3	2	-	-	-	3	3	3	-	2
CO2	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
CO3	3	3	3	3	3	3	2	-	-	-	3	3	3	-	2
CO4	3	3	2	3	3	3	2	-	-	-	2	3	3	-	2
CO5	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
Avg	3	3	2	3	3	3	2	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM10	FUNDAMENTALS OF EMBEDDED SYSTEMS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
Microprocessors and Mmicrocontrollers		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To impart knowledge on embedded system architecture and embedded development Strategies
2	To understand the bus Communication in processors and peripheral interfacing
3	To understand basics of Real Time Operating System

UNIT I	**BASICS OF EMBEDDED SYSTEMS**	9	0	0	9
Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Examples - Programming Languages - Recent Trends in Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning - Development Environment.					
UNIT II	**MEMORY MANAGEMENT AND INTERRUPTS**	9	0	0	9
Memory Access Procedure - Types of Memory - Memory Management Methods - DMA – Memory Interfacing - Polling Vs Interrupts - Types of Interrupts - Interrupt Latency - Interrupt Priority – Programmable Interrupt Controllers - Interrupt Service Routines					
UNIT III	**COMMUNICATION INTERFACES**	9	0	0	9
Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth					
UNIT IV	**REAL TIME OPERATING SYSTEMS**	9	0	0	9
Real-Time Concepts - Task Management - Task Scheduling - Classification of Scheduling Algorithms - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing - Priority Inheritance Protocol - Priority Ceiling Protocol - Inter Task Communication - Mutex - Semaphores - Message Queues - Timers - Commercial RTOS.					
UNIT V	**VALIDATION AND DEBUGGING**	9	0	0	9
Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer – Background Debug Mode - InCircuit Emulator CASE STUDY: RFID Systems - GPS Navigation System – Development of Protocol Converter.					
Total (45 L) = 45 Periods					

Text Books:

1	Sriram V Iyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2	Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.

Reference Books:

1	Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003
2	Heath, "Embedded Systems Design‖", Newnes an Imprint of Elsevier, Massachusetts, 2003.
3	Tammy Noergaard, "Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013

E-References:

1	https://lecturenotes.in/subject/225/embedded-system-es
2	https://nptel.ac.in/courses/108102045/19

3	https://www.coursera.org/learn/introduction-embedded-systems.

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Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Outline the concepts of embedded systems	Understanding
CO2	Understand the concept of memory management system and interrupts.	Understanding
CO3	Know the importance of interfaces.	Understanding
CO4	Understand real time operating system concepts.	Understanding
CO5	To realize the applications of validation and debugging.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	-	-	-	-	-	-	3	3	3	-	2
CO2	3	3	2	3	-	-	-	-	-	-	3	3	3	-	2
CO3	3	3	3	3	-	-	-	-	-	-	3	3	3	-	2
CO4	3	3	2	3	-	-	-	-	-	-	2	3	3	-	2
CO5	3	3	2	3	-	-	-	-	-	-	3	3	3	-	2
Avg	3	3	2	3	-	-	-	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

1	Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2).
2	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
3	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.
4	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.

E-References:

1	https://online.stanford.edu/courses/xee100-introduction-internet-things
2	https://www.udemy.com/topic/internet-of-things/
3	https://www.netacad.com/courses/iot

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of IoT.	Understanding
CO2	Analyze various protocols for IoT.	Applying
CO3	Design a PoC of an IoT system using Rasperry Pi/Arduino	Applying
CO4	Apply data analytics and use cloud offerings related to IoT.	Applying
CO5	Analyze applications of IoT in real time scenario	Analysing

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO2	2	1	2	1	1	-	-	-	-	-	1	-	2	2	2
CO3	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
CO4	2	2	2	1	1	-	-	-	-	-	1	-	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	2	-	2	2	2
Avg	2	1.6	2.4	1.4	1	-	-	-	-	-	1.4	-	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22EEM01	LINEAR AND DIGITAL ELECTRONICS CIRCUITS		SEMESTER			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Electron Devices and Circuits		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on the characteristics& applications of Operation Amplifier, functional diagram and applications of linear ICs.
2.	To simplify the switching functions
3.	To design the combinational logic circuits and sequential logic circuits

Unit I	**OPERATIONAL AMPLIFIERS**	**9**	**0**	**0**	**9**

Operational amplifiers - Equivalent circuit, voltage transfer curve - Open loop Op-amp configurations –Voltage series, Voltage shunt feedback amplifiers configurations, closed loop differential amplifiers for single and differential outputs.
Output offset voltage, minimizing output offset voltage due to input bias current and input offset current, factors affecting off set parameters, CMRR - Open loop and closed loop frequency response of op-amps, circuit stability, slew rate and its effects in applications.

Unit II	**APPLICATION OF OPERATIONAL AMPLIFIER AND LINEAR ICS**	**9**	**0**	**0**	**9**

DC & AC amplifiers- Summing, Scaling and Averaging amplifiers-Instrumentation amplifier- Voltage to Current converter for floating and grounded loads - Current to voltage converter - Integrator, Differentiator. Voltage comparators - Zero Crossing Detector - Schmitt trigger with voltage limiter- Precision Rectifier Circuits-Peak Detector-Sample and Hold circuit, Active Filters - Frequency response characteristics of major active filters, first and higher order low pass and high pass filters, all pass filters.
Functional block diagram and Applications of Linear ICs: IC 555 Timer -IC 566 Voltage controlled oscillator- IC 565 Phase-locked loops - IC LM317 voltage regulators.

Unit III	**COMBINATIONAL LOGIC CIRCUITS**	**9**	**0**	**0**	**9**

Representation of logic functions: SOP and POS forms - Simplification of switching functions: K-maps method and QuineMcCluskey (Tabulation) method.
Design:Adders -Subtractors– 2 bit Magnitude Comparator-Multiplexer- Demultiplexer- Encoder - Priority Encoder - Decoder – Code Converters. Implementation of combinational logic circuits using multiplexers and Decoder.

Unit IV	**SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS**	**9**	**0**	**0**	**9**

Flip-flops: SR, D, JK and T- Conversion of flip-flops; Classification of sequential circuits: Moore and Mealy models - Analysis and design of synchronous sequential circuits - Design of synchronous counters- Universal shift register.

Unit V	**ASYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS**	**9**	**0**	**0**	**9**

Fundamental mode and pulse mode circuits , Analysis procedure of asynchronous circuits with /without using of SR latches-primitive state / flow table – Reduction of state and flow table - state assignment –Design Procedure of asynchronous circuits with /without using of SR latches-Problems in asynchronous sequential circuits: cycles -Races –Hazards.

Total (45L+0T) = 45 Periods

Text Books:

1.	Ramakant A Gayakward, “Op-Amps and Linear Integrated Circuits”, Fourth Edition, Pearson Education, 2003.
2.	Donald.E.Neaman, “Electronic Circuit, Analysis and Design”, Tata McGraw Hill Publishing Company Limited, Second Edition, 2002.
3.	D.Roy Chowdhury and Shail B. Jain, “Linear Integrated Circuits”, Fourth Edition, New Age International (P) Ltd Publishers, 2014.
4.	M. Morris Mano, “Digital Design” , Third Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2003 / Pearson

	Education (Singapore) Pvt. Ltd., New Delhi, 2010 .
5.	S. Salivahanan and S. Arivazhagan, “Digital Circuits and Design”, Third Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 201
Reference Books:	
1.	Jacob Millman, Christos C.Halkias, “Integrated Electronics - Analog and Digital circuits system”, Tata McGraw Hill 2003.
2.	R.P.Jain, “Modern Digital Electronics”, Third Edition, Tata McGraw–Hill Publishing company limited, New Delhi, 2011.
3.	Thomas L. Floyd, “Digital Fundamentals”, Pearson Education, Inc, New Delhi, 2015
4.	Donald P.Leach and Albert Paul Malvino, “Digital Principles and Applications”, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2012.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the Op-amp characteristics	L2: Understanding
CO2	:	Understand the applications of Op-amp and other linear ICs.	L2: Understanding
CO3	:	Apply K-map and Tadulation methods to simplify the switching functions	L3: Applying
CO4	:	Design and implement of combinational logic circuits	L6: Creating
CO5	:	Analyse and design of synchronous & asynchronous sequential logic circuits	L4: Analyzing

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1											2		
CO2	3	2	1	1									3		
CO3	3	2		2	2								3	3	
CO4	3	2	3	1	2							2	3	3	1
CO5	3	2	3	1	2							2	3	3	1
Avg.	**2.8**	**1.8**	**2.3**	**1.25**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2.8**	**3**	**1**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22EEM02	MICROPROCESSOR AND MICROCONTROLLER		SEMESTER			
PREREQUISTIES		CATEGORY	PE	Credit		3
C Programming		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To study the architecture of μP8085 and μC 8051.
2.	To study the Interrupt structure of 8085 and 8051.
3.	To do simple applications development with programming 8085 and 8051.

UNIT I	8085 8 BIT MICROPROCESSOR	9	0	0	9

Fundamentals of microprocessors – Architecture of 8085 – Groups of Instructions - Addressing modes – Basic timing diagram – Organization and addressing of Memory and I/O systems –Interrupt structure – Stack and sub-routines - Simple 8085 based system design and programming.

UNIT II	8051 8 BIT MICROCONTROLLER	9	0	0	9

Fundamentals of microcontrollers – Architecture of 8051 – Groups of Instructions - Addressing modes – Organization of Memory systems – I/O Ports – Timers/Counters – Serial Port - Interrupt structure – Simple programming concepts using Assemblers and Compliers.

UNIT III	INTERFACING WITH 8051 MICROCONTROLLER	9	0	0	9

Need and requirements of interfacing – Interfacing – LED, 7 segment and LCD Displays – Tactile switches, Matrix keyboard – Parallel ADC – DAC – Interfacing of Current, Voltage, RTD and Hall Sensors.

UNIT IV	EXTERNAL COMMUNICATION INTERFACE	9	0	0	9

Synchronous and Asynchronous Communication. RS232, RS 485, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.

UNIT V	APPLICATIONS OF MICROCONTROLLERS	9	0	0	9

Simple programming exercises- key board and display interface –Control of servo motor stepper motor control- Application to automation systems.

Total (45L+0T)= 45 Periods

Text Books:

1.	R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2.	K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004.
3.	Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.

Reference Books:

1.	R. Kamal, "Embedded System", McGraw Hill Education, 2009.
2.	D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

E-References;

1.	www.onlinecourses.nptel.ac.in/noc18_ee41
2.	www.class-central.com
3.	www.mooc-list.com

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand basics of microprocessor and microcontroller	L2: Understanding
CO2	:	Understand the architecture of Microprocessor and Microcontroller	L1: Remembering
CO3	:	Apply the digital concepts to measure and control simple electrical systems	L3: Applying
CO4	:	Design and interface communications between digital systems	L2: Understanding
CO5	:	Design a microcontroller based electrical control system.	L5: Evaluating

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	1	1								1	1	1	
CO2	2	1	1	1								1	1	1	
CO3	2	3	2	3	2							1	1	1	2
CO4	2	3	3	3	2							2	2	2	2
CO5	2	3	3	3	2							2	2	2	2
Avg.	**2**	**2.2**	**2**	**2.2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1.4**	**1.4**	**1.4**	**2**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22EEM03	CONTROL SYSTEMS		SEMESTER			
PREREQUISTIES		**CATEGORY**	**PE**	**Credit**		**3**
Electrical Machines and Electric circuit analysis		**Hours/Week**	**L**	**T**	**P**	**TH**
			1	**1**	**0**	**3**

Course Objectives:

1.	To understand the methods of representation of physical systems and getting their transfer function models.
2.	To provide adequate knowledge in the time response of systems and steady state error analysis.
3.	To give basic knowledge in obtaining the open loop and closed loop frequency response of systems.
4.	To understand the concept of stability of control system and methods of stability analysis.
5.	To study the designing compensators for a feedback control system.

UNIT I	MODELLING OF LINEAR TIME INVARIANT SYSTEMS	6	9	0	9

Basic elements in control systems – Open and closed loop systems – Feedback control system characteristics - Mathematical model and Electrical analogy of mechanical systems – Transfer function Representation– Synchro – AC and DC servo-motors – Block diagram reduction techniques – Signal flow graphs.

UNIT II	TIME RESPONSE ANALYSIS	6	3	0	9

Standard test signals – Time response of first order and second order systems –time domain specifications - Steady-state errors and error constants – Type and order of control systems – Effect of adding poles and zeros to transfer functions – Response with P, PI, PD and PID controllers.

UNIT III	FREQUENCY RESPONSE ANALYSIS	6	3	0	9

Correlation between time and frequency response: Second order systems – Frequency domain specifications - Polar plots – Bode plots – Computation of Gain Margin and Phase Margin — Constant M and N-circles – Nichols chart.

UNIT IV	STABILITY OF CONTROL SYSTEM	6	3	0	9

BIBO stability – Necessary conditions for stability – Routh-Hurwitz stability criterion – Root locus concepts – Rules for the construction of Root loci – Nyquist stability criterion – Assessment of relative stability using Nyquist criterion.

UNIT V	COMPENSATOR AND CONTROLLER DESIGN	6	3	0	9

Need for compensation – Types of compensators – Electric network realization and frequency characteristics of basic compensators: Lag, lead and lag-lead compensators – Design of compensators using root locus and Bode plot techniques-PID controller: Design using reaction curve and Ziegler - Nichols technique.

Total (30L+15T) = 45 Periods

Text Books:

1.	A. Anand Kumar, "Control Systems", PHI Learning Pvt. Ltd., New Delhi, 2nd Edition, 2017.
2.	I.J. Nagrath, and M. Gopal, "Control Systems Engineering", New Age International Publishers, Delhi, 7th Edition, 2021.

Reference Books:

1.	K. Ogata, "Modern Control Engineering", Pearson Education, New Delhi, 5th Edition, 2021.
2.	M. Gopal, "Control Systems: Principles and Design", TMH, New Delhi, 4th Edition, 2018.

E-Reference

1.	https://nptel.ac.in/courses/107106081
2.	https://nptel.ac.in/courses/108106098

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Develop the transfer function models of any electrical and electro-mechanical systems.	L2: Understanding
CO2	:	Obtain the time responses of the systems and construct root locus plot.	L3: Applying
CO3	:	Analyze the frequency response of the system	L3: Applying
CO4	:	Analyze the absolute / relative stability of a control system.	L4: Analyzing
CO5	:	Design the compensators and PID controller of a feedback control system.	L3: Applying

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	2	2							1	3	2	1
CO2	3	3	3	2	2							1	3	2	1
CO3	3	3	3	2	2							1	3	2	1
CO4	3	3	3	2	2							1	3	2	1
CO5	3	3	3	2	2							1	3	2	1
Avg	**3**	**3**	**2.8**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**1**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22EEM04	MEASUREMENTS AND INSTRUMENTATION		SEMESTER			
PREREQUISTIES		**CATEGORY**	**PE**	**Credit**		**3**
Electric Circuit Analysis		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To educate the fundamental concepts and characteristics of measurement System
2.	To introduce the fundamentals of electrical and electronic instruments for measurement of Electrical and Non-electrical quantities
3.	To familiarize Oscilloscope and the bridge circuits for electrical parameters measurement

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement. Measurement of voltage and current - permanent magnet moving coil and moving iron type meters

UNIT II	**MEASUREMENT OF POWER , ENERGY AND FREQUENCY**	**9**	**0**	**0**	**9**

Measurement of power - single and three phase- electrodynamometer type watt meters – Construction, operation – torque equation for deflection – errors. Measurement of energy-Single phase induction type energy meters, Instrument transformers – Current and Potential transformers, Power factor meters- Single phase electrodynamometer type power factor meter, frequency meter-Electrical resonance type frequency meter

UNIT III	**DC AND AC BRIDGES**	**9**	**0**	**0**	**9**

Balance equations - Wheatstone bridge – Kelvin double Bridge –Maxwell's inductance capacitance bridge – Hay's bridge – Anderson's bridge – Schering bridge and De Sauty's bridge

UNIT IV	**POTENTIOMETERS, OSCILLOSCOPES AND DIGITAL INSTRUMENTS**	**9**	**0**	**0**	**9**

DC Potentiometer- Crompton's Potentiometer, AC potentiometer– Drysdale polar potentiometer- Gall Tinsley co-ordinate type potentiometer, Cathode Ray Oscilloscope and Digital storage Oscilloscope-Construction, operation and Applications, Digital multi-meters, Digital voltmeters.

UNIT V	**MEASUREMENT OF NON-ELECTRICAL QUANTITIES**	**9**	**0**	**0**	**9**

Classification of transducers –Position transducers, Piezo-electric transducers and Hall effect transducers. Measurement of pressure, temperature and displacement– Introduction to Smart Sensors

Total (45L+0T)= 45 Periods

Text Books:

1.	A.K. Sawhney, 'A Course in Electrical & Electronics Measurement & Instrumentation', Dhanpat Rai and Co, 2015
2.	E.O. Doebelin, 'Measurements Systems- Application and Design', Tata McGraw Hill publishing company, 2015.

Reference Books:

1.	D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt. Ltd, 2010.
2.	H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, 2015.
3.	Martin Reissland, ' Electrical Measurements', New Age International(P) Ltd., Delhi, 2011.

E-Reference:

1	https://archive.nptel.ac.in/courses/108/105/108105153/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the fundamentals of measurement system in electrical engineering.	L1: Remembering
CO2	:	Describe the working principle of different measuring instruments	L2: Understanding
CO3	:	Choose appropriate instrument for measuring the electrical parameters	L3: Applying
CO4	:	Employ the digital instruments in real time measurements.	L3: Applying
CO5	:	Select an appropriate transducer for measurement of non-electrical quantities	L4: Analysing

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	2	3				1		2		2	2	1	1
CO2	1	3			3					2		1	2	1	
CO3	1	1		2	1	1	2		1				1	2	1
CO4	1	1		1	1		2	2	1		2	2	1	3	1
CO5	2	2	3	1	2	2	1			1	3		1	2	
Avg	**1.4**	**1.8**	**2.5**	**1.75**	**1.75**	**1.5**	**1.67**	**1.5**	**1**	**1.67**	**2.5**	**1.67**	**1.4**	**1.8**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEM05	ELECTRICAL MACHINES		SEMESTER			
PREREQUISTIES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To impart knowledge on construction, working and performance of DC generators and motors.
2.	To deliberate the construction, working and performance of single phase and three phase transformers.
3.	To impart knowledge on construction, working and performance of synchronous generators and motors.
4.	To impart knowledge on construction, principle of operation and performance of single and three-phase induction motors.

UNIT I	DC GENERATORS	9	0	0	9

Principle of operation, constructional details, types - EMF equation, armature reaction, demagnetizing and cross magnetizing Ampere turns, compensating winding, commutation, methods of improving commutation, interpoles, Open circuit and load characteristics of different types of DC Generators. Parallel operation of DC Generators, applications of DC Generators.

UNIT II	DC MOTORS	9	0	0	9

Principle of operation, significance of back emf, torque equation and power developed by armature, load characteristics of shunt, series and compound type motors, starting methods, speed control methods - losses and efficiency calculation, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne's test, Hopkinson's test, Retardation test, Separation of core losses - applications of DC motors**.**

UNIT III	TRANSFORMER	9	0	0	9

Single phase transformer: Construction and principle of operation, working of practical transformer - equivalent circuit, voltage regulation, losses and efficiency- testing : polarity test, open circuit and short circuit tests, back-to back test, all day efficiency, parallel operation, applications.
Autotransformer: Construction and working, saving of copper - applications, **Three phase transformer**: construction, types of connections and their comparative features.

UNIT IV	SYNCHRONOUS GENERATOR AND MOTOR	9	0	0	9

Synchronous Generator: Constructional and working details – Types of rotors – EMF equation – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus - Synchronizing and parallel operation – Synchronizing torque - Voltage regulation – EMF, MMF and ZPF method – steady state power angle characteristics – Two reaction theory – slip test.

Synchronous Motor: Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power Developed -Hunting – natural frequency of oscillations – damper windings- synchronous condenser.

UNIT V	THREE PHASE AND SINGLE PHASE INDUCTION MOTOR	9	0	0	9

Three phase induction motor: Constructional details – Types of rotors –- Principle of operation – Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Starters: DOL, Autotransformer and Star delta starters – Speed control methods: Voltage control, Frequency control and pole changing – V/f control – Slip power recovery Scheme.

Single phase induction motor: Constructional details – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – split phase, Capacitor-start, capacitor start and capacitor run Induction motor.

Total (45L+0T)= 45 Periods

Text Books:	
1.	I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 5th Edition, 2017.
2.	P. S. Bimbhra, “Electric Machinery”, Khanna Publishers, 2nd Edition, 2021.
3.	B.L.Theraja and A.K.Theraja,” A text book of Electrical Technology - Volume-II”, S.Chand & Company Ltd., New Delhi, 23rd Edition, 2009.
Reference Books:	
1.	B.R.Gupta, ’Fundamental of Electric Machines’ New age International Publishers,3rd Edition, Reprint 2015.
2.	Murugesh Kumar, ‘Electric Machines’, Vikas Publishing House Pvt. Ltd, First edition, 2010.
3.	A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, ‘Electric Machinery’, Mc Graw Hill publishing Company Ltd, 6th Education, 2017.
4.	Stephen J. Chapman, ‘Electric Machinery Fundamentals’4th edition, McGraw Hill Education Pvt. Ltd, 4th Edition 2017.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Explain the construction and working principle of DC machines, and Interpret various characteristics of DC machines.	L2: Understanding
CO2	:	Compute various performance parameters of the machine, by conducting suitable tests.	L5: Evaluating
CO3	:	Describe the working principle of transformer, auto transformer, three phase transformer connection, and determine the efficiency and regulation.	L3: Applying
CO4	:	Understand the construction and working principle of Synchronous Machines.	L3: Applying
CO5	:	Understand the construction and working principle, speed control of three phase and single phase induction motor.	L5: Evaluating

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	1	1	1			1				1	3	2	1
CO2	3	3	1	1	1			1				1	3	2	1
CO3	3	3	1	1	1			1				1	3	2	1
CO4	3	3	1	1	1			1				1	3	2	1
CO5	3	3	1	1	1			1				1	3	2	1
Avg.	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**3**	**2**	**1**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22EEM06	ELECTRICAL DRIVES AND CONTROL		SEMESTER			
PREREQUISTIES		**CATEGORY**	**PE**	**Credit**		**3**
DC Machines and Transformers, Synchronous and Induction Machines, and Power Electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To know about the operation analyse of chopper fed DC drive, both qualitatively and quantitatively.
2.	To understand the operation and performance of AC motor drives.

UNIT I	DC MOTOR CHARACTERISTICS & CHOPPER FED DC DRIVES	9	0	0	9

Review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed. Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper.

UNIT II	MULTI-QUADRANT & CLOSED-LOOP CONTROL OF DC DRIVE	9	0	0	9

Review of Four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, current controller specification and design, speed controller specification and design.

UNIT III	INDUCTION MOTOR CHARACTERISTICS	9	0	0	9

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency. Review of three-phase voltage source inverter, generation of three-phase PWM signals, constant V/f control of induction motor

UNIT IV	CONTROL OF SLIP RING INDUCTION MOTOR	9	0	0	9

Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery. .

UNIT V	CONTROL OF SRM AND BLDC MOTOR DRIVES.	9	0	0	9

SRM construction - Principle of operation - SRM drive design factors-Torque controlled SRM- Block diagram of Instantaneous Torque control using current controllers and flux controllers. Construction and Principle of operation of BLDC Machine - Sensing and logic switching scheme,-Sinusoidal and trapezoidal type of Brushless dc motors – Block diagram of current controlledd Brushless dc motor drive

Total (45L+0T)= 45 Periods

Text Books:

1.	G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2.	R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall,2010
3.	Bose B K, "Modern Power Electronics and AC Drives", Pearson Education New Delhi, 2010.

Reference Books:

1.	G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2012.
2.	W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

E-Reference

1	https://www.iith.ac.in/~ketan/drives.htmL

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the characteristics of dc motors and induction motors.	L2: Understanding
CO2	:	Summarize the operation of chopper fed DC drives.	L4: Analyzing
CO3	:	Understand the principles of speed-control of dc motors and induction motors.	L2: Understanding
CO4	:	Identify suitable power electronic converters used for dc motor and induction motor speed control.	L3: Applying
CO5	:	Analyze the SRM and BLDC motor drive control	L4: Analyzing

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	3			1	1					1	3	2	
CO2	3	3	1	3		1	1					1	3	2	
CO3	3	3	3	3	1	1	1					1	3	2	
CO4	1	3	3	2	1	1	1					1	3	2	
CO5	3	3	3	3	1	1	1					1	3	2	
Avg.	**2.6**	**2.6**	**2.6**	**2.75**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**-**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22EEM07	ELECTRIC VEHICLES AND CONTROL		SEMESTER			
PREREQUISTIES		CATEGORY	PE	Credit		3
Electrical drives and control		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To provide knowledge on electric vehicle architecture and its configurations
2.	To impart knowledge on vehicle control, use of energy storage systems and energy management in Electric Vehicle

UNIT I	ELECTRIC VEHICLES	9	0	0	9

Configurations of Electric Vehicles (EV), Performance of Electric Vehicles, Tractive Effort in Normal Driving and Energy Consumption, Hybrid Electric Vehicles (HEV): Classification, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains

UNIT II	PLUG-IN HYBRID ELECTRICVEHICLES (PHEV) AND FUEL CELL ELECTRIC VEHICLES	9	0	0	9

Functions and Benefits of PHEV, Components of PHEVs, Operating Principles of Plug-in Hybrid Vehicle, Control Strategy of PHEV, Fuel Cell: Operation and Types, Fuel Cell Electric Vehicle: Configuration and Control Strategy

UNIT III	ELECTRIC PROPULSION SYSTEMS	9	0	0	9

Typical electric propulsion system, Classification of electric motor drives for EV and HEV, Multiquadrant Control of Chopper-Fed DC Motor Drives, Vector Control of Induction Motor drives, Permanent Magnetic Brush-Less DC Motor Drives, Switched Reluctance Motor Drives for Electric Vehicles

UNIT IV	ENERGY STORAGE SYSTEM	9	0	0	9

Status of Battery Systems for Automotive Applications, Battery Technologies: Nickel–Metal Hydride (Ni–MH) Battery, Lithium–Polymer (Li–P) Battery, Lithium-Ion (Li-Ion) Battery, Ultracapacitors: Features, operation and performance, Ultrahigh-Speed Flywheels, Hybridization of Energy Storages

UNIT V	ENERGY MANAGEMENT SYSTEM	9	0	0	9

Energy Management System(EMS) in Electric Vehicle, Rule-based control strategy: Deterministic rule-based control, Fuzzy logic-based control, and Neural network-based control. Optimization based control strategy: Dynamic Programming, Metaheuristic optimization methods and Model predictive control, Semi-active type Hybrid Energy Storage System-based EMS, Fully-active type Hybrid Energy Storage System-based EMS

Total (45L+0T)= 45 Periods

Text Books:

1.	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, Taylor & Francis Group, Second Edition ,2011.
2.	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, AliEmadi,, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles" CRC Press, 2016

Reference Books:

1.	Ali Emadi, Mehrdad Ehsani, John M.Miller ,"Vehicular Electric Power Systems", Ali Emadi, Mehrdad Ehsani, John M.Miller, Special Indian Edition, Marcel dekker, Inc 2010

E-Reference:

1	https://archive.nptel.ac.in/courses/108/106/108106170/

Course Outcomes: Upon completion of this course, the students will be able to:	**Bloom's Taxonomy Mapped**

CO1	:	Recall the fundamentals of electric vehicle and its mechanics	L1: Remembering
CO2	:	Explain the architecture of different forms of hybrid electric vehicles.	L2: Understanding
CO3	:	Illustrate the four-quadrant operation of DC drive, induction motor drive and SRM drive for Electric Vehicles.	L4: Analyzing
CO4	:	Select an appropriate energy storage system for Electric vehicle	L4: Analyzing
CO5	:	Use the suitable energy management control strategy for hybrid electric vehicle	L3: Applying

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1		1	3	1		1					1	1	2	1
CO2	1	2	3	1			2					2	1	2	
CO3	1	1			2		3						1	1	1
CO4	3	1	2	1	2		1					2	1	2	1
CO5	1	2	1	2	1							1	1	2	1
Avg	**1.4**	**1.5**	**1.75**	**1.75**	**1.5**	**-**	**1.75**	**-**	**-**	**-**	**-**	**1.5**	**1**	**1.8**	**1**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

<table>
<tr><td>22EEM08</td><td colspan="3">ELECTRICAL ENERGY CONSERVATION AND AUDITING</td><td colspan="3">SEMESTER</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>CATEGORY</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Power Generation, Transmission and Distribution System</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="7">To get knowledge about basics of energy and energy scenario of India.</td></tr>
<tr><td>2.</td><td colspan="7">To familiarise the energy conservation methods.</td></tr>
<tr><td>3.</td><td colspan="7">To acquire knowledge on energy auditing, energy efficiency and modern energy efficient devices.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>UNIT I</td><td colspan="3">ENERGY SCENARIO</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Commercial and non-commercial energy -Primary energy resources - Commercial energy production - Final energy consumption - Energy needs of growing economy - Long term energy scenario - Energy pricing - Energy sector reforms - Energy and environment - Energy security - Energy conservation and its importance - Restructuring of the energy supply sector - Energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>UNIT II</td><td colspan="3">BASICS OF ENERGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Electricity tariff - Load management and maximum demand control - Thermal Basics-fuels - Thermal energy contents of fuel, temperature and pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>UNIT III</td><td colspan="3">ENERGY MANAGEMENT AND AUDIT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Definition - Energy audit – Need and types of energy audit. Energy management (audit) approach understanding energy costs - Bench marking - Energy performance - Matching energy use to requirement - Maximizing system efficiencies - Optimizing the input energy requirements, fuel and energy substitution - Energy audit instruments. Material and energy balance: Facility as an energy system - Methods for preparing process flow, material and energy balance diagrams.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>UNIT IV</td><td colspan="3">ENERGY EFFICIENCY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Electrical system: Electricity billing - Electrical load management and maximum demand control -Power factor improvement and its benefit - Selection and location of capacitors - Performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types - Losses in induction motors - Motor efficiency - Factors affecting motor performance - Rewinding and motor replacement issues - Energy saving opportunities with energy efficient motors.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>UNIT V</td><td colspan="3">ENERGY EFFICIENT TECHNOLOGIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Maximum demand controllers - Automatic power factor controllers - Energy efficient motors –Soft starters with energy saver - Variable speed drives - Energy efficient transformers - Electronic ballast - Occupancy sensors - Energy efficient lighting controls - Energy saving potential of each technology.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8" align="right">Total (45 L+ 0 T) = 45 Periods</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Text Books:</td></tr>
<tr><td>1.</td><td colspan="7">Sonal Desai, “Handbook of Energy Audit”, McGraw Hill, 2015.</td></tr>
<tr><td>2,</td><td colspan="7">Tripathy, S. C, “Utilization of Electrical Energy and Conservation”, McGraw Hill, 1991.</td></tr>
<tr><td>3.</td><td colspan="7">Hossam A Gabbar, “Energy Conservation in Infrastructure Systems”, Wiley-IEEE Press, New Jersey, 2018</td></tr>
<tr><td colspan="8">Reference Books:</td></tr>
<tr><td>1.</td><td colspan="7">General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency, New Delhi, 2015.</td></tr>
<tr><td>2,</td><td colspan="7">Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency, New Delhi, 2015.</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the present energy scenario and future energy strategy.	L1: Understanding
CO2	Recognize the various forms of energy.	L1: Understanding
CO3	Interpret energy management methods and energy auditing.	L3: Applying
CO4	Familiar in energy efficiency of electrical systems.	L4: Analysing
CO5	Familiar with the advanced energy efficient technologies.	L4: Analysing

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	2	3	2	2		3					1	2	2	1
CO2	1	2	2	2	2		3					1	2	2	1
CO3	2	2	2	3	2		3					1	1	3	1
CO4	2	3	2	2	3		3					1	3	3	1
CO5	2	2	3	1	2		3					1	3	2	1
Avg	**1.6**	**2.2**	**2.4**	**2**	**2.2**	**-**	**3**	**-**	**-**	**-**	**-**	**1**	**2.2**	**2.4**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEM09	SMPS AND UPS			SEMESTER			
PREREQUISITES		**CATEGORY**		**PE**	**Credit**		**3**
Power Electronics		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge about modern power electronic converters and their applications in power utility.
2.	To impart knowledge about Resonant converters and UPS.

UNIT I	**DC-DC CONVERTERS**	**9**	**0**	**0**	**9**

Introduction to SMPS – Non-isolated DC-DC converters: Cuk, SEPIC topologies, Z-source converter – Zeta converter - Analysis and state space modeling –- Concept of volt-second and charge balance – High gain input-parallel output-series DC-DC converter.

UNIT II	**SWITCHED MODE POWER CONVERTERS**	**9**	**0**	**0**	**9**

Isolated DC-DC converters: Analysis and state space modelling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters- control circuits and PWM techniques – Bidirectional DC-DC converters.

UNIT III	**RESONANT CONVERTERS**	**9**	**0**	**0**	**9**

Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS , Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control.

UNIT IV	**DC-AC CONVERTERS**	**9**	**0**	**0**	**9**

Introduction – Multilevel concept – Types of multilevel inverters – Diode-clamped MLI – Flying capacitors MLI – Cascaded MLI – Cascaded MLI – Applications – Switching device currents – DC link capacitor voltage balancing – Features of MLI – Comparisons of MLI.

UNIT V	**POWER CONDITIONERS, UPS, AND FILTERS**	**9**	**0**	**0**	**9**

Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for power electronic applications – Selection of capacitors.

Total (45L+0T)= 45 Periods

Text Books:

1.	Simon Ang, Alejandro Oliva," Power-Switching Converters", Third Edition, CRC Press, 2010.
2.	M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.

Reference Books:

1.	Ned Mohan, Tore.M.Undeland, William.P.Robbins, "Power Electronics Converters, Applications and Design", 3rd Edition, John Wiley and Sons, 2006.
2.	M.H. Rashid, "Power Electronics circuits, devices and applications", 3rd Edition, PHI, New Delhi, 2007.

E-References:

1.	NPTEL Course: Power Electronics, IIT-B.
2.	www.cdeep.iitb.ac.in. (Electrical Engineering)

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Analyze the state space model for DC – DC converters.	L4: Analyzing
CO2	:	Acquire knowledge on switched mode power converters.	L2: Understanding
CO3	:	Outline the PWM techniques for DC-AC converters.	L1: Remembering
CO4	:	Discuss about modern power electronic converters and its applications in electric power utility.	L2: Understanding
CO5	:	Identify the filters and UPS.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	2	2			1					2	2	2	1
CO2	1	1	3	2			1					2	3	3	2
CO3	2	2	2	3			1					1	2	2	1
CO4	2	1	1	2			1					2	2	3	2
CO5	1	1	2	1			1					1	2	2	1
Avg.	**1.6**	**1.2**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1.6**	**2.2**	**2.4**	**1.4**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEM10	UTILIZATION OF ELECTRICAL ENERGY			SEMESTER			
PREREQUISITES		**CATEGORY**		**PE**	**Credit**		**3**
Electrical Machines, Power System, and Power Electronics		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To understand the economics of power generation, tariff and energy conservation methods.
2.	To impart knowledge on principle and design of illumination systems.
3.	To analyze the performance and different methods of electric heating and electric welding.
4.	To impart knowledge on electric traction systems and their performance.
5.	To understand electric drives for various industrial applications.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Economics of generation – definitions – load duration curve – number and size of generator units – Cost of electrical energy – tariff –– availability based Tariff- (ABT) – Battery Energy storage system (BESS)- Frequency based energy measurement - need for electrical energy conservation – methods.- Introduction to energy audit

UNIT II	**ILLUMINATION**	**9**	**0**	**0**	**9**

Introduction-nature of radiation – definition – laws of illumination – luminous efficacy-photometry – lighting calculations – design of illumination systems for residential, commercial, street lighting and sports ground– types of lamps –incandescent lamp- mercury vapour –fluorescent lamp-energy efficiency lamps – types of lighting schemes – requirements of good lighting

UNIT III	**HEATING AND WELDING**	**9**	**0**	**0**	**9**

Introduction- classification of methods of heating – requirements of a good heating material – design of heating element – temperature control of resistance furnace – electric arc furnace –induction heating – dielectric heating – electric welding – resistance welding – electric arc welding-electrical properties of arc-applications of electric arc welding.

UNIT IV	**ELECTRIC TRACTION**	**9**	**0**	**0**	**9**

Introduction – requirements of an ideal traction system – supply systems – train movement -mechanism of train movement – traction motors and control –speed control of three phase induction motor- multiple unit control – braking – recent trends in electric traction.

UNIT V	**DRIVES AND THEIR INDUSTRIAL APPLICATIONS**	**9**	**0**	**0**	**9**

Electric drive –advantages of electric drive-individual drive and group drive –factors affecting selection of motor – types of loads – steady state –transient characteristics –size of motor– load equalization – industrial applications – modern methods of speed control of D.C drives-dynamic braking using thyristors-regenerative braking using thyristors.

Total (45L+0T)= 45 Periods

Text Books:

1.	C.L. Wadhwa, “Generation, Distribution and Utilization of Electrical Energy”, New Age International Pvt.Ltd, 2003.
2.	Eric Openshaw Taylor, “Utilisation of Electric Energy”, English Universities Press Limited, 1937
3.	J.B. Gupta, “Utilization of Electric Power and Electric Traction”, S.K.Kataria and Sons, 2002.

Reference Books:

1.	G.C.Garg, S.K.Gridhar&S.M.Dhir, “A Course in Utilization of Electrical Energy”, Khanna Publishers, Delhi, 2003.
2.	H. Partab, “Art and Science of Utilization of Electrical Energy”, Dhanpat Rai and Co, New Delhi, 2004.

E-References:

1.	www.onlinecourses.nptel.ac.in
2.	www.class-central.com
3.	www.mooc-list.com

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the economics of power generation, tariff and energy conservation methods.	L2: Understanding
CO2	:	Interpret the concept behind illumination and design a suitable illumination system for a specific application.	L3: Applying
CO3	:	Design and choose an appropriate heating method for specific application and gain knowledge about electric welding system.	L4: Analyzing
CO4	:	Explain the concepts and recent trends of traction system.	L4: Analyzing
CO5	:	Discuss the concepts of electric drives and their characteristics.	L2: Understanding

COURSE ARTICULATION MATRIX															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1	1	1	1	2	1	2	2	1	1	1	2	2	3
CO2	2	3	2	3	1	1	2	1	1			1	3	3	2
CO3	3	3	1	3	1	1	2	1					2	2	3
CO4	1	2	2	3	3	1	2	1					2	3	2
CO5	3	1	1	2	1	1	2	1		1		1	2	2	3
CO6	1	3	3	3	3	1	2	2				1	3	3	2
Avg	**2.17**	**2.17**	**1.67**	**2.5**	**1.67**	**1.17**	**1.83**	**1.33**	**1.5**	**1**	**1**	**1**	**2.33**	**2.5**	**2.5**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22MEMI01	**ENGINEERING THERMODYNAMICS** *(Use of standard thermodynamic tables, Mollier diagram are permitted)*					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart the knowledge on concepts of zeroth and first law of thermodynamics.
2.	To make the learners to understand the third law of thermodynamics and analyze the various work and heat interactions in closed and open systems.
3.	To teach properties of pure substance.
4.	To impart knowledge on the concepts of steam power cycle.
5.	To derive thermodynamic relations for ideal and real gases.

UNIT I	**BASIC CONCEPT AND FIRST LAW**	**9**	**0**	**0**	**9**

Role of Thermodynamics in Engineering and Science - Applications of Thermodynamics. Basic concepts - concept of continuum, macroscopic approach, thermodynamic systems, Property, state, path and processes, quasi-static process, Thermodynamic equilibrium, Displacement work, P-V diagram. Zeroth law of thermodynamics – concept of temperature and heat. First law of thermodynamics – application to closed and open systems, steady flow processes with reference to various thermal equipment.

UNIT II	**SECOND LAW AND ENTROPY**	**9**	**0**	**0**	**9**

Heat engine – Refrigerator – Heat Pump, Second law of thermodynamics – Kelvin's and Clausius statements- Equivalence of these statements their corollaries. Reversibility and irreversibility. Carnot cycle, reversed Carnot cycle. Clausius inequality, Concept of entropy, principle of increase of entropy, T-s diagram, T-ds equations, Entropy.

UNIT III	**PROPERTIES OF PURE SUBSTANCES**	**9**	**0**	**0**	**9**

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

UNIT IV	**STEAM POWER CYCLE**	**9**	**0**	**0**	**9**

Basic Rankine cycle, T-s & h-s diagrams - Performance Improvement - Reheat cycle, regenerative cycle and their combination cycles.

UNIT V	**IDEAL AND REAL GASES AND THERMO DYNAMIC RELATIONS**	**9**	**0**	**0**	**9**

Properties of ideal and real gases, equation of state of ideal and real gases, Avogadro's law, Vander Waal's equation of states, Principle of corresponding states, reduced properties and compressibility chart. Exact differentials, Maxwell relations, Specific heat equations, Tds, relations, Clausius Clapeyron equations and Joule Thomson Coefficient.

Total (45L)= 45 Periods

Text Books:

1.	Nag. P.K, "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2017.
2.	Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.
3.	Arora C.P, "Thermodynamics", Tata McGraw Hill, New Delhi, 2003.
4.	Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987.

Reference Books:	
1.	Cengel, "Thermodynamics- An Engineering Approach", 3rd Edition, Tata McGraw Hill, 2015.
2.	Merala C, Pother, Craig W and Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGrawHill, New Delhi, 2004.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the concepts of zeroth, first and second law of thermodynamics.	Remember
CO2	Analyze the various work and heat interactions for different types of processes for closed and open systems	Evaluate
CO3	Evaluate the different properties of pure substances using steam tables and Mollier chart	Evaluate
CO4	Analyze the performance of steam power cycle.	Analyze
CO5	Derive thermodynamic relations for ideal and real gases.	Analyze

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2			1					1	3	1	1
CO2	3	3	2	2			1					1	3	1	1
CO3	3	3	3	2		1	1					1	3	1	1
CO4	2	3	2	2		1	1					1	3	1	1
CO5	3	3	2	2		1						1	3	1	1
Avg	**2.8**	**3**	**2.2**	**2**		**1**	**1**					**1**	**3**	**1**	**1**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MEMI02	FLUID MECHANICS AND MACHINERY						
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**	
1.Engineering Physics 2.Engineering Chemistry 3.Engineering Mathematics		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To understand the basic concepts and properties of fluids.
2.	To analyze the kinematic and dynamic concepts of fluid flow.
3.	To understand the various incompressible fluid flow through pipes and between parallel plates.
4.	To apply the principles of fluid mechanics to design and operation of hydraulic turbines.
5.	To apply the principles of fluid mechanics to design and operation of hydraulic pumps.

UNIT I	**INTRODUCTION AND FLUID STATICS**	**9**	**0**	**0**	**9**

Basic concepts and units of measurement of physical quantities- Classification of fluids - Properties of fluids – density, relative density, vapour pressure, surface tension, Capillarity and viscosity. Fluid statics- hydrostatic pressure, buoyancy and Archimedes' principle.

UNIT II	**FLUID KINEMATICS AND DYNAMICS**	**9**	**0**	**0**	**9**

Classification of fluid flow - system and control volume - Lagrangian and Eulerian description for fluid flow - flow patterns-streamline, pathline, streakline and timeline. Velocity potential function and Stream function - continuity equation and its applications. Fluid dynamics - Bernoulli's equation and its applications. Dimensional analysis – Buckingham's theorem, dimensional homogeneity, similarity-laws and models.

UNIT III	**FLOW THROUGH PIPES AND PLATES**	**9**	**0**	**0**	**9**

Incompressible fluid flow-Laminar flow- Hagen-Poiseuille equation, shear stress, pressure gradient relationship - flow through pipes and flow between parallel plates. Turbulent flow – flow through pipes, friction factors in turbulent flow - total energy line, hydraulic gradient line, flow through pipes in series and parallel- Moody's friction factor chart. Power transmission-Boundary layer flows - Boundary layer thickness, momentum thickness, energy thickness-boundary layer separation.

UNIT IV	**HYDRAULIC TURBINES**	**9**	**0**	**0**	**9**

Hydraulic turbines classification-impulse and reaction turbines-Working Principle, work done-efficiency and performance curves for Pelton, Francis and Kaplan turbines (Only descriptive) - Comparison between impulse and reaction turbine-specific speed degree of reaction -draft tubes.

UNIT V	**HYDRAULIC PUMPS**	**9**	**0**	**0**	**9**

Classification of hydraulic pumps- Centrifugal pumps - working principle, specific speed, performance curves and priming(Only descriptive) - Reciprocating pumps - classification, working principle, indicator diagram, air vessels and performance curves. Cavitation in pumps (Only descriptive) - Working principles of gear and vane pumps.

Total (45L)= 45 Periods

Text Books:

1.	Bansal, R.K., "A Textbook of Fluid Mechanics and Hydraulic Machines, 9th Ed", Laxmi Publication Pvt Ltd, 2010.
2.	Rajput, R.K., "A Textbook of Fluid Mechanics and Hydraulic Mechanics", S.Chand and Company Ltd, 2011.
3.	Subramanya. K., "Fluid Mechanics and Hydraulic Machines", Tata McGraw Hill Publishing Company Ltd, 2011.

Reference Books:

1.	White, "Fluid Mechanics, 8 Ed", McGraw Hill India, 2017.
2.	Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics 8 th Edition", Wiley, 2016.

3.	Yunuscengel, John. M.cimbala, “Fluid Mechanics Fundamentals and Applications”, McGraw Hill, 2017.
4.	Som, S.K, Biswas.G and SumanChakraborty, “Introduction to Fluid Mechanics and Fluid Machines”, Tata McGraw Hill India, 2011.
5.	Dr.P.N.Modi, Dr.S.M.Seth, “Hydraulics and Fluid Mechanics including Hydraulic Machines”, Standard book house, 2018.
E-References:	
1.	NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video sources on fluid mechanics.

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom’s Taxonomy Mapped**
CO1	Understand the basic concepts and properties of fluids.	Remember
CO2	Analyze the kinematic and dynamic concepts of fluid flow.	Analyze
CO3	Understand the various incompressible fluid flow through pipes and between parallel plates.	Understand
CO4	Apply the principles of fluid mechanics to design and operation of hydraulic turbines.	Apply
CO5	Apply the principles of fluid mechanics to design and operation of hydraulic pumps.	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1				2				1		2	2	1
CO2	3	3	1		2								2	2	1
CO3	2	3	2	2	1								2	2	1
CO4	3	3	3	2	1	2	1						2	2	1
CO5	3	3	3	2	1	2	1						2	2	1
Avg	**2.8**	**2.6**	**2**	**2**	**1.25**	**2**	**1.3**				**1**		**2**	**2**	**1**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEMI03	MANUFACTURING PROCESSES					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
1. Basic science, Engineering mathematics, Engineering Physics 2. Engineering Materials		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To make the students familiarize with various manufacturing processes and fabrication techniques of metals and design of casting.
2.	To develop design concepts of various manufacturing processes.
3.	Gain knowledge to select appropriate manufacturing processes for various parts.
4.	To develop an entrepreneur skill among the students.
5.	To evaluate and select plastic deformation processes for various parts.

UNIT I	**CASTING**	**9**	**0**	**0**	**9**

Concepts of Manufacturing Process -Sand casting -Patterns – Design of Pattern, mould and cores- gating and risering design, solidification time calculation - Moulding machines - Core making. Special moulding processes – CO2 moulding; shell moulding, investment moulding, pressure die casting, centrifugal casting, casting defects.

UNIT II	**WELDING**	**9**	**0**	**0**	**9**

Classification of welding processes. Principles of Oxy-acetylene gas welding. Metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermit welding, electron beam welding, laser beam welding, defects in welding, Soldering and Brazing, Adhesive Bonding.

UNIT III	**METAL FORMING**	**10**	**0**	**0**	**10**

Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, load estimation of bulk deformation processes, Hot working and cold working of metals, Forging processes – open, closed and impression die forging – forging operations. Rolling of metals– Types of Rolling mill – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types.

UNIT IV	**SHAPING OF PLASTICS**	**8**	**0**	**0**	**8**

Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – Blow moulding – Rotational moulding – Film blowing – Extrusion - Typical industrial applications – Thermoforming – Processing of Thermosets – Working principles and typical applications - Compression moulding – Transfer moulding.

UNIT V	**SHEET METAL FORMING AND POWDER METALLURGY**	**9**	**0**	**0**	**9**

Formability of Sheet Metal, load estimation of sheet metal processes - Shearing, Deep drawing, Bending operations- types of presses used, Super Plastic forming; Introduction to Powder Metallurgy– Principal steps involved – sintering and compacting techniques, Advantages, limitations and applications of powder metallurgy.

Total (45L) = 45 Periods

Text Books:

1.	HajraChoudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.
2.	NagendraParashar B.S. and Mittal R.K., "Elements of Manufacturing Processes", Prentice-Hall of India Private Limited, 2007.

Reference Books:

1.	Serope Kalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", 4/e, Pearson Education, Inc. 2007.
2.	Jain. R.K., and S.C. Gupta, "Production Technology", 16th Edition, Khanna Publishers, 2001.

3.	"H.M.T. "Production Technology – Handbook", Tata McGraw-Hill, 2000.
4.	Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.
5.	Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
E-References:	
1.	https://fdocuments.in/document/production-technology-55844cac00bfc.html?page=40

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Describe the operational features of various casting processes, design gate and riser and discover various defects in casting.	Understand
CO2	Explain various metal joining processes and compare them.	Understand
CO3	Summarize several types of metal forming processes and select suitable method for different applications.	Analyze
CO4	Analyze various manufacturing methods for plastics and their needs in industry.	Analyze
CO5	Describe various sheet metal forming processes, load estimation calculation and principles of powder metallurgy	Understand

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	1						1			1	2	1
CO2	2	1	2	1		1			1	1			1	2	1
CO3	1	1	1	1						1			1	1	1
CO4	1	1	1		1					1			1	1	1
CO5		1							1	1			1		1
Avg	**1.5**	**1**	**1.5**	**1**	**1**	**1**			**1**	**1**			**1**	**1.5**	**1**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEMI04	MATERIALS ENGINEERING					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
1. Engineering Physics 2. Engineering Chemistry		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart concept on reactions, treatment, microstructure and mechanical behavior of engineering materials at different temperature.
2.	To learn basic principles in metallurgy and materials engineering.
3.	To identity and select suitable engineering materials based on their applications.

UNIT I	**PHASE DIAGRAMS**	**9**	**0**	**0**	**9**

Crystal structures, Phases, solid solution types, compounds, Hume- Rothery rules; Gibb's phase rule; Binary isomorphous alloy systems – Eutectic, Eutectoid, Peritectic systems. Lever rule, Equilibrium and non-equilibrium cooling, Fe-C Equilibrium diagram - effects of alloying elements – Ferrite and Austenite Stabilizers, TTT and CCT diagrams.

UNIT II	**HEAT TREATMENT**	**9**	**0**	**0**	**9**

Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalizing, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburising, nitriding, cyaniding, carbo-nitriding – Flame and Induction hardening. Heat treatment of non-ferrous alloys - precipitation hardening. Heat treatment of HSS tools, gears, springs and gauges.

UNIT III	**FERROUS AND NON FERROUS METALS**	**9**	**0**	**0**	**9**

Plain carbon steels – Tool steels - maraging steels – HSLA steels .Stainless steels- ferritic and Austenitic, martensitic, duplex and precipitation hardened stainless steels. Types of Cast Irons- Gray cast iron, white cast iron, malleable cast iron, S.G.Iron. Copper alloys – Brass, Bronze and Cupronickel, Aluminium alloys, Bearing alloys.

UNIT IV	**MECHANICAL PROPERTIES AND TESTING**	**9**	**0**	**0**	**9**

Mechanical properties of engineering materials - Mechanisms of plastic deformation, slip and twinning – Creep, Fatigue and Fracture - Types of fracture – Testing of materials - tension, compression and shear loads - fatigue and creep tests – hardness and its effects – testing for hardness (Brinell, Vickers and Rockwell) - Impact test - Izod and Charpy.

UNIT V	**NON DESTRUCTIVE TESTING AND SURFACE ENGINEERING**	**9**	**0**	**0**	**9**

Non Destructive Testing: Basic principles - Testing method - Radiographic testing, Ultrasonic testing, Magnetic Particle Inspection and Liquid Penetrant Inspections. Introduction to surface engineering - Definition, diffusion techniques, deposition methods, high and low energy beam methods, surface engineering charts, elastic contact mechanics.

Total (45L) = 45 Periods

Text Books:

1.	Kenneth G. Budinski and Michael K. Buinski, "Engineering Materials", Prentice Hall of India Ltd, 2002.
2.	Raghavan, V, "Materials Science and Engineering", Prentice Hall of India (P) Ltd., 1999.
3.	Aswani.K.G, "A Text Book of Material Science", S.Chand and Co. Ltd., New Delhi, 2001.
4.	Khanna O.P., "A Text Book of Materials Science and Metallurgy", DhanpatRai Sons, 2004.

Reference Books:

1.	William. D.Callsber, "Material Science and Engineering", John Wiley and Sons, 1997.
2.	Sydney.H.Avner, "Introduction to Physical Metallurgy" Mc Graw Hill Book Company, 1994.

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		Bloom's Taxonomy Mapped
CO1	Understand the formation of materials and their classification based on atomic structure.	Understand
CO2	Understand the principles of various heat treatment processes in fabrication industry.	Understand
CO3	Describe properties, applications and types of various ferrous and non-ferrous metals used in fabrication industry	Understand
CO4	Describe various types of failure and select methods for destructive testing	Understand
CO5	Select methods for non destructive testing	Evaluate

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	1	1						2	3	1
CO2	1		2	1	1	2	1						2	3	1
CO3		1	1	1	1		1						3	2	1
CO4		2	2	1	1	1	1						2	3	1
CO5		2	2	2	1		1						2	2	1
Avg	**1**	**1.5**	**1.8**	**1.4**	**1.0**	**1.3**	**1**						**2.2**	**2.6**	**1.0**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEMI05	KINEMATICS OF MACHINERY					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
1. Engineering graphics. 2.Engineering Mechanics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the basic components and layout of linkages in the assembly of a system/ machine.
2.	To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
3.	To understand basics of cam profile and its displacement.
4.	To understand the basic concepts of toothed gearing and kinematics of gear trains.
5.	Illustrate the effects of friction drives in transmission system.

UNIT I	**BASICS OF MECHANISMS**	**9**	**0**	**0**	**9**
Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider-crank chains Limit positions- Mechanical advantage - Transmission angle- Description of some common mechanisms- Quick return mechanism, straight-line generators.					
UNIT II	**KINEMATIC ANALYSIS**	**9**	**0**	**0**	**9**
Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres - kinematic analysis of simple mechanisms- slider-crank mechanism dynamics Coincident points- Coriolis component of acceleration introduction to linkage synthesis three Position graphical synthesis for motion and path generation.					
UNIT III	**KINEMATICS OF CAM**	**9**	**0**	**0**	**9**
Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical method for cam profile design.					
UNIT IV	**GEARS AND GEAR TRAINS**	**9**	**0**	**0**	**9**
Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference / undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.					
UNIT V	**FRICTION IN MACHINE ELEMENTS**	**9**	**0**	**0**	**9**
Surface contacts- sliding and rolling friction- friction drives- friction in screw threads – bearings and lubrication- friction Clutches- belt and rope drives.					
Total (45L) = 45 Periods					

Text Books:	
1.	Rattan S.S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1998.
2.	Ghosh, A and Mallick, A.K, "Theory of Mechanisms and Machines", East-West Pvt. Ltd., New Delhi, 1988.
Reference Books:	
1.	Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2.	Rao J.S and Dukkipati R.V, "Mechanism and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
3.	Erdman AG and Sandor G N, "Mechanism Design, Analysis and Synthesis", Vol.I, PHI Inc., 1997.
4.	Ambekar A.G, "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007.

5.	John Hannah and Stephens R C, “Mechanisms of Machines”, Viva Low Price Student Edition, New Delhi, 1999.
E-References:	
1.	https://archive.nptel.ac.in/courses/112/104/112104121/
2.	https://nptel.ac.in/courses/112106270
3.	http://velhightech.com/Documents/ME8492 Kinematics of Machinery.pdf

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom’s Taxonomy Mapped**
CO1	Demonstrate and understand the concepts of various mechanisms and pairs.	Apply
CO2	Analyze the velocity and acceleration of simple mechanisms.	Analyze
CO3	Construct the cam profile for various motion.	Create
CO4	Solve problems on gears and gear trains.	Evaluate
CO5	Evaluate the friction in transmission system	Evaluate

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1									3	1	
CO2	3	2	2	1									3	1	
CO3	3	2	2	1									3	1	
CO4	3	2	2	1									3	1	
CO5	3	2	2	1									3	1	
Avg	**3**	**2**	**2**	**1**									**3**	**1**	
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEMI06	HYDRAULICS AND PNEUMATICS					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To enable the students understand the basics of hydraulics and pneumatics
2.	Applying the working principles of hydraulic actuators and control components.
3.	Designing and develop hydraulic circuits and systems.
4.	Applying the working principles of pneumatic power system and its components.
5.	Solving problems and troubles in fluid power systems.

UNIT I	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	9	0	0	9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque - Problems, Sources of Hydraulic power; Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps – Problems.

UNIT II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	9	0	0	9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary actuators - Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories; Reservoirs, Pressure Switches – Filters – types and selection - Applications – Fluid Power ANSI Symbols – Problems.

UNIT III	HYDRAULIC CIRCUITS AND SYSTEMS	9	0	0	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double - Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail - Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits – Servo and Proportional valves – Applications - Mechanical, hydraulic servo systems.

UNIT IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	9	0	0	9

Properties of air – Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – classification - single cylinder and multi cylinder circuits - Cascade method – Integration of fringe circuits, Electro Pneumatic System – Elements – Ladder diagram – timer circuits problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V	DESIGN OF FLUID POWER CIRCUITS AND TROUBLESHOOTING	9	0	0	9

Servo systems, Hydro mechanical servo systems, electro hydraulic servo systems and proportional Valves, Introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits, failure and troubleshooting. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low cost Automation – Hydraulic and Pneumatic power packs. Case studies: A simple sequence, synchronize circuits using hydraulic and pneumatics components.

Total (45L) = 45 Periods

Text Books:

1.	Manjumdar S.R, "Oil Hydraulics", Tata McGraw-Hill, December 2002.
2.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2013.

Reference Books:

1.	Andrew Parr, “Hydraulic and Pneumatics”, Jaico Publications House, 2005.
2.	Bolton W. “Pneumatic and hydraulic system”, Butterworth-Heinemann 1997
3.	Majumdar S.R., “Pneumatic systems – Principles and maintenance”, Tata McGraw Hill, 2010
4.	Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006
5.	Srinivasan.R. “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.
E-References:	
1.	http://www.fluidpowerjournal.com
2.	http://14.139.160.15/courses/112102011/2
3.	https://www.nfpa.com/home.htm

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Select the components as per the application	Evaluate
CO2	Apply the working principles of hydraulic actuators and control components.	Apply
CO3	Design and develop hydraulic circuits and systems.	Create
CO4	Apply the working principles of pneumatic power system and its components.	Apply
CO5	Solve problems and troubles in fluid power systems.	Evaluate

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1										1	1	1
CO2		2	2	1									1	1	1
CO3	1	2	3			1							1	2	1
CO4	1	1	3	2	2								2	1	1
CO5	1	1	2										1	1	1
Avg	**1.25**	**1.4**	**2.2**	**1.5**	**2**	**1**							**1.2**	**1.2**	**1**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEMI07	DESIGN OF MACHINE ELEMENTS					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
1. Student should study engineering mechanics. 2. Student should study kinematic of machinery.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	Understanding of background in mechanics of materials and design of machine components.
2.	An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
3.	An understanding the design of shafts and couplings.
4.	Familiarize the design of energy storing elements and engine components.
5.	An appreciation of the relationships between component level design and overall machine system design and performance

UNIT I	**STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS**	**9**	**0**	**0**	**9**

Introduction to the design process – Product development cycle- factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers– Direct, Bending and Torsional stress – Impact and shock loading – Calculation of principle stresses for various load combinations, eccentric loading – Factor of safety -theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations .

UNIT II	**DESIGN OF SHAFTS AND COUPLINGS**	**9**	**0**	**0**	**9**

Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of keys and key ways - Design of rigid and flexible couplings.

UNIT III	**DESIGN OF THREADED FASTENERS, RIVETED AND WELDED JOINTS**	**9**	**0**	**0**	**9**

Threaded fasteners - Design of bolted joints including eccentric loading – Design of riveted and welded joints for pressure vessels and structures- theory of bonded joints.

UNIT IV	**DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS**	**9**	**0**	**0**	**9**

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting rods and crank shafts.

UNIT V	**DESIGN OF BEARINGS**	**9**	**0**	**0**	**9**

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number - Selection of Rolling Contact bearings.

Total (45L) = 45 Periods

Text Books:

1.	Bhandari V.B, "Design of Machine Elements", Tata McGraw Hill Book Co, 2020
2.	Md.Jalaludeen.S, "A text book of Machine Design", Anuradha Publications, 2006

Reference Books:

1.	Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2.	Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3.	Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4.	PSG Tech, "Design Data Handbook", M/s.DPV Printers, Coimbatore, 2009

E-References:	
1.	https://nptel.ac.in/courses/112105124
2.	Design of Machine Elements - V. B. Bhandari - Google Books
3.	A Textbook of Machine Design by R.S.Khurmi And J.K.Gupta [tortuka]_1490186411865.pdf | DocDroid

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the influence of steady and variable stresses in machine component design.	Understand
CO2	Apply the concepts of design to shafts, keys and couplings.	Apply
CO3	Familiarize the design of temporary and permanent joints.	Understand
CO4	Design the various energy storing elements and engine components.	Analyse
CO5	Familiarize the design of various types of bearings.	Understand

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	2		1	1				1		3	2	1
CO2	2	2	1	2		1	1				1		3	2	1
CO3	2	2	1	2		1	1				1		3	2	1
CO4	2	2	1	2		1	1				1		3	2	1
CO5	2	2	1	2		1	1				1		3	2	1
Avg	**2.0**	**2.0**	**1.0**	**2.0**		**1.0**	**1.0**				**1.0**		**3.0**	**2.0**	**1.0**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MEMI08	HEAT AND MASS TRANSFER					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
1.The laws and basic concepts of thermodynamics 2. The concept of energy transfers and their conversion principles		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

COURSE OBJECTIVES	
1.	Understanding the science behind conduction heat transfer and its applications.
2.	Differentiating the concepts of forced and natural convection heat transfer.
3.	Describing the laws and concepts of radiation heat transfer.
4.	Understanding phase change processes and analyzing heat exchangers.
5.	Studying the concept of mass transfer process and its modes.

UNIT-I	**CONDUCTION HEAT TRANSFER**	**9**	**0**	**0**	**9**
General Differential equation – Cartesian(derivation of General Differential Equation), Cylindrical (derivation of General Differential Equation) and Spherical Coordinates – One DimensionalSteady State Heat-Concepts of electrical analogy, Conduction –– plane and Composite Systems – Conduction with Internal HeatGeneration., Critical thickness of insulation. Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infiniteand Infinite Solids –Use of Heisler's charts.					
UNIT-II	**CONVECTION HEAT TRANSFER**	**9**	**0**	**0**	**9**
Conservation equations, boundary layer concept – Forced convection: external flow – flow over plates, cylinders, spheres and bank of tubes. Internal flow – entrance effects. Free convection –flow over vertical plate, horizontal plate, inclined plate, cylinders and spheres.					
UNIT-III	**BOILING, CONDENSATION AND HEAT EXCHANGERS**	**9**	**0**	**0**	**9**
Regimes of Pool boiling and Flow boiling, Nusselt's theory of condensation- correlations in boiling and condensation. Heat Exchanger types - Overall Heat Transfer Co-efficient – Fouling Factors. LMTD and NTU methods.					
UNIT-IV	**RADIATION HEAT TRANSFER**	**9**	**0**	**0**	**9**
Radiation laws - Black Body and Gray body Radiation - Shape Factor - Electrical Analogy -Radiation Shields.					
UNIT-V	**MASS TRANSFER**	**9**	**0**	**0**	**9**
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion - Equimolal counter diffusion. Basic Convective Mass Transfer Problems.					
					Total(45L) = 45 Periods

TEXT BOOKS:	
1	R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2017
2	Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014.
REFERENCE BOOKS:	
1	Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5 th Edition - 2013
2	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2017
3	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012
4	Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.

COURSE OUTCOMES: On completion of the course the student will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the mechanism of heat conduction under steady and transient conditions.	Apply
CO2	Develop solutions to problems involving convective heat transfer.	Create
CO3	Design a heat exchanger for any specific application.	Understand
CO4	Adopt the concept of radiation heat transfer in real time systems.	Understand
CO5	Develop solutions to problems involving combined heat and mass transfer.	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	2		1						3	3	1
CO2	3	3	3	3	2		1						3	3	1
CO3	3	3	3	3	2		1						3	3	1
CO4	3	3	3	3	2		1						3	2	1
CO5	2	2	2	2	1		1						3	1	
Avg	**2.8**	**2.8**	**2.8**	**2.8**	**1.8**		**1**						**3**	**2.4**	**1**

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MEMI09	METROLOGY AND QUALITY CONTROL					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Horus/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

COURSE OBJECTIVES	
1.	Explaining the importance of measurements in engineering and the factors affecting measurements and to compute measurement uncertainty
2.	Applying the applications of linear and angular measuring instruments
3.	Interpretation of various tolerance symbols.
4.	Applying the SQC methods in manufacturing.
5.	Applying the advances in measurements for quality control.

UNIT-I	**BASICS OF MEASUREMENT SYSTEM AND DEVICES**	**9**	**0**	**0**	**9**
Definition of metrology, accuracy, precision and sensitivity, Abbe‘s principle. Three stages of generalized measurement system - mechanical loading – static characteristics of instruments – factors considered in selection of instruments - commonly used terms, error analysis and classification - sources of error. Measurement uncertainty.					
UNIT-II	**CALIBRATION OF INSTRUMENTS AND QUALITY STANDARDS**	**9**	**0**	**0**	**9**
Calibration of measuring instruments - principles of calibration, Calibration of Instruments - Vernier caliper, Micrometer, feeler gauges, dial indicator, surface plates, slip gauges, care of gauge blocks. General cares and rules in measurement, ISO 9000 quality standards. Comparators- mechanical, electrical, optical and pneumatic.					
UNIT-III	**GEOMETRICAL MEASUREMENT AND MACHINE ELEMENTS**	**9**	**0**	**0**	**9**
Angular measurement - optical protractors, sine bar, roundness measurement, limit gauge, design of plug gauge, Taylor‘s principle, three basic types of limit gauges, Tomlinson surface meter, computer controlled CMM. ISO metric thread, measurement of major, minor and effective diameters. Gear terminology; spur gear measurement, checking of composite errors, base pitch measurement. Principle of interferometry, laser interferometer, Machine vision, Fundamental of GD&T. Inspection of straightness, flatness, roundness deviations.					
UNIT-IV	**STATISTICAL QUALITY CONTROL**	**9**	**0**	**0**	**9**
Surface finish – terminology and measurements – Optical measuring instruments –Acceptance test for machines. Statistical Quality Control - Control charts - Sampling plans.					
UNIT-V	**SIX SIGMA**	**9**	**0**	**0**	**9**
Six sigma: Define measure, analyse, improve and control phases. Analyze phase tools: CommonTools: Histogram, Box Plot, Control chart, Scatter chart, Cause and effect diagram, Pareto analysis, interrelations diagram. Special Tools: Regression Analysis, Hypothesis Testing, ANOVA Multi variate analysis.					
					Total(45L) = 45 Periods

TEXT BOOKS:	
1	Gupta.I.C, ―A text book of Engineering Metrology, Dhanpat Rai publications, New Delhi, 2018
2	Beckwith.T.G, Roy D. Marangoni, John H. Lienhard, - Mechanical Measurements‖, Prentice Hall, 2006
REFERENCE BOOKS:	
1	Jain.R.K, ―Mechanical and Industrial Measurements, Khanna Publishers, Delhi, 1999.
2	Holmen.J.P, ―Experimental Methods for Engineers‖, Tata McGraw Hill Publications Co Limited, 2017.

3	Grant, E.L., Statistical Quality Control, Mc Graw-Hill, 2004. 3. Doeblin E.O., Measurement Systems, Mc Graw-Hill, 2004.
4	Alan S Morris, ―Measurement and Instrumentation Principles, Butterworth, 2006.
5	De Feo J A and Barnard W W, ―Six Sigma: Break trough and BeyondG, Tata McGraw-Hill, New Delhi, 2005.
E-REFERENCES:	
1	https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_405_Book_2,_for_Unit_2B.pdf
2	https://www.nist.gov/system/files/documents/srm/NIST-SRM-RM-Articlefinal.pdf
3	https://www.researchgate.net/publication/319587859_Computer-Aided_Metrology-CAM

COURSE OUTCOMES: On completion of the course the student will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the importance of measurements in engineering and the factors affecting measurements and to compute measurement uncertainty.	Understand
CO2	Apply the working principle and the applications of linear and angular measuring instruments.	Apply
CO3	Interpret of various tolerance symbols.	Apply
CO4	Apply the SQC methods in manufacturing.	Apply
CO5	Apply the advances in measurements for quality control in manufacturing industries.	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1							2	1	2				2	1	
CO2							3	1	2				1	2	
CO3							2	1					2	1	
CO4				3			2		1				1	2	
CO5				2				3	1				2	1	
Avg				**2.5**			**2.25**	**1.5**	**1.5**				**1.6**	**1.4**	

3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)

22MEMI10	DYNAMICS OF MACHINERY						
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Engineering Mechanics, Kinematics of Machinery, Strength of Materials		**Hours\Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

COURSE OBJECTIVES:

1.	To impart students with the knowledge about motion, masses and forces in machines and the Principle of Virtual Work.
2.	To facilitate the students, to understand the concept of balancing of rotating and reciprocating masses.
3.	To teach concepts of free vibration analyses of one and two degree-of-freedom rigid body systems
4.	To teach concepts of forced vibrations analyses of rigid body systems and to give awareness to students on the phenomenon of vibration and its effects.
5.	To learn about the concept of various types of governors.

UNIT I	**FORCE ANALYSIS**	**9**	**0**	**0**	**9**
Static Force Analysis, Free Body Diagrams, Conditions of Two, Three and Four Force Members. Inertia Forces and D'Alembert's Principle – Inertia Force Analysis in Reciprocating Engines – Crank Shaft Torque. Flywheels – Turning Moment Diagrams and Fluctuation of Energy of reciprocating engine mechanisms, Coefficient of Fluctuation of Energy and Speed, Weight of Flywheel Required.					
UNIT II	**BALANCING**	**9**	**0**	**0**	**9**
Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine - Balancing Multi-cylinder Engines - Partial balancing in locomotive Engines - Balancing linkages - balancing machines					
UNIT III	**FREE VIBRATION**	**9**	**0**	**0**	**9**
Basic Features of Vibratory Systems – Types – Single Degree of Freedom System – Transverse Vibration of Beams – Natural Frequency by Energy Method, Dunkerly's Method - Critical Speed - Damped Free Vibration of Single Degree Freedom System -Types of Damping – Free Vibration with Viscous Damping, Critically Damped System, Under Damped System. Torsional Systems: Natural Frequency of Two and Three Rotor Systems.					
UNIT IV	**FORCED VIBRATION**	**9**	**0**	**0**	**9**
Response to Periodic Force – Harmonic Force – Force caused by Unbalance – Support Motion - Logarithmic Decrement- Magnification Factor – Vibration Isolation and Transmissibility.					
UNIT V	**GOVERNORS**	**9**	**0**	**0**	**9**
Governors - Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors – Characteristics - Effect of friction - Controlling Force - other governor mechanisms.					
					Total (45L) = 45 Periods

TEXT BOOKS:

1.	Design of Machinery, Fourth Edition, by R.L. Norton, McGraw Hill, 2007
2.	Mechanical Vibration, V.P.Singh, Dhanpatrai, Delhi

REFERENCE BOOKS:

1.	Ballaney, P.L., "Theory of Machines and Mechanisms", Khanna Publishers, New Delhi, 2002.
2.	Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", TMH ND, 1998.
3.	Amithabha Ghosh, and Ashok Kumar Malik., "Theory of Mechanisms and Machines", 2nd Ed., Affiliated East and West Press Limited, 1998.
4.	Prof.Nakara, IIT-Delhi Reference Books

E-REFERENCES:	
1.	www.university.youth4work.com/IIT_Kharagpur_Indian-Institute-of-Technology/study/1653-dynamics-of-Machinery-ebook
2.	http://nptel.ac.in/courses/112104114/

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Apply basic principles of mechanisms in mechanical system.	Apply
CO2	Familiarize the static and dynamic analysis of simple mechanisms.	Understand
CO3	Analyze the mechanical systems subjected to free vibration.	Analyze
CO4	Analyze mechanical systems subjected to forced vibration.	Analyze
CO5	Analyze the various types of governors and its speed control mechanism.	Analyze

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	3	1					1		3	2	1	2
CO2	2	2	3	2	1					1		3	2	1	2
CO3	2	2	3	2						1		3	2	1	2
CO4	2	2	3	2	1					1		3	2	1	2
CO5	1	2	3	2						1		3	2	1	1
Avg	**1.8**	**2.0**	**3.0**	**2.2**	**1**					**1.0**		**3.0**	**2.0**	**1.0**	**1.8**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

22MTM101	ADVANCED PHYSICAL METALLURGY		Semester			
PREREQUISITES		Category	OE	Credit		3
Engineering physics		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To impart knowledge on the crystal structure, diffusion, phase diagrams for various engineering materials.

Unit I	CRYSTAL STRUCTURES	9	0	0	9

Review of atomic bonds, Lattice, unit cell, crystal systems and Bravais lattices; Principal crystal structures – BCC, FCC, HCP and its characteristics; Miller indices for crystallographic planes and directions, interplanar spacing; Volume, planar and linear atomic density; Polymorphism and allotropy; CsCl, NaCl, Diamond structures; single crystal and polycrystalline and amorphous materials; isotropy and anisotropy; Simple problems in the above topics

Unit II	CRYSTALLINE IMPERFECTIONS	9	0	0	9

Types of point defects, effect of temperature on vacancy concentration, interstitial sites-octahedral and tetrahedral sites; Line defects – dislocations – Edge, screw and mixed dislocations, Burger's vector, slip and twinning; Planar defects – grain boundaries, tilt boundaries, small angle grain boundaries; ASTM grain size number, grain size determinations; Volume defects; Simple problems in the above topics.

Unit III	ATOMIC DIFFUSION IN SOLIDS AND SOLIDIFICATION OF METAL	9	0	0	9

Diffusion mechanisms, steady state diffusion and non-steady state diffusion-Fick's first law and second law; Kirkendall effect and Darken's equation; Factors affecting diffusion; Industrial applications of diffusion processes; Simple problems in the above topics; Basic principles of solidification of metals and alloys; Growth of crystals– Planar growth, dendritic growth, Solidification time, dendrite size; Cooling curves; Cast or Ingot structure, Solidification defects – Control of casting structure; Directional solidification – single crystal growth; Simple problems in the above topics.

Unit IV	PHASE DIAGRAMS	9	0	0	9

Phases, solid solution types, compounds, Hume- Rothery rules; Gibb's phase rule; Phase diagram determination; Binary isomorphous alloy systems – composition and amount of phases, development of microstructure – equilibrium and non-equilibrium cooling- Coring and its effects, homogenization; Binary eutectic system - composition and amount of phases, development of microstructure; Eutectoid, Peritectic and monotectic reaction, Phase diagrams with intermediate phases and compounds; Ternary phase diagrams. Simple problems in the above topics.

Unit V	IRON-CARBON PHASE DIAGRAM	9	0	0	9

Iron-carbon diagram, Phases in Fe-C system, Invariant reactions, Microstructure of slowly cooled steels, composition and amount of phases, Effect of Alloying elements on Fe-C system, Type, structure, properties and applications of Plain Carbon Steels and different types of Cast iron; IS Specification for Steels and Cast Irons, Simple problems in above topics.

Total (45+0) = 45 Hours

Text Books:

1	Donald R. Askeland,"The Science and Engineering of Materials", Thomson Learning, India Edition, 2007.
2	William D.Callister, "Materials Science and Engineering – An Introduction", 4th edition, JohnWiley & Sons, New York, USA, 1997.

Reference Books:	
1	Avner S H.”An Introduction to Physical Metallurgy”, McGraw Hill Book Co, New York, USA, 1997.
2	Donald R Askeland,” Essentials of Material Science and Engineering “, Thomson Learning, India Edition, 2007
3	Raghavan V., “Physical Metallurgy – Principles and Practice”, Prentice Hall of India Ltd., New Delhi, 199.
4	William F.Smith, “Foundations of Materials Science and Engineering”, Second Edition, McGraw-Hill Inc, New York, 1993.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Describe the basic crystal structure, orientation and their influence on macroscopic properties.	L2: Understanding
CO2	:	Discuss the role of imperfections in strengthening the materials.	L2: Understanding
CO3	:	Diagonise the diffusion mechanism in solidification of materials under different conditions.	L4:Analysing
CO4	:	Apply the concept of phase diagrams in equilibrium transformation of materials phases.	L3:Applying
CO5	:	Construct the Fe-Fe_3C phase diagram and discuss various properties of steel and cast iron.	L3:Applying

<u>COURSE ARTICULATION MATRIX</u>

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1		1	
CO2	1	1				1	1						1			1
CO3	1	1	1	1		1							1	1		
CO4	1	1		1	1								1			
CO5	1	1		1									1			1
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTM102	THERMODYNAMICS AND KINETICS IN METALLURGY			Semester		
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
Engineering physics and Engineering chemistry		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Learning Objectives						
1	To learn the basic principles and concepts of thermodynamics in the field of Metallurgy and materials; and to learn about equations and their applications.					
Unit I	**FUNDAMENTAL CONCEPT AND INTERNAL ENERGY**		**9**	**0**	**0**	**9**
Introduction: System and surrounding, Classification of systems, Path and state properties, Thermodynamic processes, Thermodynamic equilibrium, Reversible and Irreversible processes. First law of thermodynamics: Heat and work, Internal energy, Heat capacity of materials, Cp-Cv relations, Nernst Equation, Enthalpy, Thermochemistry Hess's law, Kirchoff's law, Maximum flame temperature.						
Unit II	**ENTROPY AND AUXILARY FUNCTIONS**		**9**	**0**	**0**	**9**
Second law of thermodynamics: Carnot cycle, Entropy - Statistical interpretation of entropy, Free energy, Combined statement of first and second laws, Thermodynamic functions - Maxwell's relations, Gibbs Helmholtz equation. Third and Zeroth laws of thermodynamics : Definition, concept and applications						
Unit III	**THERMODYNAMIC POTENTIALS AND PHASE EQUILIBRIA**		**9**	**0**	**0**	**9**
Thermodynamic potentials: Fugacity, Activity and Equilibrium constant. Clausius - Clayperon equation, Troutons rule. Le Chatelier's principle, Vant Hoff's equation. Equilibria in phase diagrams: Phase rule, Phase stability, Thermodynamics of surfaces, interfaces and defects, P-G-T diagrams, Application of free energy - composition diagrams to the study of alloy systems.						
Unit IV	**THERMODYNAMICS OF SOLUTIONS**		**9**	**0**	**0**	**9**
Gibbs - Duhem equation, Partial and integral molar quantities, chemical potential, Ideal solutions - Raoult's law, Real solutions, Activity coefficient, Henry's law, Alternative standard states, Sievert's law, Mixing functions and excess functions, Regular solutions, Applications of Gibbs - Duhem equation.						
Unit V	**THERMODYNAMICS OF REACTIONS AND KINETICS**		**9**	**0**	**0**	**9**
Electro chemical process: Cells, Interconversion of free energy and electrical work, Determination of thermodynamic quantities using reversible cells, Solid electrolytic cells. Kinetics: First, Second and third order reactions, Arrhenius equation - activation energy, Determination of order of the reaction.						
						Total (45+0) = 45 Hours

Text Books:	
1	Upadhyaya G S andDube R K., "Problems in Metallurgical Thermodynamics & Kinetics",Pergamon, 1977.
2	Ahindra Ghosh, Text book of Materials & MetallurgicalThermodynamics, Prentice Hall India, 2002
3	. David R Gaskell, "Introduction to the Thermodynamics of Materials", Fifth Edition, Taylor & Francis, 2008

Reference Books:	
1	David V Ragone, "Thermodynamics of Materials - Volume-1", John Wiley & Sons, Inc. 1995.
2	Dr S.K Dutta,Prof A.B.Lele – Metallurgical thermodynamics kinetics and numericals,S.Chand& co Ltd.,New Delhi 2011
3	Darken LS and Gurry R W,"Physical Chemistry of Metals", CBS publications and distributors, 2002.
4	Parker R H, "An introduction to chemical metallurgy", Pergamon press, New York, second edition, 1978.
5	Kapoor M.L., "Chemical and Metallurgical Thermodynamics Vol. I and II", Nem Chand, 1st Ed., 1981

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the fundamental concepts of thermodynamics and internal energy	L2: Understanding
CO2	:	State the thermodynamics entropy and auxilary functions.	L2: Understanding
CO3	:	Identify the basic laws, chemical potential and phase equilibria.	L4:Analysing
CO4	:	Describe the thermodynamics of the solution and various important equations.	L2: Understanding
CO5	:	Apply to solve problems related to electrochemical processes and kinetics.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1	1		
CO2	1	1	1										1		1	
CO3	1	1		1	1								1			
CO4	1			1	1								1		1	1
CO5	1	1				1	1						1		1	
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTM103	MECHANICAL BEHAVIOUR OF MATERIALS		Semester			
PREREQUISITES			**OE**	**Credit**		**3**
Engineering physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Learning Objectives						
1	To know the fundamental concepts of deformation behaviour for structural engineering applications.					
Unit I	**DISLOCATIONS AND PLASTIC DEFORMATION**		**9**	**0**	**0**	**9**
Strength of perfect crystal and need for dislocations; Characteristics of dislocations – Edge dislocation, Screw dislocation, Burger's vector, mixed dislocation, dislocation loops; Movement of dislocation – Pierls stress, Cross slip, Climb; Dislocations in FCC, HCP and BCC lattice; Stress fields and energies of dislocations, forces on and between dislocations; Dislocation density; Intersections of dislocations – Jogs and kinks; Dislocation multiplication; Dislocation pile-ups; Deformation by slip and twinning; Critical resolved shear stress; Deformation bands and kink bands.						
Unit II	**STRENGTHENING MECHANISMS**		**9**	**0**	**0**	**9**
Strain hardening; Grain boundary strengthening; Solid solution strengthening - yield-point phenomenon, strain ageing; Precipitation hardening - Conditions for precipitation hardening, Ageing, Formation of precipitates, coarsening of precipitates, Mechanism of strengthening; Dispersion strengthening; Fiber strengthening; Martensite strengthening - examples for above strengthening mechanisms from ferrous and non-ferrous systems, Bauschinger effect; Preferred orientation; Sever plastic deformation.						
Unit III	**FRACTURE AND FRACTURE MECHANICS**		**9**	**0**	**0**	**9**
Types of fracture – ductile and brittle fracture, Ductile to Brittle Transition Temperature (DBTT), Metallurgical factors affecting DBTT, determination of DBTT, Hydrogen embrittlement and other embrittlement, Theoretical cohesive strength of metals, Griffith's theory of brittle fracture, Orowan's modification. Fracture mechanics - introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of KIC, introduction to COD, J integral.						
Unit IV	**FATIGUE BEHAVIOUR AND TESTS**		**9**	**0**	**0**	**9**
Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, HCF / LCF, thermo-mechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.						
Unit V	**CREEP BEHAVIOUR AND TESTS**		**9**	**0**	**0**	**9**
Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametetric methods of extrapolation. Deformation Mechanism Maps						
						Total (45+0) = 45 Hours

Text Books:	
1	George. E. Dieter, "Mechanical Metallurgy", 3rd Edition, McGraw-Hill Publications, New York, SI Edition, 2004

2	Marc Andr'e Meyers, Krishan Kumar Chawla, “Mechanical Behavior of Materials”, Cambridge University Press, UK, 2009.

Reference Books:	
1	Reed Hill, R.E., "Physical Metallurgy Principles", Affiliated East West Press, New Delhi, 1992.
2	Davis.H.E. Troxell G.E., Hauck.G.E.W. “The Testing of Engineering Materials”, McGraw-Hill, 1982.
3	Wulff et al Vol. III “Mechanical Behavior of Materials”, John Wiley and Sons, New York, USA, 1983.
4	Honeycombe R.W.K., “Plastic Deformation of Materials”, Edward Arnold Publishers, 1984

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Discuss the mechanical behaviour of materials.	L2: Understanding
CO2	:	Discuss the strengthening mechanisms of materials.	L2: Understanding
CO3	:	List the various types of fractures and their mechanisms, fracture mechanics and various theories describing fracture mechanics.	L2: Understanding
CO4	:	Discuss the fatigue behaviour and the mechanism of fatigue, SN curve and fatigue testing machines.	L2: Understanding
CO5	:	Describe the creep behaviour and mechanism, factors affecting creep and creep testing machines.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
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	1
CO5	1	1		1	1								1	1		
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22MTM104	RATE PROCESSES IN METALLURGY		Semester			
PREREQUISITES			**OE**	**Credit**		**3**
Engineering physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To learn the basic principles and concepts of kinetics in the domain of metallurgy and materials; to learn about equations and their applications; And to appreciate that metallurgical kinetics as a Knowledge base with abundant applications.

Unit	Title	L	T	P	TH
Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction: Role of kinetics, heterogeneous and homogeneous kinetics, Role of heat and mass transfer in metallurgical kinetics, rate expression, Effect of Temperature and concentration on reaction kinetics: effect of temperature (Arrhenius Equation), Effect of concentration (order of a reaction), significance and determination of activation energy.					
Unit II	**KINETICS OF SOLID-FLUID REACTION**	**9**	**0**	**0**	**9**
Kinetics of solid-fluid reaction: kinetic steps, rate controlling step, definition of various resistances in series, shrinking core model, chemical reaction as rate controlling step, Product layer diffusion as rate controlling step, Mass transfer through external fluid film as rate controlling step, heat transfer as the rate controlling step, Concentration boundary layer, definition and significance of heat and mass transfer coefficient, Theoretical models for mass transfer coefficients, Correlations for heat and mass transfer coefficients					
Unit III	**LIQUID-SOLID PHASE TRANSFORMATION**	**9**	**0**	**0**	**9**
Principles of Solidification in metals and alloys: thermodynamics involved, eutectic and peritectic Solidification, Homogeneous and heterogeneous nucleation, Mechanisms of growth. Rapid Solidification Processing.					
Unit IV	**SOLID STATE PHASE TRANSFORMATIONS**	**9**	**0**	**0**	**9**
Nucleation and growth Kinetics, homogeneous and heterogeneous transformation, Precipitation: Coherency, age hardening, particle Coarsening. Ostwald ripening, Order-disorder transformation, spinodal decomposition, massive transformations					
Unit V	**SOLID STATE PHASE TRANSFORMATIONS IN STEEL**	**9**	**0**	**0**	**9**
Reconstructive and displacive transformations; Pearlitic transformation: mechanism and kinetics: Johnson-Mehl equation, morphology of pearlite; Bainitic transformation: mechanism and kinetics; morphology of upper bainite and lower bainite; Martensitic transformation: Mechanism- diffusionless displacive nature; morphology of high carbon and low carbon martensite.					
					Total (45+0) = 45 Hours

Text Books:	
1.	Ahindra Ghosh and Sudipto Ghosh, A Text book of Metallurgical Kinetics, PHI learning Pvt. Ltd., New Delhi, 2014
2.	H.S. Ray, Kinetics of Metallurgical Reactions, International Science publisher, 1993.
3.	F. Habashi, Kinetics of Metallurgical Processes, Metallurgy Extractive Québec, 1999.
4.	Upadhyaya G S and Dube R K., "Problems in Metallurgical Thermodynamics & Kinetics", Pergamon, 1977.

Reference Books:	
1.	Phase transformations in metals and alloys- D.A. Potter and K.E. Easterling, CRC Press, 1992. 2. Transformations in Metals, P.G. Shewmon, Mc-Graw Hill, 1969.
2.	Introduction to Physical Metallurgy – S. N. Avner, Tata McGraw Hill, 1997.
3.	Physical Metallurgy Principles, R. E. Reed-Hill and R. Abbaschian, 3rd ed, PWS-Kent Publishing, 1992.
4.	Modern Physical Metallurgy, R. E. Smallman, Butterworths, 1963

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the thermodynamic aspects of phase changes.	L2: Understanding
CO2	:	Discuss the fundamentals of solid –fluid reactions.	L2: Understanding
CO3	:	Explain the eutectic and peritectic solidifications and rapid solidification processes.	L2: Understanding
CO4	:	Describe the fundamentals of solidification.	L1: Remembering
CO5	:	Apply the solid state phase transformations in steel.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
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		1
CO5	1		1			1	1								1	1
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTM105	CORROSION AND SURFACE ENGINEERING		Semester			
PREREQUISITES			OE	Credit		3
Engineering chemistry		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the corrosion and surface engineering, with its application in engineering field.

Unit I	MECHANISMS AND TYPES OF CORROSION	9	0	0	9

Principles of direct and Electro chemical Corrosion, Hydrogen evolution and Oxygen absorption mechanisms – Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitations, Crevice Fretting, Erosion and Stress Corrosion, corrosion fatigue, hydrogen damage –Factors influencing corrosion

Unit II	TESTING AND PREVENTION OF CORROSION	9	0	0	9

Corrosion testing techniques and procedures- Corrosion Testing ASTM Standards, Pitting Corrosion Test, Hydrogen Induced Cracking Test, Sulphide Stress Corrosion Cracking Test- Prevention of Corrosion-Design against corrosion –Modifications of corrosive environment –Inhibitors – Cathodic Protection –Special surfacing processes.

Unit III	CORROSION OF INDUSTRIAL COMPONENTS	9	0	0	9

Corrosion in fossil fuel power plants, Automotive industry, Chemical processing industries, corrosion in petroleum production operations and refining, Corrosion of pipelines- wear of industrial components.

Unit IV	SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE	9	0	0	9

Diffusion coatings –Electro and Electroless Plating –Hot dip coating –Hard facing-Metal spraying, Flame and Arc processes- Conversion coating –Selection of coating for wear and Corrosion resistance.

Unit V	THIN LAYER ENGINEERING PROCESSES	9	0	0	9

Laser and Electron Beam hardening –Effect of process variables such as power and scan speed - Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating-Properties and applications of thin coatings.

Total (45+0) = 45 Hours

Reference Books:

1.	Fontana. G., Corrosion Engineering, McGraw Hill,1985.
2.	Kenneth G. Budinski, Surface Engineering for Wear Resistance, Prenticehall,1992.
3.	ASM Metals Hand Book –Vol. 5, Surface Engineering,1996.
4.	Denny A Jones, “Principles and prevention of corrosion”, 2ndedition, Prentice Hall, New Jersey,1995.
5.	ASM International, Surface Engineering for Corrosion and Wear Resistance,2005.
6.	Schweitzer. P.A., Corrosion Engineering Hand Book, 3rd Edition, Marcel Decker, 1996.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Name the different types of corrosion and their mechanism.	L2: Understanding
CO2	:	Estimate corrosion resistance by different tests.	L4:Analysing
CO3	:	Explain the corrosion behavior of different metals in different industries.	L2: Understanding
CO4	:	Classify the different forms of processing techniques of surface engineering materials.	L1: Remembering
CO5	:	Select the type of deposition and spraying technique.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1	1		
CO2	1	1		1		1							1	1		
CO3	1	1	1	1			1								1	1
CO4	1	1		1	1										1	1
CO5	1	1		1	1								1	1		
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

<table>
<tr><td>22MTM106</td><td colspan="2">MATERIALS CHARACTERIZATION</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="2">PREREQUISITES</td><td></td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Engineering physics</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To acquire knowledge on various characterizations, chemical and thermal analysis of metallurgical components using its analysis tools.</td></tr>
<tr><td>Unit I</td><td colspan="2">OPTICAL MICROSCOPY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Metallographic specimen preparation. Macro-examination -applications. Metallurgical microscope - principle, construction and working, , Optic properties - magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources, lens aberrations and their remedial measures, Various illumination techniques-bright field , dark field, phase-contrast, polarized light illuminations, interference microscopy, high temperature microscopy; Quantitative metallography – Image analysis.</td></tr>
<tr><td>Unit II</td><td colspan="2">X-RAY DIFFRACTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Characteristic X-ray spectrum, Bragg's Law, Diffraction methods - Laue method, rotating crystal method and powder method. Diffraction intensity – structure factor calculation. X-ray diffractometer -general features, filters and counters. Applications of X-ray diffraction in materials characterisation – Determination of crystallite size, crystal structure, precise lattice parameter, measurement of stress.</td></tr>
<tr><td>Unit III</td><td colspan="2">ELECTRON MICROSCOPY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Electron beam - specimen interactions. Construction and operation of Transmission Electron Microscopy – Diffraction effects and image formation, various imaging modes, selected area diffraction, applications, specimen preparation techniques. Scanning electron microscopy – principle, equipment, various operating modes and applications, Electron probe microanalyser (EPMA)- principle, instrumentation, qualitative and quantitative analysis. Introduction to HRTEM, FESEM, EBSD.</td></tr>
<tr><td>Unit IV</td><td colspan="2">SPECTROSCOPIC TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">X-ray spectroscopy – EDS and WDS. Principle, instrumentation, working and applications of Auger Electron spectroscopy, X-ray photoelectron spectroscopy and Secondary ion mass spectroscopy / ion microprobe. Optical emission spectroscopy, Atomic Absorption spectroscopy and X-ray fluorescence spectroscopy - principle, construction, working and applications. UV-Vis, FTIR and Raman spectroscopy.</td></tr>
<tr><td>Unit V</td><td colspan="2">THERMAL ANALYSIS AND ADVANCED CHARACTERIZATION TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Thermal Analysis: Principles of differential thermal analysis, differential scanning calorimetry and thermo-graviometric analysis – Instrumentation and applications. Advanced characterization techniques: Scanning probe microscopy - STM and AFM - principle, instrumentation and applications. Field ion microscopy including atom probe - principles, instrumentation and applications.</td></tr>
<tr><td colspan="7">Total (45+0) = 45 Hours</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Cullity, B.D., Elements of X Ray Diffraction, Addison-Wesley Publishing Company Inc, Philippines, 1978</td></tr>
</table>

2.	Brandon, D. and W.D. Kaplan, Microstructural Characterization of Materials, John Wiley & Sons Ltd, England, 2013.
3.	Leng, Y., Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd, Singapore, 2008
Reference Books:	
1.	ASM Handbook, Volume 10, Materials Characterization, ASM international, USA, 1986.
2.	Vander Voort, G.F., Metallography: Principle and practice, ASM International, 1999.
3.	Phillips V A, Modern Metallographic Techniques and their Applications, Wiley Eastern, 1971.
4.	Angelo, P. C., Materials Characterization, Reed Elsevier India Pvt Ltd, Haryana, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the principles of metallurgical microscope, optical properties and various illumination techniques.	L2: Understanding
CO2	:	Analyze the various diffraction methods, X-ray diffractometer and determination of crystal parameter.	L4:Analysing
CO3	:	Discuss the principles of TEM, SEM, EPMA.	L2: Understanding
CO4	:	Explain various spectroscopic techniques,	L2: Understanding
CO5	:	Discuss the chemical and thermal analysis using advanced methods.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	`1		1	1								1		1	
CO2	1	1	1	1		1							1			1
CO3	1		1			1	1					1	1			1
CO4	1	1		1	1							1	1			1
CO5	1	1		1	1								1		1	
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0					1.0	1.0		1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22MTM107	AUTOMOTIVE, AEROSPACE AND DEFENCE MATERIAL		Semester			
PREREQUISITES			OE	Credit		3
Engineering physics		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the properties and applications various materials suitable for automobile, aircraft and defnce industries and its components.

Unit I	**MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS**	**9**	**0**	**0**	**9**

Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.

Unit II	**MATERIALS FOR AUTOMOTIVE STRUCTURES**	**9**	**0**	**0**	**9**

Materials selection for bearings, leaf springs, chasis & frames, Bumper, shock absorbers, wind screens, panels, brake shoes, Disc, wheels, differentials , damping and antifriction fluids, Tyres and tubes. Materials for electronic devices meant for engine control, ABS, Steering, Suspension, Sensors, anti-collision, Anti-fog, Head lamps.

Unit III	**AEROSPACE METALS AND ALLOYS**	**9**	**0**	**0**	**9**

Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles. Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy- application of materials in Thermal protection systems of Aerospace vehicles – super alloys

Unit IV	**CERAMICS AND COMPOSITES**	**9**	**0**	**0**	**9**

Introduction – physical metallurgy – modern ceramic materials – cermet - cutting tools – glass ceramic – production of semi-fabricated forms - Plastics and rubber – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design.

Unit V	**NUCLEAR WASTE AND RADIATION PROTECTION, IRRADIATION EFEFCTS**	**9**	**0**	**0**	**9**

Introduction-unit of nuclear radiation-Types of waste –disposal –ICRP recommendations-radiation hazards and prevention –radiation dose units - Irradiation Examination of Fuels, Irradiation behaviour of metallic uranium – irradiation growth, thermal cycling, swelling, adjusted uranium, blistering in uranium rods. Irradiation effects in ceramic oxide and mixed oxide fuels, definition and units of burn up, main causes of fuel element failure in power reactors and remedies to avoid failures.

Total (45+0) = 45 Hours

Reference Books:

1.	ASM Handbook, “Selection of Materials Vol. 1 and 2”, ASM Metals Park, Ohio. USA, 1991.
2.	Materials Science and Engineering, Willium D. Callister, Jr. John Wiley & Sons publications Or Callister’s Materials Science and Engineering Adapted By R. Balasubramaniam, Wiley India, Edition -2010.

3.	Material Science and Engineering, V. Raghavan, Prentice Hall of India, 4th Edition.
4.	Engineering Metallurgy Applied Physical Metallurgy, R. A. Higgins, 6th Edition
5.	Gladius Lewis, "Selection of Engineering Materials", Prentice Hall Inc. New Jersey USA, 1995.
6.	Charles J A and Crane. F A. A., "Selection and Use of Engineering Materials", 3rd Edition, Butterworths, London UK, 1996
7.	ASM Handbook. "Materials Selection and Design", Vol. 20- ASM Metals Park Ohio.USA, 1997
8.	Cantor," Automotive Engineering: Lightweight, Functional, and Novel Materials", Taylor & Francis Group, London, 2006

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Describe the materials selection criteria for engine and transmission systems.	L2: Understanding
CO2	:	Analyze the different materials used for automotive structures and Different electronic materials for automotive applications.	L4:Analysing
CO3	:	Explain various topics such as elements of aerospace materials and mechanical behaviour of materials,	L2: Understanding
CO4	:	Compare the ceramics and composites of aerospace materials	L4:Analysing
CO5	:	Examine the fuels for nuclear materials.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1	1		
CO2	1	1	1			1							1	1		
CO3	1			1	1								1		1	
CO4	1	1	1				1						1			1
CO5	1	1		1	1								1			1
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																