CURRICULUM

ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULAM AND SYLLABUS- REGULATIONS 2022

SEMESTER I										
Sl. No.	**Course Code**	**Course Title**	**Category**	**Hours per Week**			**Credits**	**Maximum Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
1.	22MC101	Induction Program	MC	-	-	-	0	-	-	-
THEORY										
2.	22EN101	Communicative English (Theory and Practical)	HS	2	0	2	3	50	50	100
3.	22MA102	Matrices, Calculus and 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.	22CS103	C Programming for Electrical Engineers	ES	3	0	0	3	40	60	100
6.	22CM101	Basic Civil and Mechanical Engineering	ES	4	0	0	4	40	60	100
7	22MC102	Heritage of Tamils /தமிழர்மரபு	HSMC	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							**21.5**			**800**

SEMESTER II										
Sl. No.	**Course Code**	**Course Title**	**Category**	**Hours per week**			**Credits**	**Maximum Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1.	22MA204	Fourier Series And Transforms	BS	2	1	0	3	40	60	100
2.	22PH202	Physics -Waves, Optics and Quantum Mechanics	BS	2	1	0	3	40	60	100
3.	22CY101	Engineering Chemistry	BS	3	1	0	4	40	60	100
4.	22HS201	Universal Human Values	HS	2	1	0	3	40	60	100
5.	22ME101	Engineering Graphics and Design	ES	1	0	4	3	40	60	100
6.	22MCIN01	Engineering Sprints	EEC	0	0	2	1	100	-	100
7	22MC201	Tamils and Technology / தமிழரும்தொழில்நுட்பமும்	HSMC	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
TOTAL							**22**			**1000**
*Only for NCC students, it is not considered for CGPA calculation										

SEMESTER III

Sl. No.	Course Code	Course Title	Category	Hours per week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
THEORY										
1.	22MA302	Statistics and Numerical Methods	BS	3	1	0	4	40	60	100
2.	22EE301	Electric Circuit Analysis	PC	3	1	0	4	40	60	100
3.	22EE302	Electromagnetic Theory	PC	2	1	0	3	40	60	100
4.	22EE303	DC Machines and Transformers	PC	2	1	0	3	40	60	100
5.	22EE304	Electron Devices and Circuits	PC	3	0	0	3	40	60	100
6.	22EE305	Signals and Systems	PC	2	1	0	3	40	60	100
7.	22MCIN02	Innovation Sprints	EE	0	0	2	1	100	-	100
8	22MC301	Indian Constitution	MC	2	0	0	0	100	-	100
9.	22NC301	NCC Course – II (only for NCC Students)*	NC	3	0	0	3*	40	60	100
PRACTICAL										
10	22EE306	DC Machines and Transformers Laboratory	PC	0	0	3	1.5	60	40	100
11	22EE307	Electric Circuits and Electron Devices Laboratory	PC	0	0	3	1.5	60	40	100
TOTAL							**24**			**1000**

*Only for NCC students, it is not considered for CGPA calculation

SEMESTERIV

Sl. No.	Course Code	Course Title	Category	Hours per week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
THEORY										
1.	22EE401	Synchronous and Induction Machines	PC	2	1	0	3	40	60	100
2.	22EE402	Measurements and Instrumentation	PC	3	0	0	3	40	60	100
3.	22EE403	Analog and Digital Integrated Circuits	PC	3	0	0	3	40	60	100
4.	22EE404	Power Generation, Transmission and Distribution System	PC	3	0	0	3	40	60	100
5.	22EE405	Power Electronics	PC	3	0	0	3	40	60	100
6	22MCIN03	Design Sprints	EE	0	0	2	1	100	-	100
7	22CYMC01	Environmental Science	MC	2	0	1	0	100	-	100
PRACTICAL										
8.	22EE406	Synchronous and Induction Machines Laboratory	PC	0	0	3	1.5	60	40	100
9.	22EE407	Analog and Digital Integrated Circuits Laboratory	PC	0	0	3	1.5	60	40	100
10.`	22EN401	Placement and Soft Skills Laboratory	HS	0	0	4	2	60	40	100
TOTAL							**21**			**1000**

SEMESTERV

Sl. No.	Course Code	Course Title	Category	Hours per week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
THEORY										
1.	22EE501	Control Systems	PC	2	1	0	3	40	60	100
2.	22EE502	Microprocessors and Microcontrollers	PC	3	0	0	3	40	60	100
3.	22EE503	Electrical Machine Design	PC	2	1	0	3	40	60	100
4.	22EE504	Electrical Drives and Control	PC	3	0	0	3	40	60	100
5.	22EE505	Power System Analysis and Stability	PC	2	1	0	3	40	60	100
6.	22EE506	Solar and Wind Energy Conversion System	PC	3	0	0	3	40	60	100
7.	22MCIN04	Ideation Sprints	EE	0	0	2	1	100	-	100
PRACTICAL										
8.	22EE507	Power Electronics and Energy Systems Laboratory	PC	0	0	3	1.5	60	40	100
9.	22EE508	Microprocessor and Microcontroller Laboratory	PC	0	0	3	1.5	60	40	100
10.	22EE509	Control and Instrumentation Laboratory	PC	0	0	3	1.5	60	40	100
TOTAL							**23.5**			**1000**

SEMESTER VI (REGULAR STREAM)

Sl. No.	Course Code	Course Title	Category	Hours per week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
THEORY										
1.	22EEPE1X	Professional Elective – I	PE	3	0	0	3	40	60	100
2.	22EEPE2X	Professional Elective – II	PE	3	0	0	3	40	60	100
3.	22EEPE3X	Professional Elective – III	PE	3	0	0	3	40	60	100
4.	22- -OE1X	Open Elective - I	OE	3	0	0	3	40	60	100
5.	22- -OE2X	Open Elective - II	OE	3	0	0	3	40	60	100
6.	22- -OE3X	Open Elective - III	OE	3	0	0	3	40	60	100
PRACTICAL										
7.	22EE601	Mini Project	EE	0	0	6	3	60	40	100
TOTAL							**21**			**700**

SEMESTER VI (PROTOSEM STREAM)

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credits	Maximum 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										
7.	22PSEE01	Robotics	EE	0	0	6	3	100	-	100
TOTAL							**21**			**700**

SEMESTER VII

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
THEORY										
1.	22EE701	Power System Protection and Switch Gear	PC	3	0	0	3	40	60	100
2.	22EE702	Smart GridTechnologies	PC	3	0	0	3	40	60	100
3	22EE703	High Voltage Engineering	PC	3	0	0	3	40	60	100
4.	22EE704	Industrial Management and Economics	PC	3	0	0	3	40	60	100
5	22EEPE4X	Professional Elective – IV	PC	3	0	0	3	40	60	100
6.	22- -OE4X	Open Elective - IV	HS	3	0	0	3	40	60	100
PRACTICAL										
7.	22EE705	Power Systems Laboratory	PC	0	0	3	1.5	60	40	100
8.	22EE706	Electric Drives and Control Laboratory	PC	0	0	3	1.5	60	40	100
TOTAL							**21**			**800**

SEMESTER VIII

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
THEORY										
1.	22EEPE5X	Professional Elective – V	PE	3	0	0	3	40	60	100
2	22EEPE6X	Professional Elective – VI	PE	3	0	0	3	40	60	100
PRACTICAL										
2.	22EE801	Project Work	EE	0	0	20	10	120	80	200
TOTAL							**16**			**500**
GRAND TOTAL							**170**			

PROFESSIONAL ELECTIVES COURSES

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
ELECTIVE – I (VI SEMESTER)										
1	22EEPE11	Network Analysis and Synthesis	PE	3	0	0	3	40	60	100
2	22EEPE12	Advanced Control Systems	PE	3	0	0	3	40	60	100
3	22EEPE13	Discrete Control Systems	PE	3	0	0	3	40	60	100
4	22EEPE14	Biomedical Instrumentation	PE	3	0	0	3	40	60	100
5	22EEPE15	Biology for Electrical Engineers	PE	3	0	0	3	40	60	100
6	22EEPE16	Adaptive Control	PE	3	0	0	3	40	60	100
ELECTIVE – II (VI SEMESTER)										
1	22EEPE21	HVDC Transmission Systems	PE	3	0	0	3	40	60	100
2	22EEPE22	EHVAC Transmission Systems	PE	3	0	0	3	40	60	100
3	22EEPE23	Flexible AC Transmission System	PE	3	0	0	3	40	60	100
4	22EEPE24	Power System Operation and Control	PE	3	0	0	3	40	60	100
5	22EEPE25	Underground Cable Engineering	PE	3	0	0	3	40	60	100
6	22EEPE26	Power System State Estimation and Security Control	PE	3	0	0	3	40	60	100
ELECTIVE – III (VI SEMESTER)										
1	22EEPE31	Digital Signal Processing	PE	3	0	0	3	40	60	100
2	22EEPE32	Embedded System Design	PE	3	0	0	3	40	60	100
3	22EEPE33	Artificial Intelligence and Computer Vision	PE	3	0	0	3	40	60	100
4	22EEPE34	Soft Computing Techniques	PE	3	0	0	3	40	60	100
5	22EEPE35	Internet of Things for Electrical System	PE	3	0	0	3	40	60	100
6	22EEPE36	MEMS and NEMS	PE	3	0	0	3	40	60	100
ELECTIVE – IV (VIII SEMESTER)										
1	22EEPE41	Power System Transients	PE	3	0	0	3	40	60	100
2	22EEPE42	Power Quality	PE	3	0	0	3	40	60	100
3	22EEPE43	Distributed Generation and Micro Grid	PE	3	0	0	3	40	60	100
4	22EEPE44	Restructured Power System	PE	3	0	0	3	40	60	100
5	22EEPE45	Control and Integration of Renewable Energy Sources	PE	3	0	0	3	40	60	100
6	22EEPE46	Design and Modelling of Renewable Energy System	PE	3	0	0	3	40	60	100
ELECTIVE – V (VIII SEMESTER)										
1	22EEPE51	Utilization of Electrical Energy	PE	3	0	0	3	40	60	100

2	22EEPE52	Electrical Energy Conservation and Auditing	PE	3	0	0	3	40	60	100
3	22EEPE53	Electrical Wiring Estimation and Costing	PE	3	0	0	3	40	60	100
4	22EEPE54	Traction Engineering	PE	3	0	0	3	40	60	100
5	22EEPE55	Energy Storage Systems and Application	PE	3	0	0	3	40	60	100
6	22EEPE56	SMPS and UPS	PE	3	0	0	3	40	60	100
ELECTIVE – VI (VIII SEMESTER)										
1	22EEPE61	Special Electrical Machines	PE	3	0	0	3	40	60	100
2	22EEPE62	Industrial Electrical Systems	PE	3	0	0	3	40	60	100
3	22EEPE63	Electric Vehicles and Control	PE	3	0	0	3	40	60	100
4	22EEPE64	Embedded Control for Electrical Drives	PE	3	0	0	3	40	60	100
5	22EEPE65	Grid Integration of Electric Vehicles	PE	3	0	0	3	40	60	100
6	22EEPE66	Embedded System for Automotive Applications	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVE COURSES

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
COURSES OFFERED BY DEPARTMENT OF MATHEMATICS										
1	22MAOE01	Sampling Theory and Numarical Methods	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 DEPARTMENT OFCIVIL 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 DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
8	22CSOE01	Object Oriented Programming using Concept	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 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 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 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	Robotics 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 DEPARTMENT OF METALLURGICAL ENGINEERING										
37	22MTOE01	Foundry and Welding Technology	OE	3	0	0	3	40	60	100
38	22MTOE02	Advanced 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

Enrollment of B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech.(Honours) or Minor degree.

For B.E./B.Tech.(Honours) , a student shall register for the additional courses (18 credits) from semester V onwards . These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degrees, 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.

B.E. - ELECTRICAL AND ELECTRONICS ENGINEERING - HONOURS DEGREE
Professional Elective Courses – Verticals

Sl. No.	VERTICAL - I	VERTICAL - II	VERTICAL - III
	POWER ENGINEERING	**POWER CONVERTERS AND DRIVES**	**ELECTRIC VEHICLE TECHNOLOGY**
1.	22EEH101 Substation Engineering and Automation	22EEH201 Analysis of Electrical Machines	22EEH301 Electric Vehicle Architecture
2.	22EEH102 Energy Management System and SCADA	22EEH202 Multilevel Power Converters	22EEH302 Design of Motor and Power Converters for Electric Vehicle
3.	22EEH103 Power System Automation	22EEH203 Modelling and Control of Power Converters	22EEH303 Electric Vehicle Design, Mechanics and Control
4.	22EEH104 Power Plant Engineering	22EEH204 Digital Controller in Power Electronics Applications	22EEH304 Design of Electric Vehicle Charging System
5.	22EEH105 Computer Relaying and Wide Area Measurement Systems	22EEH205 PWM Converters and Applications	22EEH305 Testing of Electric Vehicles
6.	22EEH106 Power System Planning and Reliability	22EEH206 Grid Converters for Renewable Energy Applications	22EEH306 Intelligent Control of Electric Vehicles
7.	22EEH107 Advanced Power System Protection	22EEH207 Modern Electrical Drives	22EEH307 Hybrid Electric vehicles
8.	22EEH108 High Voltage Insulation Systems	-	22EEH308 Battery Management Systems
9.	-	-	22EEH309 Advanced Electrical Drives for Electric Vehicle

B.E. - ELECTRICAL AND ELECTRONICS ENGINEERING – HONOURS DEGREEE
PROFESSIONAL ELECTIVE COURSES VERTICALS

VERTICAL – 1 : POWER ENGINEERING

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credit	Maximum Marks		
				L	T	P		CA	FE	Total
1	22EEH101	Substation Engineering and Automation	PE	3	0	0	3	40	60	100
2	22EEH102	Energy Management System and SCADA	PE	3	0	0	3	40	60	100
3	22EEH103	Power System Automation	PE	3	0	0	3	40	60	100
4	22EEH104	Power Plant Engineering	PE	3	0	0	3	40	60	100
5	22EEH105	Computer Relaying and Wide Area Measurement Systems	PE	3	0	0	3	40	60	100
6	22EEH106	Power System Planning and Reliability	PE	3	0	0	3	40	60	100
7	22EEH107	Advanced Power System Protection	PE	3	0	0	3	40	60	100
8	22EEH108	High Voltage Insulation Systems	PE	3	0	0	3	40	60	100

VERTICAL – II: POWER CONVERTERS AND DRIVES

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credit	Maximum Marks		
				L	T	P		CA	FE	Total
1	22EEH201	Analysis of Electrical Machines	PE	3	0	0	3	40	60	100
2	22EEH202	Multilevel Power Converters	PE	3	0	0	3	40	60	100
3	22EEH203	Modelling and Control of Power Converters	PE	3	0	0	3	40	60	100
4	22EEH204	Digital Controller in Power Electronics Applications	PE	3	0	0	3	40	60	100
5	22EEH205	PWM Converters and Application	PE	3	0	0	3	40	60	100
6	22EEH206	Grid Converters for Renewable Energy Applications	PE	3	0	0	3	40	60	100
7	22EEH207	Modern Electrical Drives	PE	3	0	0	3	40	60	100

VERTICAL – III: ELECTRICAL VEHICLE TECHNOLOGY

Sl. No.	Course Code	Course Title	Category	Hours per Week			Credit	Maximum Marks		
				L	T	P		CA	FE	Total
1	22EEH301	Electric Vehicle Architecture	PE	3	0	0	3	40	60	100
2	22EEH302	Design of Motor and Power Converters for Electric Vehicles	PE	3	0	0	3	40	60	100
3	22EEH303	Electric Vehicle Design, Mechanics and Control	PE	3	0	0	3	40	60	100

4	22EEH304	Design of Electric Vehicle Charging System	PE	3	0	0	3	40	60	100
5	22EEH305	Testing of Electric Vehicles	PE	3	0	0	3	40	60	100
6	22EEH306	Intelligent Control of Electric Vehicles	PE	3	0	0	3	40	60	100
7	22EEH307	Hybrid Electric vehicles	PE	3	0	0	3	40	60	100
8	22EEH308	Battery Management Systems	PE	3	0	0	3	40	60	100
9	22EEH309	Advanced Electrical Drives for Electric Vehicle	PE	3	0	0	3	40	60	100

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 Microcontroller	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 – Measurements and Instrumentation	22MEM04 Materials Engineering	22MTM04 Rate Processess 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 – Electrical 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 Vehicles and Control	22MEM07 Design of Machine Elements	22MTM07 Automotive, Aerospace and Defence Materials
-----	22CSM08 Virtualization and Cloud Computing	22ECM08 Fundamentals of IoT	22EEM08 – Electrical Energy Conservation and Auditing	22MEM08 Heat and Mass Transfer	-----
-----	-----	22ECM09 Wireless Sensors and Networking	22EEM09 – SMPS and UPS	22MEM09 Metrology and Quality Control	-----
-----	-----	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 OF CREDITS FOR REGULAR STREAM

Sl. No	Course Components	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Science (HS)	3	4		2			3		**12**
2	Basic Sciences (BS)	7	13	4						**24**
3	Engineering Sciences (ES)	10.5	3							**13.5**
4	Professional Core (PC)			19	18	22.5		12		**71.5**
5	Professional Electives (PE)						9	3	6	**18**
6	Open Electives (OE)						9	3		**12**
7	Employment Enhancement Course (EE)		1	1	1	1	3		10	**17**
8	Mandatory / Management / Non-Credit Course (MC/HSMC)	1	1	√	√					**2**
	Total Credits	**21.5**	**22**	**24**	**21**	**23.5**	**21**	**21**	**16**	**170**

COMPARISION OF CREDITS SUMMARY

Sl. No	Course Components	AICTE Recommendation		ANNA UNIVERSITY Curriculum R2021		Autonomous Curriculum R2022	
		Credits	% Credits	Credits	% Credits	Credits	% Credits
1	Humanities and Social Science (HS)	12	7.59	12	7.2	**12**	7.05
2	Basic Sciences (BS)	26	16.45	25	15	**24**	14.1
3	Engineering Sciences (ES)	20	12.65	14	8.38	**13.5**	7.94
4	Professional Core (PC)	53	33.5	69	41.3	**71.5**	42
5	Professional Electives (PE)	18	11.4	21	12.6	**18**	10.6
6	Open Electives (OE)	18	11.4	12	7.2	**12**	7.05
7	Employment Enhancement Course (EE)	11	7	14	8.38	**17**	10
8	Mandatory / Management / Non-Credit Course (MC/HSMC)	-	-	-	-	**2**	1.2
	Total Credits	**158**	**100%**	**167**	**100%**	**170**	**100%**

SUMMARY OF CREDITS FOR PROTOSEM STREAM

Sl. No	**Course Components**	**Credits per Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	Humanities and Social Science (HS)	3	4		2			3		**12**
2	Basic Sciences (BS)	7	13	4						**24**
3	Engineering Sciences (ES)	10.5	3							**13.5**
4	Professional Core (PC)			19	18	22.5		12		**71.5**
5	Professional Electives (PE)						9	3	6	**18**
6	Open Electives (OE)						9	3		**12**
7	Employment Enhancement Course (EE)		1	1	1	1	3		10	**17**
8	Mandatory / Management / Non-Credit Courses (MC/HSMC)	1	1	√	√					**2**
	Total	**21.5**	**22**	**24**	**21**	**23.5**	**21**	**21**	**16**	**170**

SYLLABUS

PROFESSIONAL CORE COURSES

B.E ELECTRICAL AND ELECTRONICS ENGINEERING - FULL TIME

REGULATION 2022 – SYLLABUS

22MC101	**INDUCTION PROGRAM**		**SEMESTER**			**I**
PREREQUISITES		**CATEGORY**	**MC**	**Credit**		**0**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**0**	**0**

This is a mandatory 2 or 3 weeks programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

COURSE OBJECTIVES

The purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

ACTIVITY BASED PROGRAMME

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

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.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

References:

Guide to Induction program from AICTE

Total = 21Days

22EN101	**COMMUNICATIVE ENGLISH**		**SEMESTER**			**I / II**
PREREQUISITES		**CATEGORY**	**HS**	**Credit**		**3**
1. 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	**INTERPRETATATION**	**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, and 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	L2: Understanding
CO2	:	Use language effectively at technical and professional contexts	L3: Applying
CO3	:	Apply the academic and functional writing skills in formal and informal communicative contexts	L3: Applying
CO4	:	Interpret pictorial representation of statistical data and charts	L3: Applying

COURSE ARTICULATION MATRIX

COs /POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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)

22MA102	**MATRICES, CALCULUS AND DIFFERENTIAL EQUATIONS**	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**BS**	**Credit**		**4**
Basic 12th level Matrices, Differential Calculus, Integral Calculus, Vector Algebra 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 the geometrical application of differential calculus and integral calculus.
3.	To familiarize the solutions of ordinary differential equations of higher order.
4.	To obtain the knowledge of solving partial differential equations of higher order with constant coefficients.
5.	To acquire the knowledge of vector differentiation and integration and its applications.

UNIT I	**MATRICES**	**9**	**3**	**0**	**12**
Symmetric, Skew Symmetric and Orthogonal Matrices – Characteristic equation of a Matrix – Eigen values and Eigen vectors – Properties – Cayley-Hamilton theorem (excluding proof) – Diagonalization of Matrices - Gauss elimination technique - Reduction of quadratic form to canonical form by orthogonal transformation.					
UNIT II	**MULTI VARIABLE CALCULUS**	**9**	**3**	**0**	**12**
Maxima, Minima and Saddle point- – Method of Lagrangian multipliers- 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 III	**ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER**	**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.					
UNIT IV	**PARTIAL DIFFERENTIAL EQUATIONS**	**9**	**3**	**0**	**12**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange’s linear equation – Linear partial differential equations of second and higher order with constant coefficients - Solution of Laplace equation by method of separation of variables.					
UNIT V	**VECTOR CALCULUS**	**9**	**3**	**0**	**12**
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 parallelopipeds.					
					Total (45L+15T) = 60 Periods

Text Books:

1.	Grewal. B.S, “Higher Engineering Mathematics”, 43rd Edition, Khanna Publications, Delhi, 2015.
2.	Veerarajan T, “Engineering Mathematics for First Year”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.

Reference Books:

1.	James Stewart, “Essential Calculus”, 2nd Edition, Cengage Learning, New Delhi, 2013.
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, 2006.
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 Mapped**
CO1	:	Learn the fundamental knowledge of Matrix theory.	L2: Understanding
CO2	:	Solve Engineering problems using multiple integral calculus.	L3: Applying
CO3	:	Acquire skills in solving ordinary differential equations.	L3: Applying
CO4	:	Understanding the concept of partial differential equations.	L2: Understanding
CO5	:	Acquire skills in applications of Vector Calculus.	L3: 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		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)															

22PH102	**MATERIALS SCIENCE FOR ENGINEERING**	**SEMESTER**			**I**
PREREQUISITES	**CATEGORY**	**BS**	**Credit**		**3**
Basic knowledge in Engineering Materials	**Hours/Week**	**L**	**T**	**P**	**TH**
		2	**1**	**0**	**3**

Course Objectives:

1.	To understand the concept of classical free electron theory and band theory of solids
2.	To gain knowledge in the basic concept of semiconductors.
3.	To obtain knowledge in dielectric polarization, dielectric losses and application of dielectrics.
4.	To understand the concept of magnetic materials, superconductors and their applications.
5.	To acquire knowledge in synthesis of metallic glasses, smart materials and nano phase materials

UNIT I	**CONDUCTING MATERIALS**	**6**	**3**	**0**	**9**

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

UNIT II	**SEMICONDUCTING MATERIALS**	**6**	**3**	**0**	**9**

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

UNIT III	**DIELECTRIC MATERIALS**	**6**	**3**	**0**	**9**

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.

UNIT IV	**MAGNETIC AND SUPERCONDUCTING MATERIALS**	**6**	**3**	**0**	**9**

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.

UNIT V	**MODERN ENGINEERING MATERIALS**	**6**	**3**	**0**	**9**

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.

Total (30L+15T)= 45 Periods

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 Mapped**
CO1	:	Understanding 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	:	Applying the concept of magnetic and superconducting materials.	Understanding

CO5	:	Apply various techniques to synthesis modern engineering materials	Applying

COURSE ARTICULATION MATRIX															
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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)															

22CS103	**C PROGRAMMING FOR ELECTRICAL ENGINEERS**		**SEMESTER**			**I**
PREREQUISITES		**CATEGORY**	**ES**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To provide complete knowledge about the programming concepts of C language.
2.	To provide knowledge to develop solution for algebraic equations.

UNIT I	**C Programming Basics and Control Statements**	**9**	**0**	**0**	**9**
C Character set- Identifies and Keywords- Data Type- Declarations-Expressions-Statements and Symbolic constants- Operators – Arithmetic Operators – Unary operators – Relational and Logical Operators – Assignment operators – Conditional operators- Managing Input and Output operations- Decision Making-Branching and Looping statements.					
UNIT II	**Arrays and Strings**	**9**	**0**	**0**	**9**
Pre-processor directives-Storage classes-Arrays – Initialization – Declaration – one dimensional and two dimensional arrays. Strings - String operations – String handling functions-Simple programs-sorting-searching.					
UNIT III	**Functions and Pointers**	**9**	**0**	**0**	**9**
Function – Library functions and user-defined functions – Function prototypes and function definitions – Call by value –Call by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays.					
UNIT IV	**Structures, Unions and File**	**9**	**0**	**0**	**9**
Introduction – need for structure data type – structure definition – Structure declaration – Structure within a structure – Passing structures to functions – Array of structures – Pointers to structures-Union-basic file operation.					
UNIT V	**Solving system of algebraic equations**	**9**	**0**	**0**	**9**
Solving system of simple differential equations, Numerical integration, Numerical differentiation, simultaneous equations / Non simultaneous equations. Plotting of functions					
					Total (45L+0T)= 45 Periods

Text Books:	
1	E.Balagurusamy, “Programming in ANSI C” fourth Edition, Tata McGraw-Hill, 2008.(Unit II-V).
Reference Books:	
1.	Byron S Gottfried, “Programming with C”, Schaum’s Outlines, Second Edition, Tata McGraw-Hill,2006.
2.	Yashavant P. Kanetkar. “Let Us C”, BPB Publications, 2011.

Course Outcomes:			**Bloom’s Taxonomy Mapped**
Upon completion of this course, the students will be able to:			
CO1	:	Familiarize C programming concepts.	L2: Understanding
CO2	:	Apply the concept of C programming to develop solution.	L3: Applying
CO3	:	Develop the C programming concepts for solving algebraic equations.	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	3	2	1						2	1	1		
CO2	3	3	3	2	1						2	1	1		
CO3	3	3	3	2	1						2	1	1		
Avg	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**-**	**-**

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

22CM101	BASIC CIVIL AND MECHANICAL ENGINEERING		SEMESTER		I
PREREQUISITES		**CATEGORY**	**ES**	**Credit**	**4**
		Hours/Week	**L**	**T**	**P**	**TH**
			4	**0**	**0**	**4**

CIVIL ENGINEERING

Course Objectives:

1.	To provide the students an illustration of the significance of the Civil Engineering profession satisfying the societal needs.
2.	To help the students acquire knowledge in the basic of surveying and materials using in construction.
3.	To provide an insight to the essentials of components of a building and infrastructure facilities.

UNIT I	**CIVIL ENGINEERING MATERIALS AND SURVEYING**	**12**	**0**	**0**	**12**

Mechanics: Mechanical properties of materials- stress- strain- types of stresses and stain. Elasticity- Hooke’s law- stress strain Curve of ductile material. Civil Engineering Material: Bricks- Stones – Sand- Cement – Concrete – Steel. Surveying: Objects- Principles- Classification- Measurement of distances.

UNIT II	**BUILDING COMPONENTS AND STRUCTURES**	**12**	**0**	**0**	**12**

Foundation: Functions of foundation- Types. Superstructure: Brick Masonry – Stone Masonry – Beams – Columns – Lintels – Roofing- Flooring- Plastering. Dams: Types of Dams – Cross section details of Gravity Dam. Introduction to Green Building Concept.

Total (24L+0T)= 24 Periods

Text Books:

1.	Shanmugam G and Palanichamy M.S “ Basic Civil and Mechanical Engineering” , McGraw Public Education, 2018.
2.	Ramamrutham.S, “ Basic Civil Engineering”, Dhanpat Rai Publishing Co (p), Ltd, 2013.

Reference Books:

1.	Seetharaman S, “ Basic Civil Engineering”, Anuradha Agencies, 2005.

E-Reference

1	www.onlinecourses.nptel.ac.in/
2	www.vidyarthiplus.com

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Acquire the basic Knowledge in different fields of Civil Engineering.	L1: Remembering
CO2	:	Appraise the materials used in construction.	L3: Applying
CO3	:	Illustrate the ideas of Civil Engineering Applications.	L3: Applying
CO4	:	Understand the different parts of buildings.	L2: 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**	**PSO 3**
CO1	3	2	1			2	1	2							
CO2	2		2			1	1	2							
CO3	1	2	1			1	1	1							
CO4	1	1					1								
Avg	**1.8**	**1.66**	**1.33**	**-**	**-**	**1.33**	**1**	**1.66**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22CM101	BASIC CIVIL AND MECHANICAL ENGINEERING		SEMESTER			I
PREREQUISITE:		CATEGORY	ES	Credit		4
		Hours/Week	L	T	P	TH
			4	0	0	4

MECHANICAL ENGINEERING

Course Objectives:

1.	To introduce the essentials of Civil and Mechanical engineering discipline to the students of all branches of engineering.
2.	To understand the various components, operations and applications of power plants, IC engines and refrigeration and air conditioning system.

UNIT I	BOILERS, TURBINES AND PUMPS	12	0	0	12

Boilers- Classification of boilers- Working Principle of various types of boilers – Horizontal boiler, Vertical boiler - Description of: Lancashire boiler, Locomotive boiler, Babcock and Wilcox boiler, Cochran boiler (simple vertical boiler only) - Boiler Mountings and Accessories.

Turbines – Classification - Working Principle of Impulse and Reaction turbines,

Pumps - working principle of reciprocating (single and double acting) and centrifugal pumps.

UNIT II	INTERNAL COMBUSTION ENGINES	12	0	0	12

Introduction to I.C.Engines, terminologies, classification and components – working principles of petrol and diesel engines – comparison of four stroke and two stroke cycle engines – applications of IC engines.

UNIT III	REFRIGERATION AND AIR CONDITIONING SYSTEM	12	0	0	12

Definition of refrigeration and air conditioning – terminology; refrigerants – definition, classification, working principle of vapour compression system and vapour absorption system – window and split type room air conditioner.

Total (36L+0T) = 36 Periods

Text Books:

1.	Shanmugam G and Palanisamy M S, “Basic Civil and Mechanical Engineering”, TMH publishing Co, New Delhi, 1996.
2.	Ramamrutham. S,”Basic Civil Engineering”, DhanpatRai publishing Co.(P) Ltd.1999.

Reference Books:

1.	Seetharaman S, “Basic Civil Engineering”, Anuradha Agencies, (2005).
2.	Venugopal K and Prabu Raja V, “Basic Civil Engineering”, Anuradha publishers, Kumbakonam, 2000.
3.	Shantha Kumar S R J, “Basic Civil Engineering”, Hi-tech publications, Mayiladuthurai, 2000.

Course Outcomes: **Upon the completion of the course, the students will be able to**		**Bloom’s Taxonomy Mapped**
CO1	Gain the knowledge about various types of boilers, turbines and pumps.	L2: Understanding
CO2	Gain the knowledge about the working of IC engine, its components and its application and able to demonstrate the working of Refrigeration and Air conditioning.	L2: 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	PSO 3
CO1	1			1		2	1								
CO2	1			1		1	1								
Avg	**1**	**-**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

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

22MC102	**தமிழர் மரபு** **B.E. (Common to all Branches)**				**பருவம் I**
முன்நிபந்தனைகள்:		**CATEGORY**	**L**	**T**	**P**	**C**
இலக்கணம் மற்றும் இலக்கியத்தின் அடிப்படைகள்		**BS**	**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 சமய சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மை கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம் , ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி– தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II	**மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**	**3**	**0**	**0**	**3**

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

அலகு III	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**:	**3**	**0**	**0**	**3**

தெருக்கூத்து, கரகாட்டம் , வில்லுப்பாட் டு, கணியான் கூத் து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம் , வளரி, புலியாட்டம் , தமிழர்களின் விளையாட்டுகள்.

அலகு IV	**தமிழர்களின் திணைக் கோட்பாடுகள்**:	**3**	**0**	**0**	**3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்கொப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு –சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர் களின் வெற்றி.

அலகு V	**இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**:	**3**	**0**	**0**	**3**

இந்திய விடுதலை போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Total = 15 Periods

Text Books/ Reference Books:	
1.	தமிழக வரலாறு – மக்களும் பண்பாடும்- கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2.	கணினித் தமிழ்- முனைவர் இல. சுந்தரம்(விகடன் பிரசுரம்)
3.	கீழடி- வைகை நதிகரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை- ஆற்றங்கரை நாகரீகம் (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.	L2: Understanding
CO2	சிற்பக் கலைகளில் அடங்கியுள்ள பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை பற்றியும், தமிழர்களின் சமூக, பொருளாதார வாழ்வில் கோவில்களின் பங்கினை பற்றியும் தெரிந்து கொண்டனர்.	L2: Understanding
CO3	தமிழர்களின் வாழ்வியல் முறைகளோடு ஒன்றிய நாட்டுபுறக் கலைகள் மற்றும் தமிழர்களின் வீர விளையாட்டுகளை பற்றி அறிந்து கொண்டனர்.	L2: Understanding
CO4	சங்ககாலத்தில் தமிழர்கள் பின்பற்றிய திணைக் கோட்பாடுகள் பற்றி நடந்து கொண்டனர்.	L3: Applying
CO5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்க்குத் தமிழர்களின் பங்கினை பற்றியும் அறிந்து கொண்டனர்.	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				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)

22MC102	**HERITAGE OF TAMILS** **B.E. (Common to all Branches)**		**SEMSTER**			**I**
PREREQUISITES		**CATEGORY**	**BS**	**Credit**		**1**
Basics of Tamil Language and Literature		**Hours/Week**	**L**	**T**	**P**	**TH**
			1	**0**	**0**	**1**

Course Objectives:

1.	To obtain the knowledge of Tamil Language and Literature.
2.	To familiarize with painting and Sculpture.
3.	To know about the folks and martial arts.
4.	To understand the Thinai concept of Tamils
5.	To know about the contribution of Tamils to Indian National Movement and Indian Culture.

UNIT I	**LANGUAGE AND LITERATURE**	**3**	**0**	**0**	**3**
Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.					
UNIT II	**HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**	**3**	**0**	**0**	**3**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.					
UNIT III	**FOLK AND MARTIAL ARTS**	**3**	**0**	**0**	**3**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.					
UNIT IV	**THINAI CONCEPT OF TAMILS**	**3**	**0**	**0**	**3**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.					
UNIT V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3**	**0**	**0**	**3**
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.					
					Total = 15 Periods

Text Books/ Reference 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.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
4.	Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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.	L2: Understanding
CO2	:	Familiarize about painting and Sculpture.	L2: Understanding
CO3	:	Acquire the knowledge about folks and Martial arts.	L2: Understanding
CO4	:	Learn the knowledge of Thinai concepts of Tamils	L3: Applying
CO5	:	Acquire the Knowledge about contribution of Tamils to Indian national movement and Indian culture.	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				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**		**SEMESTER**			**I**
PREREQUISITE		**CATEGORY**	**ES**	**Credit**		**1.5**
		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

A. Word Processing

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 function and use-defined formulae
7. Creating different types 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 (0T+45P)= 45 Periods

COURSE OUTCOMES: After the successful completion of the practical session, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the usage of features supported by word processing applications.	L3 : Applying
CO2	Demonstrate the usage of features supported by spread sheet applications.	L3 : Applying
CO3	Apply general programming techniques to develop digital solution to problems	L3 : Applying
CO4	Implement solutions develop with general programming techniques in C programming language	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			1		
CO2	3	3											1		
CO3	3	3	2	2	2	1	1	1			2	3	1		
CO4	3	3	2	2	2	1	1	1			2	3	1		
Avg	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**-**	**3**	**2**	**3**	**1**	**-**	**-**

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

22ME102	**WORKSHOP MANUFACTURING PRACTICES**			**SEMESTER**			**I**
PREREQUISITES		**CATEGORY**	**ES**	**Credit**			**2**
NIL		**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 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: Green sand preparation- mould making practice.
7. Sheet metal: Cone, Tray, Cylinder.
8. Carpentry: CROSS, T and DOVETAIL joints.
9. Drilling: Simple exercises.

Total (P) = 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 Puplishing 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.	L2: Understanding
CO2	Prepare fitting of metal and wooden pieces using simple fitting and carpentry tools manually.	L3: Applying
CO3	Prepare the mould cavity by using proper moulding tools in foundry section	L3-Applying
CO4	Fabrication of components using welding, lathe and drilling machine.	L4: Analyzing
CO5	Make the model using sheet metal works.	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						3									
CO2		3		2	1										2
CO3		3		2	1										2
CO4		3		2	1										2
Avg	**-**	**3**	**-**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

<table>
<tr><td>22MA204</td><td colspan="2">FOURIER SERIES AND TRANSFORMS</td><td colspan="3">SEMESTER</td><td>II</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 12th level knowledge of Taylor series, 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>2</td><td>1</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:

1.	To introduce the concept of Fourier series.
2.	To understand the application of Fourier analysis in solving boundary value problems.
3.	To obtain the knowledge of Laplace transform techniques and inverse Laplace transform using convolution theorem.
4.	To familiarize with Fourier, transform of a function and its sine and cosine transforms.
5.	To gain the skills to form difference equations and find its solution by using Z-transform method.

UNIT I	**FOURIER SERIES**	**6**	**3**	**0**	**9**

Dirichlet’s conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval’s Identity

UNIT II	**BOUNDARY VALUE PROBLEMS**	**6**	**3**	**0**	**9**

Classification of second order quasi linear partial differential equations – Solutions of one-dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation (Infinite plate only).

UNIT III	**LAPLACE TRANSFORM**	**6**	**3**	**0**	**9**

Laplace Transform- Conditions for existence – Transform of elementary functions – Basic Properties – Transform of derivatives and integrals – Initial and Final value theorems- Transform of periodic Functions – Inverse Laplace Transform- statement and application of convolution theorem.

UNIT IV	**FOURIER TRANSFORM**	**6**	**3**	**0**	**9**

Statement of Fourier integral theorem – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval’s Identity.

UNIT V	**Z -TRANSFORM AND DIFFERENCE EQUATIONS**	**6**	**3**	**0**	**9**

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 by partial fraction only.

Total (30L+15T) = 45 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.

Reference Books:

1.	Grewal, B.S., “Higher Engineering Mathematics”, 43rd Edition, Khanna Publishers, Delhi, 2015.
2.	Wylie C. Ray and Barrett Louis, C., “Advanced Engineering Mathematics”, 6th Edition, McGraw-Hill, Inc., New York, 1995.
3.	Andrews, L.A., and Shivamoggi B.K., “Integral Transforms for Engineers and Applied Mathematicians”, MacMillan, New York, 1988.
4.	Narayanan, S., Manicavachagom Pillai, T.K. and Ramaniah, G., “Advanced Mathematics for Engineering Students”, Volumes II and III, Ananda Book Depot, 2019.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Acquire the knowledge about Fourier series.	L2: Understanding
CO2	:	Appreciate the physical significance of Fourier series techniques in solving one and two-dimensional heat flow problems and one-dimensional wave equations.	L2: Understanding
CO3	:	Acquire the knowledge about Laplace transforms.	L2: Understanding
CO4	:	Apply the knowledge of Fourier transform in engineering problems.	L3: Applying
CO5	:	Apply the knowledge of Z-transform in engineering problems.	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**	**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)															

22PH202	**PHYSICS – WAVES, OPTICS AND QUANTUM MECHANICS**		**SEMESTER**			**II**
PREREQUISITES		**CATEGORY**	**BS**	**Credit**		**3**
Knowledge concerned with light and waves		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**1**	**0**	**3**

Course Objectives:

1.	To understand Simple harmonic motion and Waves
2.	To obtain knowledge in the Propagation of light
3.	To acquire knowledge of wave optics
4.	To understand the Principle and working of laser with applications
5.	To know the basic concepts of quantum Mechanics and Matter Waves

UNIT I	**SIMPLE HARMONIC OSCILLATION AND WAVES**	**6**	**3**	**0**	**9**

Simple harmonic motion ; Damped Simple harmonic motion ; Forced vibrations – resonance; Wave motion- types and characteristics - velocity of a transverse wave along a stretched string -frequency of a vibrating string – progressive waves & stationary waves – wave equation for progressive and Stationary waves.

UNIT II	**THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS**	**6**	**3**	**0**	**9**

Fermat's Principle - laws of reflection and refraction ; Mirage effect ; Total internal reflection ; Matrix method - imaging by a spherical refracting surface - imaging by a coaxial optical system; Optical Instruments - simple and compound microscope - astronomical telescope.

UNIT III	**WAVE OPTICS**	**6**	**3**	**0**	**9**

Huygens Principle ; Principle of superposition ; Interference of Light – Young's double slit experiment - Newtons rings - experimental arrangement to determine the wavelength of sodium light ; Michelson Interferometer ; Fraunhofer diffraction from a single slit ; Diffraction grating –determination of wavelength of light and dispersive power ; Polarisation - Polarisation by reflection - Brewsters Law.

UNIT IV	**LASERS**	**6**	**3**	**0**	**9**

Properties of Laser beams - monochromacity, coherence , directionality and brightness ; Einstein's theory of matter radiation interaction and A&B coefficients - amplification of light by population inversion - pumping methods ; Different types of laser – Nd-YAG,CO$_2$laser,Semiconductor diode laser (Homo and Hetero junction) – construction, Working and Energy level diagram ; Applications of laser.

UNIT V	**QUANTUM MECHANICS**	**6**	**3**	**0**	**9**

Introduction - matter waves - de Broglie equation – Davisson and Germer experiment- G.P.Thomson experiment; Wave packet; Wave function - Physical Significance of wave function; Heisenberg uncertainty principle; Time independent and dependent Schrödinger equation; Application of Schrödinger equation - Particle in a one dimensional box.

Total (30L+15T)= 45 Periods

Text Books:

1.	Ajoy Ghatak,'Optics',Tata Mc Graw Hill Publishing Co.Ltd, Sixth Edition,2016
2.	Gupta Kumar Sharma, 'Quantum Mechanics',Jai Prakash Nath & co, New Edition, 2021
3.	Gaur R.K and Gupta S.L,'Engineering Physics',Dhanpat Rai Publishers,2012

Reference Books:

1.	Palanisamy P.K,'Engineering Physics',Scitech Publications, 2011
2.	Rajendran V and Marikani A, 'Engineering Physics', PHI learning PVT, India, 2009

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand Simple harmonic oscillation and propagation of waves.	L2-Understanding
CO2	:	Apply matrix method to analyse system of reflecting and refracting surfaces.	L3-Applying
CO3	:	Analyze the various experimental techniques in wave optics.	L4-Analyzing
CO4	:	Understand the concept of laser and its applications.	L2-Understanding
CO5	:	Gain knowledge in the basics of quantum mechanics.	L1-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	3	1	1				1	1			1	1	1	
CO2	2	2	1	1	1			1				1	1	1	1
CO3	3	2	1	1	1			2	1			1	1	1	1
CO4	3	1	2	1	2	1			1			2		1	1
CO5	3	2	2	1	1							2	1	1	1
Avg	2.6	2	1.4	1	1.25	1	-	1.33	1	-	-	1.4	1	1	1
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22CY101	**ENGINEERING CHEMISTRY**		**SEMESTER**			**II**
PREREQUISITES		**CATEGORY**	**BS**	**Credit**		**4**
Basic Chemistry		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**1**	**0**	**4**

Course Objectives: To make the students conversant with the

1. Basic Principles of Spectroscopy and their applications.
2. Knowledge of different methods for water analysis and purification & Nanomaterials and its application.
3. Various adsorption technics and basic knowledge of Phase equilibria.
4. Principles of electrochemistry, electrochemical cells, corrosion, and its control.
5. Basis of polymer preparations and applications and enhancement of the quantity and quality of fuels.

UNIT I	**SPECTROSCOPIC TECHNIQUES**	**9**	**3**	**0**	**12**

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.

UNIT II	**WATER TECHNOLOGY AND NANO TECHNOLOGY**	**9**	**3**	**0**	**12**

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.

UNIT III	**SURFACE CHEMISTRY AND PHASE EQUILIBRIA**	**9**	**3**	**0**	**12**

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.

UNIT IV	**ELECTROCHEMISTRY**	**9**	**3**	**0**	**12**

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.

UNIT V	**POLYMERS AND FUELS**	**9**	**3**	**0**	**12**

Polymers – definition – polymerization – types – addition and condensation polymerization – free radical polymerization mechanism – plastics, classification – preparation, properties and uses of PVC, Teflon, polycarbonate, polyurethane, nylon-6,6, PET – Rubber- vulcanization of rubber, synthetic rubbers – butyl rubber, SBR – biopolymers – Nylon-2-Nylon-6 and PHBV

Fuels - classification with examples, calorific value-classification (HCV & LCV), determination of calorific value of solid and liquid fuels using Bomb 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.

Total (45L+15T) = 60 Periods

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-Reference	
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 Mapped**
CO1	:	To recall the basic principles of spectroscopy and their applications	L1: Remembering
CO2	:	To paraphrase the different methods for water analysis & purification and Nanomaterials & its applications	L2: Understanding
CO3	:	To apply the various adsorption technics and basic knowledge of Phase equilibria	L3: Applying
CO4	:	To integrate the principles of electrochemistry, electrochemical cells, corrosion, and its control	L6: Creating
CO5	:	To assess the basis of polymer preparations & applications and enhancement of the quantity & quality of fuels.	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**	**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)															

22HS201	**UNIVERSAL HUMAN VALUES**		**SEMESTER**			**II**
PREREQUISITE:		**CATEGORY**	**HS**	**Credit**		**3**
Universal human values introduction		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**1**	**0**	**3**
COURSE OBJECTIVES						
1.	To development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.					
2.	To understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.					
3.	To strengthening of self-reflection.					
4.	To development of commitment and courage to act.					
UNIT I	**BASIC CONCEPTS OF HUMAN VALUES**		**6**	**3**	**0**	**9**
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.						
UNIT II	**UNDERSTANTING HARMONY IN THE HUMAN BEING**		**6**	**3**	**0**	**9**
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.						
UNIT III	**UNDERSTANING HARMONY IN THE FAMILY AND SOCIETY**		**6**	**3**	**0**	**9**
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.						
UNIT IV	**UNDERSTANING HARMONY IN THE NATURE AND EXISTENCE**		**6**	**3**	**0**	**9**
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.						
UNIT V	**HOLISTIC UNDERSTANING OF HARMONY**		**6**	**3**	**0**	**9**
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.						
						Total (30L + 15T) = 45 Periods

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.	Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	The Story of Stuff (Book)
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 this 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	L5: Evaluating
CO2	:	Handle problems with sustainable solutions, while keeping human relationships and human nature in mind	L3: Applying
CO3	:	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society)	L5: 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.	L3: Applying

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		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)

22ME101	**ENGINEERING GRAPHICS AND DESIGN**		**SEMESTER**			**II**
PREREQUISITE:		**CATEGORY**	**ES**	**Credit**		**3**
1. Students should know about the basics of drawings. 2. Students should be able to construct geometric shapes.		**Hours/Week**	**L**	**T**	**P**	**TH**
			1	**0**	**4**	**5**

Course Objectives:	
1.	To impart knowledge on graphical skills for communications of concepts, ideas and design of engineering products and to provide exposure to design.
2.	To expose them to existing national standards related to technical drawings.
3.	To understand the basics of points, lines, planes and solids.
4.	To understand the basics of the surface of object.
5.	To expose them to isometric and perspective views of simple solids.

UNIT I	**PROJECTION OF POINTS, LINES AND PLANE SURFACES**	**3**	**0**	**12**	**15**
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.					
UNIT II	**PROJECTION OF SOLIDS**	**3**	**0**	**12**	**15**
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.					
UNIT III	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**	**3**	**0**	**12**	**15**
Sectioning of 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.					
UNIT IV	**ORTHOGRAPHIC AND ISOMETRIC PROJECTION**	**3**	**0**	**12**	**15**
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 object. Principles of isometric projection – isometric scale - isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.					
UNIT V	**PERSPECTIVE PROJECTION**	**3**	**0**	**12**	**15**
Perspective projection of prisms, pyramids and cylinders by visual ray and vanishing point methods.					
Total (15L+ 60P) = 75 Periods					

Text Books:	
1.	Bhatt, N.D.,Panchal V M and Pramod R. Ingle, “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2014.
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, New Delhi, 2008.
2.	Gopalakrishna, K. R., “Engineering Drawing”,Subhas Stores, Bangalore, 2007.
3.	Natarajan, K. V., “A text book of Engineering Graphics”, 28thEdition,Dhanalakshmi Publishers, Chennai, 2015.
4.	Shah, M. B., and Rana, B. C., “Engineering Drawing”, Pearson Education, 2ndEdition, 2009.
5.	Venugopal, K. and Prabhu Raja, V., “Engineering Graphics”, New Age International (P) Ltd. New Delhi, 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 the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Ability to understand the fundamental concepts of projection of points, lines and planes.	L2: Understanding
CO2	Ability to Project the different views of solids with various positions.	L2: Understanding
CO3	Ability to section the solids with various positions and develop the lateral surfaces of solids.	L4: Analyzing
CO4	Familiarize to convert the isometric projection into orthographic projection of simple solids and vice versa.	L3: Applying
CO5	Visualize and project the perspective sections of simple solids.	L4: Analyzing

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO 11**	**PO1 2**	**PS O1**	**PS O2**	**PS O3**
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)															

<table>
<tr><td>22MCIN01</td><td colspan="4">ENGINEERING SPRINTS</td><td colspan="3">SEMESTER</td><td>II</td></tr>
<tr><td colspan="3">PREREQUISITE:</td><td colspan="2">CATEGORY</td><td>EEC</td><td colspan="2">Credit</td><td>1</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>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td colspan="9">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="8">To strengthen conceptual understanding of fundamental engineering concepts.</td></tr>
<tr><td>2.</td><td colspan="8">To spark curiosity in students’ Minds.</td></tr>
<tr><td>3.</td><td colspan="8">To focus on teaching through a problem-solving approach using Street Fight Engineering principles pioneered.</td></tr>
<tr><td>4.</td><td colspan="8">To foster the growth of functional independence and self-driven learning habits</td></tr>
<tr><td>5.</td><td colspan="8">To maximize the interest levels toward learning - as students aspire to create meaningful changes in the world.</td></tr>
<tr><td>UNIT I</td><td colspan="4">STREET FIGHTING ENGINEERING</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="9">Why Street fight 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</td></tr>
<tr><td>UNIT II</td><td colspan="4">PROGRAMMING PARADIGM</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="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</td></tr>
<tr><td>UNIT III</td><td colspan="4">BRAINS OF MACHINES</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="9">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 new innovations using Idea Hexagon - Brains of Digital camera</td></tr>
<tr><td>UNIT IV</td><td colspan="4">MACHINES THAT MAKE-UP THE WORLD</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="9">Basic of Electronics Passive Components -Need for sensors & Actuators - Analyzing & Understanding electronic circuits - How to Build a Basic Custom Hardware - Bootloader& its purpose</td></tr>
<tr><td>UNIT V</td><td colspan="4">ENGINEERING THE REAL WORLD</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="9">Real-world as systems - Introduction to Systems Thinking - Stock and Flow Diagrams - System Traps - Intervening in System - Living in a World of Systems</td></tr>
<tr><td colspan="9">Total (15P) = 15 Periods</td></tr>
</table>

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 the course, the students will be able to:**		**Bloom’s Taxonomy Mapped**
CO1	Apply street fight engineering concepts to solve problems	L3: Applying
CO2	Construct flowcharts & block diagrams for algorithms	L3: Applying
CO3	Apply the Idea Hexagon Tool to learn innovation models	L3: Applying
CO4	Understand basic electronics for building hardware	L3: Applying
CO5	Examine real-world problems with a system view	L4: Analyzing

COURSE ARTICULATION MATRIX															
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3							2		2				2
CO2	2			3					2						2
CO3	2	2		3					2		2				2
CO4	2	2		3				1	2		2				2
CO5		3				1	2		2	1	2				2
Avg.	**2**	**2.5**	**-**	**3**	**-**	**1**	**2**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**2**
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22MC201	**தமிழரும் தொழில்நுட்பமும்** **B.E. (Common to all Branches)**	**பருவம் II**	**II**

முன்நிபந்தனைகள்:	**CATEGORY**	**BS**	**Credit**		**1**
இலக்கணம் மற்றும் இலக்கியத்தின் அடிப்படைகள்	**Hours/Week**	**L**	**T**	**P**	**TH**
		1	**0**	**0**	**1**

பாடநெறி நோக்கங்கள்: மாணவர்களால்

1.	நெசவுத் தொழிலின் நன்மைகள், அதன் பயன்கள், பானைத் தொழில் நுட்பத்தைப் பற்றி நன்கு அறிந்து கொள்ள முடியும்.
2.	கட்டிடம் கட்டுதல் மற்றும் கட்டிடத் தொழிலுள்ள நுட்பங்கள் பற்றி அறிந்து கொள்ள முடியும்.
3.	உற்பத்தி தொழில் நுட்பம், இரும்பு, உலோகம், கனிமம், தொழிற்சாலைகள் பற்றி அறிந்து அவற்றின் பயன்பாடுகளை வெளிப்படுத்த முடியும்.
4.	வேளாண்மை மற்றும் நீர் பாசன முறைகள், தொழில் நுட்பம், ஏர் உழுதல் போன்ற பண்டைய கால நெறி முறைகளைப் பற்றி தெரிந்து நடைமுறைப் படுத்த முடியும்.
5.	இன்றைய கால கட்டத்தில் உள்ளவாறு அறிவியல் வளர்ச்சி, கணினித் தமிழ் பற்றி தெரிந்து கொண்டு அறிவை விரிவாக்க முடியும்.

அலகு I	**நெசவு மற்றும் பானை தொழில்நுட்பம்**:	**3**	**0**	**0**	**3**

சங்க காலத்தில் நெசவுத் தொழில் – பானை தொழில் நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**:	**3**	**0**	**0**	**3**

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

அலகு III	**உற்பத்தித் தொழில் நுட்பம்**:	**3**	**0**	**0**	**3**

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

அலகு IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**:	**3**	**0**	**0**	**3**

அணை, ஏரி, குளங்கள் , மதகு – சோழர் காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பொடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவசார் சமூகம்.

அலகு V	**அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**:	**3**	**0**	**0**	**3**

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.

Total = 15 Periods

Text Books/ Reference Books:

1.	தமிழக வரலாறு – மக்களும் பண்பாடும்- கே. கே. பிள்ளை (வெளீயிடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2.	கணினித் தமிழ்- முனைவர் இல. சுந்தரம்(விகடன் பிரசுரம்)
3.	கீழடி- வைகை நதிகரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை- ஆற்றங்கரை நாகரீகம் (தொல்லியல் துறை வெளியீடு)

பாடநெறி முடிவுகள்: இந்தப் படிப்பு முடிந்ததும், மாணவர்களால்			**Bloom's Taxonomy Mapped**
CO1	:	சங்காலத்தில் இருந்த நல்ல தொழில்களையும் கைவிணை கலைகளால் எற்படும் நன்மைகளையும் பற்றி அறிந்து கொண்டனர்.	L2: Understanding
CO2	:	கட்டிடங்கள் மற்றும் வீட்டுப்பொருட்ளை வடிவமைப்பது, சங்காலத்தில் இருந்த கோவில்களை பற்றி அறிந்து கொண்டனர்.	L2: Understanding
CO3	:	உலோகவியல், இரும்பு தொழிற்சாலைகள், தொல்லியல் சான்றுகள், உற்பத்தி தொழில் நுட்பத்தை பற்றி அறிந்து கொண்டனர்.	L3: Applying
CO4	:	பழங்காலத்தில் வேளாண்மை, நீர்பாசனம், மீன் வளம், கால்நடை பராமரிப்பு, அறிவுசார் சமூகம் பற்றி அறிந்து கொண்டனர்.	L3: Applying
CO5	:	அறிவியல் தமிழின் வளர்ச்சி, கணித்தமிழ் வளர்ச்சி, மென்பொருள் உருவாக்கம், இணைய கல்வி கழகம், இணையத்தில் தமிழ் அகராதிகள் பற்றி அறிந்து கொண்டனர்.	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						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 B.E. (Common to all Branches)	SEMESTER	II

PREREQUISITES	CATEGORY	BS	Credit		1
Basics of Tamil Language and Literature	Hours/Week	L	T	P	TH
		1	0	0	1

Course Objectives:	
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 technologies.
4.	To obtain the knowledge of agriculture and irrigation technology.
5.	To know about the development of Scientific Tamil and Tamil computing.

UNITI	**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)- Thirumalai Nayakar 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 gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.					
UNIT IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	3	0	0	3
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.					
UNIT 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/ Reference 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.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
4.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

Course Outcomes: Upon completion of this course, the Students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Obtain the knowledge about weaving and ceramic technology.	L2: Understanding
CO2	:	Familiarize about design and construction technology during Sangam age and British period.	L2: Understanding
CO3	:	Understanding about the manufacturing technologies.	L3: Applying
CO4	:	Acquire the skills in agriculture and irrigation technology.	L3: Applying
CO5	:	Acquire the knowledge about the development of Scientific Tamil and Tamil computing.	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						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)															

22NC201	**NCC COURSE - I (ONLY FOR NCC STUDENTS)**		**SEMESTER**			**II**
PREREQUISITE:		**CATEGORY**	**NC**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
1.	To maintain the unity and disciplines to the students					
UNIT I	**NCC GENERAL & NATIONAL INTEGRATION AND AWARENESS**		**9**	**0**	**0**	**9**
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.						
UNIT II	**PERSONALITY DEVELOPMENT & LEADERSHIP DEVELOPMENT**		**9**	**0**	**0**	**9**
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.						
UNIT III	**DISASTER MANAGEMENT AND HEALTH & HYGIENE**		**9**	**0**	**0**	**9**
Disaster Management Capsule- SochVichar, Types - Organisation, Capability & Role of NCC Cadets – Fire Service & Fire Fighting – Initiative Training, Organisation Skills, Do's and don't – Natural Disasters, Man Made Disasters; Health & Sanitation – First aid in Common Medical Emergencies, Treatment & Care of Wounds – Introduction to Yoga & Exercises.						
UNIT IV	**PRINCIPLES OF FLIGHT & GENERAL SERVICE KNOWLEDGE**		**9**	**0**	**0**	**9**
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.						
UNIT V	**NAVIGATION, AEROENGINES, AIRCOMPAIGNS & AIRMANSHIP**		**9**	**0**	**0**	**9**
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.						
Total (45L+0T) = 45 Periods						

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Acquired knowledge about the history of NCC, its organization, incentives of NCC, duties, different NCC camps.	L4: Analyzing
CO2	Understand the concept of national integration and its importance.	L2: Understanding
CO3	Understand the importance disaster management and health and hygiene.	L2: Understanding
CO4	Understand the importance principal of Flight and knowledge about armed services.	L2: Understanding
CO5	Understand and learn the importance of navigation, Aero engines & Airmanship work.	L2: Understanding

22EN102	**PROFESSIONAL SKILLS LABORATORY**		**SEMESTER**			**I / II**
PREREQUISITE		**CATEGORY**	**HS**	**Credit**		**1**
1. Basic language skills listening, speaking, reading and writing.		**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

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 this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Read passages fluently with good pronunciation	L1: Remembering
CO2	:	Develop an expressive style of reading	L6: Creating
CO3	:	Make effective oral presentations in technical and general contexts	L6: Creating
CO4	:	Excel at professional oral communication	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				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**
PREREQUISITES			**CATEGORY**	**BS**	**Credit**		**1.5**
Basic theoretical knowledge in Physics			**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 this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Handle different measuring instruments and to measure different parameters.	L3: Applying
CO2	:	Calculate the important parameters and to arrive at the final result based on the experimental measurements.	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	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**
PREREQUISITE		**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.	L2: Understanding
CO2	To calculate the composition of brass quantitatively and the molecular weight of polymers.	L3: Applying
CO3	To understand the principle and applications of conductometric and pH titrations, spectrometer, and potentiometric titrations.	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	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)

22MA302	**STATISTICS AND NUMERICAL METHODS**			**SEMESTER**		**III**
PREREQUISITES		**CATEGORY**	**BS**	**Credit**		**4**
Basic 12th level knowledge of Statistics, Solving equations, Matrices and Differential Calculus.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**1**	**0**	**4**

Course Objectives:

1.	To understand the statistical averages and fitting of curves.
2.	To gain the knowledge of significance test for large and small samples.
3.	To obtain the knowledge about numerical interpolation, differentiation and integration.
4.	To acquire knowledge of numerical solution to first order ordinary differential equations using single step and multi-step methods.
5.	To gain the knowledge of numerical solution to second order partial differential equations by using explicit and implicit methods.

UNIT I	**BASIC STATISTICS**	**9**	**3**	**0**	**12**

Measures of Central tendency: Moments, Skewness and Kurtosis, Curve fitting by the Method of Least Squares –Fitting of straight lines, second degree parabolas and curves reducible to linear forms.

UNIT II	**TEST OF HYPOTHESIS**	**9**	**3**	**0**	**12**

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 and correlation co-efficient, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

UNIT III	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9**	**3**	**0**	**12**

Solution of Algebraic and Transcendental equations by Newton-Raphson method- Solution of system of equations by Gauss Elimination and Gauss Seidel iterative methods - Interpolation using Newton’s Forward and Backward formulae. Interpolation with unequal intervals: Newton’s divided difference and Lagrange’s formulae Numerical Differentiation and Integration: Trapezoidal rule and Simpson’s 1/3 rule, Simpson’s 3/8 rule.

UNIT IV	**NUMERICAL SOLUTION FOR ORDINARY DIFFERENTIAL EQUATIONS**	**9**	**3**	**0**	**12**

Ordinary differential equations: Taylor series method- Euler and modified Euler’s method- Runge-Kutta method of fourth order for solving first and second order differential equations- Milne’s and Adam’s predictor - corrector methods.

UNIT V	**NUMERICAL SOLUTION FOR PARTIAL DIFFERENTIAL EQUATIONS**	**9**	**3**	**0**	**12**

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 (45L+15T) = 60 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”,11th Edition, S. Chand and Sons, New Delhi, 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", 6th 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 statistical averages and fitting the curves by Least Square Method.	L2: Understanding
CO2	:	Acquire the techniques of interpolation.	L3: Applying
CO3	:	Familiar with the numerical differentiation and integration	L2: Understanding
CO4	:	Solve the initial value problems for ordinary differential equations.	L3: Applying
CO5	:	Find the numerical solution of partial differential equation by using Finite difference method.	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	2	3	3									2		
CO2	3	2	3	3									2		
CO3	3	2	2	3									2		
CO4	3	2	2	2									2		
CO5	3	2	2	2									2		
Avg	**3**	**2**	**2.4**	**2.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

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

22EE301	**ELECTRIC CIRCUIT ANALYSIS**	**SEMESTER**			**III**
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**4**
Mathematics and Physics	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**1**	**0**	**4**

Course Objectives:

1.	To study the fundamentals of the concept of circuit elements, the basic laws of networks.
2.	To learn and analyse the AC single phase and three phase circuits.
3.	To understand the Laplace Transforms in the context of circuit representations.
4.	To analyse the two-port network and its parameters.

UNIT I	**ANALYSIS METHODS AND NETWORK THEOREMS**	**9**	**3**	**0**	**12**

Node and Mesh Analysis. Analysis with dependent current and voltage sources. Concept of duality and dual networks. Applications of: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem.

UNIT II	**SOLUTION OF FIRST AND SECOND ORDER NETWORKS**	**9**	**3**	**0**	**12**

Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

UNIT III	**SINUSOIDAL STEADY STATE ANALYSIS**	**9**	**3**	**0**	**12**

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Single Phase circuits, Three-phase circuits – Balanced and Unbalanced Circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

UNIT IV	**ELECTRIC CIRCUIT ANALYSIS USING LAPLACE TRANSFORMS**	**9**	**3**	**0**	**12**

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots)

UNIT V	**RESONANCE AND TWO PORT NETWORK FUNCTIONS**	**9**	**3**	**0**	**12**

Series and Parallel Resonance and analysis. Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Total (45L+15T) = 60 Periods

Text Books:

1.	M Nahvi and I.A.Edminister "Electric Circuits"; Schaum's outline series, McGraw Hill, 5th Edition, 2019.
2.	Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Fifth Edition, McGraw Hill, 2019.
3.	James W. Nilsson and Susan A. Riedel ," Electric circuits ", Pearson Education, Inc, 11th Edition, 2019.

Reference Books:

1.	William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, New Delhi, 9th Edition, 2020.
2.	Sudhakar. A, Shyammohan. S.P "Circuits and Networks-Analysis and Synthesis" McGraw Hill, 5th Edition, 2017.
3.	M. E. Van Valkenburg and T.S. Rathore, "Network Analysis", Revised 3rd Edition, Pearson Education, 2019.
4.	D. Roy Choudhury, "Networks and Systems", New Age International Publishers, Second Edition, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Solve the electrical network using mesh, nodal analysis and applying network theorems.	L3: Applying
CO2	:	Solve the first order and second order differential equations for series and parallel circuits and analyse its steady state and transient response.	L3: Applying
CO3	:	Analyze the steady state response for AC sinusoidal input and and basic concepts of resonance and coupled circuits.	L4: Analyzing
CO4	:	Analyse the electrical circuit using Laplace transforms	L4: Analyzing
CO5	:	Understand the two port networks and its parameters for electric circuit analysis.	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	2	1	2	3		1				2	3	3	2	1
CO2	3	2	1	2	3		1				2	3	3	2	1
CO3	3	2	1	2	3		1				2	3	3	2	1
CO4	3	3		2	2						2	2	3	2	1
CO5	3	2		2	2						2	2	3	2	1
Avg.	**3**	**2.2**	**1**	**2**	**2.6**	**-**	**1**	**-**	**-**	**-**	**2**	**2.6**	**3**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE302	**ELECTROMAGNETIC THEORY**		**SEMESTER**			**III**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
Basic Electrical and Electronics Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**1**	**0**	**3**
Course Objectives:						
To impart knowledge on the basic concepts of vectors, coordinate systems, static and dynamic electric and magnetic fields and apply maxwells equations for various engineering applications involving electromagnetic waves.						
UNIT I	**ELECTROSTATICS – I**		**6**	**3**	**0**	**9**
Vector fields: Components of a vector and Classification of vector fields - Coordinate Systems and transformation – Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications.						
UNIT II	**ELECTROSTATICS – II**		**6**	**3**	**0**	**9**
Electric flux density – Electric potential – Electric dipole – Electric field in free space, conductors, dielectrics, - Dielectric polarization- Dielectric strength- Electric field in multiple dielectrics-– Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.						
UNIT III	**MAGNETOSTATICS**		**6**	**3**	**0**	**9**
Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetic scalar and vector potential - Magnetic force, Torque and Moment - Magnetization, Magnetic field in multiple media – Boundary conditions, Poisson's Equation, Inductance, Energy density, Applications.						
UNIT IV	**ELECTRODYNAMIC FIELDS**		**6**	**3**	**0**	**9**
. Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form) – Time-Varying Potentials - Time-Harmonic Fields - Relation between field theory and circuit theory						
UNIT V	**ELECTROMAGNETIC WAVES**		**6**	**3**	**0**	**9**
Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.						
Total (30L+15T) = 45 Periods						

Text Books:	
1.	Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2.	William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
3.	Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.
Reference Books:	
1.	V.V.Sarwate, 'Electromagnetic fields and waves', First Edition, Newage Publishers, 1993.
2.	J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition, Khanna Publishers.
3.	Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), McGraw Hill, 2010.
4.	S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education(India) Private Limited, 2012.
5.	K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Eighth Reprint : 2015.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the fundamental concept, laws and theorem of electric and magnetic fields.	L1: Remembering
CO2	:	Associate the concepts in electrostatic fields and magnetic fields.	L2: Understanding
CO3	:	Analyze the Electric and magnetic Field in material space.	L4: Analysing
CO4	:	Apply the boundary conditions to the applications in electrostatic fields and magnetostatic fields.	L3: Applying
CO5	:	Assess the knowledge of electromagnetic waves and characterizing parameters.	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	3	3	2	2	2								3	1	
CO2	1	3	2	2	2								2	1	
CO3	1	3	2	2	2								2	1	
CO4	1	1	3	3	2								2	2	
CO5	1	1	3	2	2								2	2	
Avg	**1.4**	**2.2**	**2.4**	**2.2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.1**	**1.4**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EE303</td><td colspan="2">DC MACHINES AND TRANSFORMERS</td><td colspan="3">SEMESTER</td><td>III</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</td><td colspan="2">Credit</td><td>3</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>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 concepts of electromechanical energy conversion and to gain the knowledge on single and multiply-excited magnetic systems.</td></tr>
<tr><td>2.</td><td colspan="6">To gain the knowledge on construction and principles of operation of DC machines and transformers.</td></tr>
<tr><td>3.</td><td colspan="6">To analyze the performance characteristics of different types of DC machines and transformers.</td></tr>
<tr><td>4.</td><td colspan="6">To appreciate the applications of DC machines and transformers.</td></tr>
<tr><td>5.</td><td colspan="6">To analyze the performance of DC machines and transformers by conducting various tests.</td></tr>
<tr><td>Unit I</td><td colspan="2">ELECTROMECHANICAL ENERGY CONVERSION</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Magnetic circuits – Magnetically induced EMF and force – AC operation of magnetic circuits – Energy in magnetic systems – Field energy & mechanical force – Single and Multiply-excited magnetic field systems.</td></tr>
<tr><td>Unit II</td><td colspan="2">DC GENERATORS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Constructional features of DC machine – Principle of operation of DC generator – EMF equation – Types of excitation – No load and load characteristics of DC generators – Commutation - Armature reaction – Parallel operation of DC generators - Applications.</td></tr>
<tr><td>Unit III</td><td colspan="2">DC MOTORS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Principle of operation of DC motors - Back EMF – Torque equation – Types of DC motors – Speed and Torque characteristics of DC motors – Starting of DC motors: 3- point starter, 4- point starter – Speed control of shunt and series motor : Field current control and Armature voltage control – Applications.</td></tr>
<tr><td>Unit IV</td><td colspan="2">TRANSFORMERS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Constructional features of single phase transformers–Principle of operation - EMF equation –ideal transformer characteristics - Practical Transformer working on No- load and Load with phasor diagram – Equivalent circuit – Regulation – Parallel operation - Autotransformers - Three phase transformer connections.</td></tr>
<tr><td>Unit V</td><td colspan="2">TESTING OF DC MACHINES AND TRANSFORMERS</td><td>6</td><td>3</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Losses and efficiency – Condition for maximum efficiency – Testing of DC machines: Swinburne's test and Hopkinson's test - Testing of transformers: open circuit and short circuit tests, Sumpner's test – All day efficiency.</td></tr>
<tr><td colspan="7" align="right">Total (30L+15T)= 45 Periods</td></tr>
</table>

Text Books:

1.	D.P. Kothari, I.J. Nagrath, "Electric Machines", Fifth Edition, McGraw-Hill Education, New York, 2017.
2.	Dr. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, New Delhi, 2nd Edition, 2021.

Reference Books:

1.	B.L. Theraja& A.K. Theraja, "Electrical Technology", Vol.II, S.Chand & Company Ltd., New Delhi, 2015.
2.	A.E. Fitzgerald, Charles Kingsley, Stephen. D.Umans, "Electric Machinery", McGraw Hill Education Ltd, 6th Edition, 2017.
3.	K. Murugesh Kumar, "DC Machines and Transformers", Vikas Publishing House Pvt. Ltd., Second Edition, 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	:	Recite the concepts of electromechanical energy conversion principles for single and multiply excited magnetic field system.	L1: Remembering
CO2	:	Explain the construction and working principal of DC machines and transformers.	L2: Understanding
CO3	:	Evaluate the performance characteristics of DC machines and transformers.	L5: Evaluating
CO4	:	Compute various performance parameters of DC machines, by conducting suitable tests.	L3: Applying
CO5	:	Predetermine efficiency and regulation parameters of Transformer by conducting suitable test.	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**	**PSO 3**
CO1	3	2	1			1						1	3	1	1
CO2	3	2	1			1						1	3	1	1
CO3	3	2	1			1						1	3	1	1
CO4	3	2	3	1								1	3	1	1
CO5	3	2	3	1								1	3	1	1
Avg	**3**	**2**	**1.8**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**1**

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

<table>
<tr><td>22EE304</td><td colspan="2">ELECTRON DEVICES AND CIRCUITS</td><td colspan="3">SEMESTER</td><td>III</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</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 Objectives:</td></tr>
<tr><td>1.</td><td colspan="6">To understand the characteristics of diodes.</td></tr>
<tr><td>2.</td><td colspan="6">To understand the characteristics of transistors.</td></tr>
<tr><td>3.</td><td colspan="6">To design amplifier circuits</td></tr>
<tr><td>4.</td><td colspan="6">To design the oscillator circuits.</td></tr>
<tr><td>UNIT I</td><td colspan="2">DIODES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Structure – Equilibrium conditions – Energy Band Concepts – Zero bias – Forward Bias – Reverse bias – Junction capacitances – one sided and Non- uniformly doped junctions – Ideal PN junction current, P-N junction diode, V-I characteristics of a diode, review of half-wave and full-wave rectifiers, Zener diodes, voltage regulator using zener diode, clamping and clipping circuits.</td></tr>
<tr><td>UNIT II</td><td colspan="2">TRANSISTORS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Physical behaviour of a BJT – Ebers - Moll model. Modes of transistor operation - Common base, common emitter and common collector configurations, Input and output characteristics, Early effect, regions of operation. AC and DC load lines - Need for stability of Q-Point. Bias stability – fixed bias, collector to base bias, self bias. Junction field effect transistor – structure, JFET structure and MOSFET characteristics and characteristics -UJT- structure and characteristics.</td></tr>
<tr><td>UNIT III</td><td colspan="2">SMALL SIGNAL AMPLIFIER CIRCUITS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Single stage BJT and FET amplifiers, Analysis at low, medium and high frequencies – BJT and FET Differential amplifier, Differential and Common mode gain with resistive load and active load, CMRR - Cascode and Darlington Amplifiers.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">LARGE SIGNAL AMPLIFIER CIRCIUTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Power amplifiers– Classification, Single ended and Push-pull Configuration, Power dissipation, Output power and Conversion efficiency, Complementary symmetry power amplifiers, Class AB operation, Class C and Class D amplifiers, thermal considerations.</td></tr>
<tr><td>UNIT V</td><td colspan="2">FEEDBACK AMPLIFIERS AND OSCILLATORS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T)= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Millman J, Halkias C, SatyaBrata JIT, “Electronic Devices & Circuits”, Tata McGraw-Hill, New Delhi, 2010.</td></tr>
<tr><td>2.</td><td>David A. Bell, “Electronic Devices and Circuits”, New Delhi: Oxford University Press, 5th Edition, 2008.</td></tr>
<tr><td>3.</td><td>Boylestead L R, Nashelsky L, “Electronic Devices and Circuit Theory”, Pearson Education, New Delhi, 2009.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>Rashid, “Micro Electronic Circuits” Thomson publications, 1999.</td></tr>
<tr><td>2.</td><td>Donald L.Schilling and Charles Belove, “Electronic Circuits”, 3 Edition, Tata McGraw Hill, 2010.</td></tr>
<tr><td>3.</td><td>Adel Sedra, Kenneth.C Smith, “Microelectronics Circuits”, Oxford University Press, New Delhi, 2010</td></tr>
<tr><td colspan="2">E-Reference</td></tr>
<tr><td>1</td><td>https://electronicsforu.com/resources/electronic-devices-and-circuit-theory</td></tr>
<tr><td>2</td><td>https://nptel.ac.in/courses/117103063/</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 Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>:</td><td>Understand overview of semiconductor devices.</td><td>L2: Understanding</td></tr>
<tr><td>CO2</td><td>:</td><td>Recognize the fundamentals and characteristics of BJT</td><td>L1: Remembering</td></tr>
<tr><td>CO3</td><td>:</td><td>Analyze the fundamentals and characteristics of FET and UJT</td><td>L2: Understanding</td></tr>
<tr><td>CO4</td><td>:</td><td>Design and analyze the amplifiers</td><td>L4: Analysing</td></tr>
<tr><td>CO5</td><td>:</td><td>Design and analyze the differential amplifiers</td><td>L4: Analysing</td></tr>
</table>

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	1	1	1	1	3	1			1		1	1	1
CO2	2	3	3	3	2	1	2	1	1		1		1	1	1
CO3	3	2	2	3	2	1	2	1	1		1		1	1	1
CO4	2	3	2	3	3	1	2	1	1		1		2	2	1
CO5	2	2	3	3	3	1	2	1	1		1		2	2	1
Avg.	**2**	**2.2**	**2.2**	**2.6**	**2.2**	**1**	**2.2**	**1**	**1**	**-**	**1**	**-**	**1.4**	**1.4**	**1**
3/2/1-indiates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE305	SIGNALS AND SYSTEMS			SEMESTER			III
PREREQUISITES			**CATEGORY**	**PC**	**Credit**		**3**
Fourier Series and Transforms			**Hours/Week**	**L**	**T**	**P**	**C**
				2	**1**	**0**	**3**

Course Objectives:

1.	To understand the concepts of continuous time and discrete time systems.
2.	To analyze systems in complex frequency domain.
3.	To understand sampling theorem and its implications.

UNIT I	**INTRODUCTION TO SIGNALS AND SYSTEMS**	**6**	**3**	**0**	**9**

Signals and systems- Signal properties: periodicity, absolute integrability, deterministic and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & amp; Aperiodic signals, Deterministic & amp; Random signals, Energy & amp; Power signals. System properties: linearity, additivity and homogeneity, shift-invariance, causality, stability, realizability, Examples.

UNIT II	**CONTINUOUS AND DISCRETE-TIME LTI SYSTEMS**	**6**	**3**	**0**	**9**

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

UNIT III	**FOURIER AND LAPLACE TRANSFORMS**	**6**	**3**	**0**	**9**

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior.

UNIT IV	**Z- TRANSFORMS**	**6**	**3**	**0**	**9**

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z transform, application to discrete systems - Stability analysis, frequency response – Convolution.

UNIT V	**SAMPLING AND RECONSTRUCTION**	**6**	**3**	**0**	**9**

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Total (30L+15T)= 45 Periods

Text Books:

1.	Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, 2015.
2.	J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3.	B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.
4.	A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall,2009.

Reference Books:

1.	H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
2.	S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.
3.	M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.

E-Reference:

1	https://nptel.ac.in/courses/117104074/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Determine if a given system is linear/causal/stable	L2: Understanding
CO2	:	Capable of determining the frequency components present in a deterministic signal	L1: Remembering
CO3	:	Capable of characterizing LTI systems in the time domain and frequency domain	L1: Remembering
CO4	:	To be able to compute the output of an LTI system in the time and frequency domains	L3: Applying
CO5	:	Capable of determining the frequency response of discrete system using Z transform	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	1	1	1	1	1	1							1	1	
CO2	2	3	3	3	2	1							1	1	
CO3	3	2	2	3	2	1							1	1	
CO4	2	3	2	3	3	1							2	2	
CO5	2	2	3	3	3	1							2	2	
Avg.	**2**	**2.2**	**2.2**	**2.6**	**2.2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.4**	**1.4**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22MCIN02	**INNOVATION SPRINTS**		**SEMESTER**			**III**
PREREQUISITES		**CATEGORY**	**EE**	**Credit**		**1**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**2**	**2**
Course 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 validation and customer discovery problems.					
UNIT I	**CHALLENGE CURATION**		**0**	**0**	**3**	**3**
Introduction: Design Thinking Principles - Design Thinking Values - Design Thinking Methods - Challenge impact setting - Framing the design challenge.						
UNIT II	**CUSTOMER-CENTRIC INNOVATION**		**0**	**0**	**3**	**3**
Understanding Customer needs - Empathy building techniques - gap analysis – adoptionbarriers - observations and insights - Translating Insights into Innovation Opportunities.						
UNIT III	**IDEA GENERATION**		**0**	**0**	**3**	**3**
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	**PROTOTYPING**		**0**	**0**	**3**	**3**
Prototyping 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**	**3**	**3**
Science of Storytelling - the blueprint for storytelling - Pitch Script - Pitch Presentations - Best practices to creating a compelling pitch - communication fundamentals						
						Total (15L) = 15 Periods

Text Books:	
1.	Tim Brown (2019), “Change by Design: How design thinking transforms organizations and inspires innovation”
2.	Jan Chipchase& Simon 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.	IdrisMootee(2013), Design Thinking for Strategic Innovation, Willey
5.	Alexander Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want (Strategyzer) - John Wiley & Sons, 2014
Reference Books:	
1.	avoia. Alberto, 2009 The Pretotyping Manifesto -
2.	https://sites.google.com/a/pretotyping.org/www/the-pretotyping-manifesto
3.	Jazz Factory, All about Presentations - http://blog.jazzfactory.in/
4.	Pretotyping Methodology - https://www.pretotyping.org/methodology.html

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom’s Taxonomy Mapped**
CO1	Identify real-world problems	L2: Understanding
CO2	Apply the challenge curation techniques to real-world problems.	L3: Applying
CO3	Analyze the problems and generate solutions to address the challenges	L4: Analyzing
CO4	Build solutions using pertotyping tools & techniques	L3: Applying

CO5	Develop an innovation pitch to effectively communicate the idea to solve the identified problem	L4: 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**	**PS O1**	**PS O2**	**PS O3**
CO1		3				2	1		2						2
CO2		3		2					2						2
CO3			3	2					2						2
CO4	2		3					1	2						2
CO5									2	3					2
Avg.	**2**	**3**	**3**	**2**	**-**	**2**	**1**	**1**	**2**	**3**	**-**	**-**	**-**	**-**	**2**
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

COURSE OBJECTIVES:

1. Learn the salient features of the Indian Constitution.
2. To study the List the Fundamental Rights and Fundamental Duties.
3. To study the Present a systematic analysis of all dimensions of Indian Political System.
4. To study the Understand the power and functions of the Parliament, the Legislature and the Judiciary.

UNIT I		**3**	**0**	**0**	**3**

Union and its Territory – Citizenship–Fundamental Rights–Directive Principles of State Policy–Fundamental Duties

UNIT II		**3**	**0**	**0**	**3**

The Union–The States–The Union Territories–The Panchayats–The Municipalities

UNIT III		**3**	**0**	**0**	**3**

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		**3**	**0**	**0**	**3**

Services under the Union, the States – Tribunals – Elections– Special Provisions –Relating to certain Classes

UNIT V		**3**	**0**	**0**	**2**

Languages–Emergency Provisions – Miscellaneous–Amendment of the Constitution

Total (15L+0T)= 15 Periods

REFERENCE BOOKS:

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

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the emergence and evolution of the Indian Constitution	L2: Understanding
CO2	Explain the key concepts of Indian Political System	L2: Understanding
CO3	Describe the role of constitution in a democratic society.	L2: Understanding
CO4	Present the structure and functions of the Central and State Governments, the Legislature and the Judiciary	L3: Applying

<table>
<tr><td>22NC301</td><td colspan="2">NCC COURSE-II</td><td colspan="3">SEMESTER</td><td>III</td></tr>
<tr><td colspan="2">PRE-REQUISITE:</td><td>CATEGORY</td><td>NC</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>C</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 maintain the unity and disciplines to the students</td></tr>
<tr><td>UNIT I</td><td colspan="2">SOCIAL SERVICE & COMMUNITY DEVELOPMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT II</td><td colspan="2">GENERAL AWARENESS & ADVENTURE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">General Knowledge – Logical & Analytical Reasoning - Modes of Entry to Army, CAPF, Police – SSB Procedure; Para Sailing – Slithering – Rock climbing – Cycling and Trekking.</td></tr>
<tr><td>UNIT III</td><td colspan="2">AEROENGINES & NAVIGATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">AIRFRAME & METEOROLOGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT V</td><td colspan="2">FLIGHT INSTRUMENTS & AEROMODELLING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7" align="right">Total (45L+0P) = 45 Periods</td></tr>
</table>

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.	L2: Understanding
CO2	Understand the adventure activities and verbal training on defence examinations.	L1: Remembering
CO3	Understand the technical knowledge on aero engines and map reading.	L2: Understanding
CO4	Understand the structure and control of an aircraft.	L2: Understanding
CO5	Understand and learn the importance of avionic instruments on aircraft control.	L1: Remembering

22EE306	**DC MACHINES AND TRANSFORMERS LABORATORY**		**SEMESTER**			**III**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1. To understand the performance characteristics of DC machines and transformers
2. To gain knowledge on experimental skill of testing different types of DC machines and transformers.

LIST OF EXPERIMENTS

1. Open circuit and load characteristics of separately excited DC generator.
2. Open circuit and load characteristics of DC shunt generator.
3. Load characteristics of DC long shunt and short shunt compound generator with cumulative and differential connections.
4. Load test on DC shunt motor.
5. Load test on DC series motor.
6. Speed control of DC shunt motor
7. Swinburne’s test on DC machine
8. Hopkinson’s test on two identical DC machines.
9. Load test on single-phase transformer / three phase Transformer
10. Open circuit and Short circuit tests on single phase Transformer
11. Sumpner’s test on Single-phase transformers.
12. Study of DC motor starters and 3-phase transformer connections

Total (0+45)= 45 Periods

Reference Books:

1. G.P. Chhalotra, ‘Experiments in Electrical Engineering’, 3rd Edition., Khanna Publishers, Delhi, 2004.
2. C.S. Indulkar, ‘Laboratory Experiments in Electrical Power’, 3rd Edition., Khanna Publishers, Delhi, 2010.
3. DC machines and transformers laboratory manual prepared by the department.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Determine the characteristics of different types of machines.	L2: Understanding
CO2	:	Demonstrate the speed-control technique for a DC shunt motor.	L2: Understanding
CO3	:	Predetermine the performance parameter of DC machine.	L3: Applying
CO4	:	Predetermine the performance parameter of transformer.	L3: Applying
CO5	:	Understand DC motor starters and 3-phase transformer connections.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO5**	**P O6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	3	2					2	1		1	3	1	1
CO2	3	2	2	2					2	1		1	3	1	1
CO3	3	2	3	2					2	1		1	3	1	1
CO4	3	2	3	2					2	1		1	3	1	1
CO5	3	2	1	2					2	2		1	3	1	1
Avg	**3**	**2**	**2.4**	**2**	**-**	**-**	**-**	**-**	**2**	**1.2**	**-**	**1**	**3**	**1**	**1**

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

22EE307	ELECTRIC CIRCUITS AND ELECTRON DEVICES LABORATORY		SEMESTER			III
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
Engineering physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1.	To verify the laws and theorems in electric circuits.
2.	To verify the characteristics of electron devices and design its application circuits.
3	To observe the behaviour of the electrical and electronic circuits through its frequency response.

LIST OF EXPERIMENTS

I. ELECTRIC CIRCUITS

1. Verification of Ohm's law and Kirchoff's laws
2. Verification of Thevenin's / Norton's theorem.
3. Verification of Superposition theorem.
4. Verification of Maximum Power transfer theorem
5. Frequency response of series / parallel resonance circuits
6. Transient response of RL, RC and RLC circuit with DC inputs.

II. ELECTRON DEVICES AND CIRCUITS

1. Characteristics of PN Junction Diode and Clippers / Clampers.
2. Design and Implementation of Zener Diode and Voltage regulators.
3. Design and Implementation of Single phase half wave rectifier with and without filters.
4. Design and Implementation of full wave rectifier with and without filters.
5. Static Characteristics of BJT under CE/ CB/ CC.
6. Static characteristics of JFET.

Total (0L+45P)= 45 Periods

Reference Books:

1	David A. Bell, "Electronic Devices and Circuits", New Delhi: Oxford University Press, 5th Edition, 2008.
2	Millman J, Halkias C, SatyaBrata JIT, "Electronic Devices & Circuits", Tata McGraw-Hill, New Delhi, 2010.
3	Boylestead L R, Nashelsky L, "Electronic Devices and Circuit Theory", Pearson Education, New Delhi, 2009.

E –References:

1	https://electronicsforu.com/resources/electronic-devices-and-circuit-theory
2	https://nptel.ac.in/courses/117103063/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Verify the laws and theorems experimentally.	L2: Understanding
CO2	:	Understand the behaviour of electric circuits.	L2: Understanding
CO3	:	Verify the characteristics of different electron devices.	L3: Applying
CO4	:	Design the circuits based on the application.	L3: Applying
CO5	:	Observe the behaviour of electronic circuits.	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	1	1							1		
CO2	3	2	2	2	2	1							2		
CO3	2	1	1	1	1	1							1		
CO4	3	2	2	2	2	1							2		
CO5	3	1	2	2	2	1							2		
Avg.	**2.6**	**1.4**	**1.6**	**1.6**	**1.6**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.6**	**-**	-
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE401	**SYNCHRONOUS AND INDUCTION MACHINES**		**SEMESTER**			**IV**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
Electromagnetic Theory		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**1**	**0**	**3**

Course Objectives:

This course provides understanding of AC machinery fundamentals, machine parts and helps to develop the skills for operating AC machines, and equips students to analyze the equivalent circuits of Induction and Synchronous Machines.

UNIT I	**ALTERNATOR**	**6**	**3**	**0**	**9**

Construction, types, practical rating of synchronous generators, winding factors, production of EMF, armature reaction, Synchronous reactance, phasor diagram, Methods of pre-determination of voltage regulation- Synchronous impedance, ampere turn, Potier triangle methods. Two reaction theory–Slip test, and parallel operation synchronization -Change of excitation and mechanical input

UNIT II	**SYNCHRONOUS MOTOR**	**6**	**3**	**0**	**9**

Theory of operation–phasor diagrams, Torque equation – Operation on infinite bus bars, variation of current and power factor with excitation. Hunting and its suppression, V and inverted V curves, Synchronous condenser, method of starting.

UNIT III	**THREE PHASE INDUCTION MACHINES**	**6**	**3**	**0**	**9**

Constructional details, types, production of rotating magnetic field-principle of operation and practical rating of induction motors. Need for starting – Types of starters – DOL, Rotor resistance and Auto transformer and star-delta starters. Generator action: self-excitation, operation, and applications.

UNIT IV	**ANALYSIS AND TESTING OF THREE PHASE INDUCTION MOTORS**	**6**	**3**	**0**	**9**

Phasor diagram, equivalent circuit, Torque equation-starting and maximum-torque, maximum-output, slip for maximum-output, Torque-slip characteristics, losses and efficiency. Testing-no load and blocked rotor tests- equivalent circuit parameters, circle diagram.

UNIT V	**SINGLE PHASE INDUCTION MOTOR**	**6**	**3**	**0**	**9**

Constructional details of single-phase induction motor – Double field revolving theory and operation – Equivalent circuit – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor – repulsion motor Hysteresis motor.

Total (30L+15T) = 45 Periods

Text Books:

1.	D.P. Kothari, I.J. Nagrath, “Electric Machines”, 5th Edition, McGraw-Hill Education, New York, 2017.
2.	Dr.P.S.Bimbhra, “Electrical Machinery”, Khanna Publishers, Delhi, 2nd Edition, 2021.
3.	A.E. Fitzgerald, Charles Kingsley, Stephen. D.Umans, “Electric Machinery”, McGraw Hill Education, 6th Edition 2017.

References:

1.	B.L.Theraja & A.K. Theraja, “Electrical Technology”, Vol.II, S.Chand& Company Ltd., New Delhi, 2015.
2	Alexander S. Langsdorf, “Theory of Alternating-Current Machinery”, Tata McGraw Hill Publications, 2001.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Familiarize with construction, working principle, synchronizing techniques and performance of Synchronous Generator.	L1: Remembering
CO2	:	Understand the working principle, torque equation, and excitation control for Synchronous Motor.	L2: Understanding
CO3	:	Operate three phase Induction machine as motor and as a generator, analyze the performance of three phase induction motor.	L4: Analyzing
CO4	:	Know double field revolving theory and starting mechanisms for single-phase induction motors.	L2: Understanding
CO5	:	Use synchronous and induction motors in practical domain with specified ratings.	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1		1			2				1	2	1	1	
CO2	2	1		1	2						1	1	1	2	
CO3	3	1	1	3			2		2		2		1	2	1
CO4	1	1	1	1	1					2		2	1	1	
CO5	1	1	2	3							2		1	1	1
Avg	**1.4**	**1**	**1.3**	**1.8**	**1.5**	**-**	**2**	**-**	**2**	**2**	**1.5**	**1.7**	**1**	**1.4**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE402	**MEASUREMENTS AND INSTRUMENTATION**		**SEMESTER**			**IV**
PREREQUISITES		**CATEGORY**	**PC**	**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 and use 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							2		2	2	1	1
CO2	1	3	1		2					1		1	2	1	
CO3	1	1		2	1		2						1	2	1
CO4	1	1	2	1	1	1	2				2	2	1	3	1
CO5	2	2	3	1	2	2	1			1	3		1	2	
Avg	**1.4**	**1.8**	**2**	**1.33**	**1.5**	**1.5**	**1.67**	**-**	**-**	**1.33**	**2.5**	**1.67**	**1.4**	**1.8**	**1**

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

22EE403	ANALOG AND DIGITAL INTEGRATED CIRCUITS		SEMESTER			IV
PREREQUISITES		**CATEGORY**	**PC**	**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 and applications of Operational 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. D.Roy Chowdhury and Shail B. Jain, “Linear Integrated Circuits”, Fourth Edition, New Age International (P) Ltd Publishers, 2014.
3. M. Morris Mano, “Digital Design” , Third Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2010 .
4. S. Salivahanan and S. Arivazhagan, “Digital Circuits and Design”, Third Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 2011

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 tabulation 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**	**2.33**	**1.25**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2.8**	**3**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE404	**POWER GENERATION, TRANSMISSION AND DISTRIBUTION SYSTEM**	**SEMESTER**			**IV**
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**3**
Electric circuit analysis, Electromagnetic Theory	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**
Course Objectives:					
1.	To impart knowledge on power generation plants and Substation				
2.	To study the line parameters and analyze the performance of the transmission system				
3.	To learn insulators, cables and grounding methodologies for power system				
UNIT I	**POWER GENERATION SYSTEMS**	**9**	**0**	**0**	**9**
Structure of electric power system-Terms, factors and significance of Load curve –Economics of Power Generation-Cost of Electrical Energy- Power generating Station: layout and operation of Thermal power plant, Hydroelectric power plant and Nuclear power plants –Comparison of power plants.					
UNIT II	**TRANSMISSION LINE PARAMETERS**	**9**	**0**	**0**	**9**
Line resistance- Inductance and capacitance calculations of single phase and three phase transmission lines with single and double circuits–Effect of earth on the capacitance of the transmission line– Skin and proximity effects-Inductive interference between power and communication lines.					
UNIT III	**PERFORMANCE OF TRANSMISSION LINES**	**9**	**0**	**0**	**9**
Representation of Lines-Performance of Short line, medium line and long transmission line; equivalent circuits, Phasor Diagrams, transmission efficiency and voltage regulation, ABCD constants-surge-impedance loading-Ferranti effect and corona effect.					
UNIT IV	**OVERHEAD LINE INSULATORS AND CABLES**	**9**	**0**	**0**	**9**
Insulators: Types, Potential distribution over a string of suspension insulators- improvement of string efficiency. Underground cables: Constructional features of LT and HT cables, capacitance of single core and 3- core cables, dielectric stress in a single core cable- grading of cables, thermal resistance of dielectric of a single core cable.					
UNIT V	**SUBSTATION, GROUNDING SYSTEM AND DISTRIBUTION SYSTEM**	**9**	**0**	**0**	**9**
Substation: Lay out and operation-bus-bar arrangements in sub stations- Grounding: Need and Types, Neutral grounding and Resonant grounding- Transformer Earthling-Distribution system: Classification, Layout of AC and DC distribution, Connection Schemes of Distribution system.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	C.L. Wadhwa, “Electrical Power Systems”, New age International (P) Ltd., 2018.
2.	S.N.Singh, “Electric Power Generation, Transmission and Distribution”, Second Edition, PHI Pvt. Ltd., New Delhi, 2012.
Reference Books:	
1.	Ray, “Electrical Power systems: Concepts, Theory and Practice”, PHI Pvt.Ltd., New Delhi,2012.
2.	V.K. Mehta, Rohit Mehta, “Principles of Power System”, S.Chand & Company Ltd., New Delhi, 2012
E-Reference	
1	https://archive.nptel.ac.in/courses/108/102/108102047/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Explain the operation of generating stations and substations	L2: Understanding
CO2	:	Model the transmission lines using system parameters	L3: Applying
CO3	:	Analyze the performance of different types of transmission lines	L4: Analysing
CO4	:	Select an appropriate insulator and cable for transmission and distribution system	L3: Applying
CO5	:	Describe the substation components and grounding techniques.	L1: 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**	**PS O1**	**PS O2**	**PS O3**
CO1	1	2	1			2	2				1	3	1	2	1
CO2	2	3	3	3	3		1				1		2	1	
CO3	2		2	2	2		1						1	3	
CO4	2			2		2	1					2	1	2	1
CO5	1	1	1		2	1	2				2	2	1	2	1
Avg	**1.6**	**2**	**1.75**	**2.33**	**2.33**	**1.67**	**1.4**	**-**	**-**	**-**	**1.33**	**2.33**	**1.2**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EE405</td><td colspan="2">POWER ELECTRONICS</td><td colspan="3">SEMESTER</td><td>IV</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Electron 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 an overview of power semiconductor devices.</td></tr>
<tr><td>2.</td><td colspan="6">To obtain the knowledge of controlled rectifiers.</td></tr>
<tr><td>3.</td><td colspan="6">To acquire the principles of DC-DC converter.</td></tr>
<tr><td>4.</td><td colspan="6">To understand the principles of inverters and ac voltage controllers.</td></tr>
<tr><td>UNIT I</td><td colspan="2">POWER SEMICONDUCTOR DEVICES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Concept of power electronics- Structure, Operation, Static and Switching characteristics of power semiconductor devices: Power Diode, SCR, MOSFET, IGBT- Thyristor ratings and protection, Gate drive circuits for MOSFET and IGBT - Switching and Conduction losses in a generic power semiconductor device.</td></tr>
<tr><td>UNIT II</td><td colspan="2">PHASE CONTROLLED RECTIFIERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Single phase and three phase fully controlled rectifiers: Power circuit, Operation, Waveform analysis and performance parameters - Effect of source inductance for Single phase and Three phase fully controlled rectifier - Single phase and Three phase dual converters.</td></tr>
<tr><td>UNIT III</td><td colspan="2">DC TO DC CONVERTER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage– control strategy –Power Circuit and steady state analysis of Buck converter, Boost converter, Buck – boost converter and SEPIC converter- Design of inductor and capacitors for DC-DC converters.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">INVERTERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Power circuit of single phase voltage source inverter, square wave operation of the inverter, bipolar and unipolar sinusoidal modulation, modulation index and output voltage, Power circuit of a three-phase voltage source inverter, operation with three-phase sinusoidal modulation – Single phase Auto sequential Commutated Current Source Inverter.</td></tr>
<tr><td>UNIT V</td><td colspan="2">AC TO AC CONVERTERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction and principle of operation of Single phase and Three phase AC voltage controllers – Multistage sequence control –Applications of AC Voltage Controllers–Introduction to Matrix converters.</td></tr>
<tr><td colspan="7">Total (45L+0T)= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>M.H.Rashid, “Power Electronics: Circuits, Devices and Applications”, Pearson Education, PHI 4th Edition, New Delhi, 2017.</td></tr>
<tr><td>2.</td><td>P .S.Bimbra, “Power Electronics” Khanna Publishers, New Delhi 2018.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>Ned Mohan, Tore. M. Undel and, William. P. Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley and sons, 2007.</td></tr>
<tr><td>2.</td><td>R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.</td></tr>
<tr><td>3.</td><td>M.D. Singh and K.B. Khanchandani, “Power Electronics,” McGraw Hill India, 2013.</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.class-central.com</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 Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>:</td><td>Choose suitable Power Semiconductor Device for the power conversion.</td><td>L3: Applying</td></tr>
<tr><td>CO2</td><td>:</td><td>Know the operation of converters, inverters and AC voltage controllers.</td><td>L2: Understanding</td></tr>
<tr><td>CO3</td><td>:</td><td>Analyse the performance of converters and inverters.</td><td>L4: Analyzing</td></tr>
<tr><td>CO4</td><td>:</td><td>Design converter and inverter circuits.</td><td>L3: Applying</td></tr>
<tr><td>CO5</td><td>:</td><td>Identify suitable control techniques for the converter.</td><td>L1: Remembering</td></tr>
</table>

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	3		1					1	1	2	1
CO2	1		2	1	1						1	1	1	1	2
CO3	1	2	3	2	3						1	1	1	2	1
CO4	2	1	3	3	2		1				1	1	1	2	1
CO5	1	3	2	2	3		1				1	1	1	2	1
Avg	**1.4**	**1.75**	**2.2**	**1.8**	**2.4**	**-**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1.8**	**1.2**
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 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**	**3**	**0**	**0**	**3**

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**	**3**	**0**	**0**	**3**

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**	**3**	**0**	**0**	**3**

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**	**3**	**0**	**0**	**3**

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**	**3**	**0**	**0**	**3**

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 (15L) = 15 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3		1						2						2
CO2	2	3							2						2
CO3	3		1						2						2
CO4			3	2	3				2						2
CO5	2		2		1				2						2
Avg.	**2.5**	**3**	**1.75**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**

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

22CYMC01	**ENVIRONMENTAL SCIENCE**		**SEMESTER**			**IV**
PREREQUISITES		**CATEGORY**	**MC**	**Credit**		**0**
Basic Science		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**0**	**1**	**3**

Course Objectives:

1.	To learn the concept of non-conventional energy systems.
2.	To explore the environmental impact assessment and to learn about the consequence of different types of pollutants.
3.	To have an ancient wisdom drawn from Vedas.
4.	To acquire activity-based knowledge to preserve environment.
5.	To learn about conservation of water and its optimization.

ENVIRONMENTAL AWARENESS	**30**	**0**	**0**	**30**

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.

ENVIRONMENTAL ACTIVITIES	**0**	**0**	**15**	**15**

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.

Total (30L+15P) = 45 Periods

Text Books:

1.	Elements of Environmental science and Engineering, P.Meenakshi, Prenitce — Hall of India, New Delhi, 2009.
2.	A Textbook of Environmental Chemistry and Pollution Control: (With Energy, Ecology, Ethics and Society), Revise Edition, Dr. S.S. Dara, D.D. Mishra Published by S. Chand & Company Ltd, 20 14.

Reference Books:

1.	Introduction to Environmental Engineering and Science, Gilbert M. Masters; Wendell P. Ela Publisher: Prentice-Hal India, 3rd Edition, 2008.
2.	Environmental Science, F;ldren D. Enger, BredleyF.Smith, WCD McGraw Hill 14'" Edition 2015.

E-Reference:

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 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.	L2: Understanding
CO2	**:**	Predict the methods to conserve energy and ways to make optimal use of the energy for the future.	L3: Applying

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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)

22EE406	SYNCHRONOUS AND INDUCTION MACHINES LABORATORY		SEMESTER		IV
PREREQUISITES	CATEGORY	PC	Credit		1.5
	Hours/Week	L	T	P	TH
		0	0	3	3

Course Objectives:

1. To expose the students to the operation of synchronous machines and induction motors and strength their experimental skill

LIST OF EXPERIMENTS

1. Predetermination of Voltage Regulation of three-phase alternator by EMF and MMF methods.
2. Predetermination of Voltage Regulation of three-phase alternator by ZPF.
3. Slip test on three-phase salient pole alternator.
4. V and inverted V curves of synchronous motors
5. Load test on three phase Induction motor.
6. Circle diagram for three phase induction motor with No load and blocked rotor test data.
7. Load test on three-phase Alternator.
8. Synchronization of three-phase alternator
9. Separation of losses in three phase induction motor.
10. Load test on single-phase induction motor.
11. Equivalent circuit and pre-determination of performance characteristics of single-phase induction motor.
12. Separation of losses in single phase transformer using alternator
13. Study of AC starters

Total (0T+45P)= 45 Periods

Reference Books:

1. EEE Department, “Synchronous and Induction Machines Laboratory Manual”, 1st Edition, 2019, Government College of Engineering, Salem.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Predetermine the voltage regulation of a given alternator using different methodologies.	L3: Applying
CO2	:	Analyze the performance of a given synchronous motor under various excitation conditions.	L4: Analyzing
CO3	:	Obtain the Performance characteristics of three - phase induction machines using direct and indirect methods.	L3: Applying
CO4	:	Develop the equivalent circuit and analyze the characteristics of single-phase induction motor.	L4: Analyzing
CO5	:	Acquire knowledge on separation of losses and starting methods of AC machines.	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	2	3	2	1				2	1		1	3	2	1
CO2	3	2	3	2					2	1		1	3	2	1
CO3	3	2	3	2	1				2	1		1	3	2	1
CO4	3	2	3	2					2	1		1	2	3	1
CO5	3	2	3	2	1				2	2		1	2	3	1
Avg	**3**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**1.2**	**-**	**1**	**2.6**	**2.4**	**1**

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

22EE407	ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY			SEMESTER		IV
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
Electron Devices and Circuits Laboratory		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1.	To expose the characteristics and applications of Linear ICs and to study various digital electronics circuits used in simple system configuration

LIST OF EXPERIMENTS (Any 10 Experiments)

1.	Verification of IC 741 characteristics: inverting and non-inverting amplifier - voltage follower.
2.	Verification of IC 741 Applications circuits: summer, differentiator and integrator.
3.	Design of zero crossing detector and Schmitt trigger circuit using OP-AMP.
4.	Design and testing of first order Low Pass and High Pass Active filters.
5.	Design of Wien bridge oscillator and RC phase shift oscillator using OP-AMP.
6.	Design of Astable and Monostable Multivibrator circuits using NE/SE 555 timer.
7.	Design of Voltage controlled oscillator using NE/SE 566.
8.	Design of Voltage regulator using IC723.
9..	Design of +5V, 1A regulated Power supply using IC 7805.
10.	Design of variable power supply using IC LM317.
11.	Design of dual power supply using LM 320 / LM340.
12.	Realize the switching functions using minimum number of NAND/NOR gates.
13.	Design of code converter circuits.
14.	Study of different types of Flip-Flops.
15.	Design of 3-bit synchronous counters.
16.	Implementation of Multipliexers, Demultiplexers , Encoders And Decoders
17.	Design of 4-Bit shift registers using flip-flop.
18.	Testing of asynchronous counters using flip-flops.

Total (0T+45P)= 45 Periods

Reference Books:

1.	Roy Choudhury. D and Shail. B. Jain, “Linear Integrated Circuits”, New Age International 4th Edition, 2011.
2.	Gayakwad. R.A, “Op-amps & Linear Integrated Circuits”, Pearson education, 4th Edition, 2015

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Study the characteristics and mathematical applications of op-amp.	L1: Remembering
CO2	:	Design and verify waveform generator circuits and filter circuits using op-amp.	L3: Applying
CO3	:	Design voltage regulator and power supply circuit using linear ICs.	L3: Applying
CO4	:	Realize the switching function using universal gates .	L6: Creating
CO5	:	Realize the various types of combinational and sequential logic circuits .	L5: Evaluating

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			2	1	
CO2	3	2	1	1					2	1			3	2	
CO3	3	2			2				2	1			3	2	
CO4	3	2			2				2	1		2	3	2	1
CO5	3	2			2				2	1		2	3	2	1
Avg	**2.8**	**1.8**	**1**	**1**	**2**	**-**	**-**	**-**	**2**	**1**	**-**	**2**	**2.8**	**1.8**	**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**
1. Basic knowledge in reading skill and writing skill 2. Basic ability in listening skill and speaking skill	**Hours/Week**	**L**	**T**	**P**	**TH**
		0	**0**	**4**	**4**

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 employ ability and soft skills of students

UNIT I	**WRITING SKILLS**	**0**	**0**	**12**	**12**
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**	**0**	**0**	**12**	**12**
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**	**0**	**0**	**12**	**12**
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**	**0**	**0**	**12**	**12**
Error Spotting, Listening Comprehension, Reading comprehension, Rearranging Jumbled sentences, Vocabulary					
UNIT V	**REASONING ABILITIES**	**0**	**0**	**12**	**12**
Series completion, Analogy, Classification, Coding-Decoding, Blood relations, Seating Arrangements, Directional Sense, Venn Diagram, Logical reasoning, Statements and Conclusions					

Total (0L+ 60P) = 60 Periods

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/

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

COURSE OUTCOMES: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	participate in group discussion and interview confidently	L3: Applying
CO2	:	develop adequate soft skills and career skills required for the workplace	L6: Creating
CO3	:	make effective presentations on given topics	L6: Creating
CO4	:	apply their verbal ability and reasoning ability in campus interviews	L3: Applying

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
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)

22EE501	**CONTROL SYSTEMS**		**SEMESTER**			**V**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
Electrical Machines and Electric circuit Analysis		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**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 three ways of designing compensators for a Feedback control system.

UNIT I	**MODELING OF LINEAR TIME INVARIANT SYSTEM**	**6**	**3**	**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)															

<table>
<tr><td>22EE502</td><td colspan="2">MICROPROCESSORS AND MICROCONTROLLERS</td><td colspan="3">SEMESTER</td><td>V</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">C Programming</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 architecture of µP8085 and µC 8051</td></tr>
<tr><td>2.</td><td colspan="6">To study the Interrupt structure of 8085 and 8051.</td></tr>
<tr><td>3.</td><td colspan="6">To do simple applications development with programming 8085 and 8051.</td></tr>
<tr><td>UNIT I</td><td colspan="2">8085 8 BIT MICROPROCESSOR</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT II</td><td colspan="2">8051 8 BIT MICROCONTROLLER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT III</td><td colspan="2">INTERFACING WITH 8051 MICROCONTROLLER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">EXTERNAL COMMUNICATION INTERFACE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Synchronous and Asynchronous Communication. RS232, RS 485, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.</td></tr>
<tr><td>UNIT V</td><td colspan="2">APPLICATIONS OF MICROCONTROLLERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Simple programming exercises- key board and display interface –Control of servo motor stepper motor control- Application to automation systems.</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T)= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>R.S. Gaonkar, ‘Microprocessor Architecture Programming and Application’, with 8085, Wiley Eastern Ltd., New Delhi, 2013.</td></tr>
<tr><td>2.</td><td>K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.</td></tr>
<tr><td>3.</td><td>Muhammad Ali Mazidi& Janice GilliMazidi, R.D.Kinely ‘The 8051 Micro Controller and Embedded Systems’, PHI Pearson Education, 5th Indian reprint, 2003.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>R. Kamal, “Embedded System”, McGraw Hill Education,2009.</td></tr>
<tr><td>2.</td><td>D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.</td></tr>
<tr><td colspan="2">E-Reference</td></tr>
<tr><td>1.</td><td>www.onlinecourses.nptel.ac.in/noc18_ee41</td></tr>
<tr><td>2.</td><td>www.class-central.com</td></tr>
<tr><td>3.</td><td>www.mooc-list.com</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 Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>:</td><td>Understand the basics of microprocessor and microcontroller</td><td>L2: Understanding</td></tr>
<tr><td>CO2</td><td>:</td><td>Understand the architecture of Microprocessor and Microcontroller</td><td>L1: Remembering</td></tr>
<tr><td>CO3</td><td>:</td><td>Apply the digital concepts to measure and control simple electrical systems</td><td>L3: Applying</td></tr>
<tr><td>CO4</td><td>:</td><td>Design and interface communications between digital systems</td><td>L2: Understanding</td></tr>
<tr><td>CO5</td><td>:</td><td>Design a microcontroller based electrical control system.</td><td>L5: Evaluating</td></tr>
</table>

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)															

22EE503	**ELECTRICAL MACHINE DESIGN**		**SEMESTER**			**V**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
DC Machines and Transformers, Synchronous and Induction Machines		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To Study mmf calculation and thermal rating of various types of electrical machines
2.	To Design armature and field systems for D.C. machines.
3.	To Design core, yoke, windings and cooling systems of transformers.
4.	To Design stator and rotor of induction machines.
5.	To Design stator and rotor of synchronous machines and study their thermal behavior

UNIT I	**INTRODCUTION**	**9**	**0**	**0**	**9**
Major considerations – Limitations – Electrical Engineering Materials – Space factor - Design of Magnetic Circuits: MMF calculation for Air gap and Teeth - Iron losses and Magnetizing current calculations. Design of lap winding and wave winding - Standard specification.					
UNIT II	**DC MACHINES**	**9**	**0**	**0**	**9**
Design of rotating machines – D.C machines output equations – Main dimensions- Choice of Specific Electric and Magnetic Loading -Selection of number of poles – Armature design – Design of commutator and brushes-Design of slot, air gap, field coils.					
UNIT III	**TRANSFORMERS**	**9**	**0**	**0**	**9**
KVA output for single and three phase transformers – Window space factor – Overall dimensions – Operating characteristics – Regulation – No load current – Temperature rise of Transformers– Design of Tank with & without cooling tubes – Thermal rating – Methods of cooling of Transformers – Design of inductors.					
UNIT IV	**INDUCTION MOTORS**	**9**	**0**	**0**	**9**
Output equation of Induction motor – Main dimensions –Choice of electrical and magnetic loadings-Length of air gap- Rules for selecting rotor slots of squirrel cage machines– Design of rotor bars & slots – Design of end rings – Design of wound rotor-Operating characteristics –Short circuit current –Circle diagram.					
UNIT V	**SYNCHRONOUS MOTORS**	**9**	**0**	**0**	**9**
Runaway speed – construction – output equations – choice of loadings – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length– Design of rotor –Design of damper winding – Determination of full load field mmf – Design of field winding – Computer Program – design of Stator main dimensions					
Total (45L+0T)= 45 Periods					

Text Books:

1.	Sawhney, A.K., 'A Course in Electrical Machine Design', 6th edition, Dhanpat Rai & Sons, New Delhi, 2014..
2.	Sen.,S.K., 'PrinciplesofElectricalMachineDesignswithComputerProgrammes',Oxford and IBH PublishingCo.Pvt.Ltd. NewDelhi,2009.

Reference Books:

1.	R.K.Agarwal, Principles of Electrical Machine design, S.K. Kataria and Sons, Delhi 2014.
2.	V.N. Mittle, ' Design of Electrical Machines',5th edition, Standard Publications and Distributors, Delhi, 2013.
3.	V Rajini, V.S Nagarajan, ‘Electrical Machine Design’, Pearson, first edition 2018.

E-Reference

1	http://cusp.umn.edu/machine_design.php

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Classify the materials used for the construction of electrical machines and be able to calculate the MMF in magnetic parts of rotating machines.	L4: Analyzing
CO2	:	Familiarize the importance of magnetic, thermal, and electrical loading of AC and DC Machines.	L2: Understanding
CO3	:	Design and Analyze Armature and Field Systems for DC Machines.	L4: Analyzing
CO4	:	Design and Analyze core, windings and cooling system of transformers.	L4: Analyzing
CO5	:	Design and analyze Stator and rotor of Induction Machines and Synchronous machines.	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	1	2	1	1	1							1	3	1	
CO2	1	2	1	1	1							1	3	1	
CO3	1	2	1	1	1							1	3	1	
CO4	1	2	1	1	1							1	3	1	
CO5	1	2	1	1	1							1	3	1	
Avg	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EE504</td><td colspan="2">ELECTRICAL DRIVES AND CONTROL</td><td colspan="3">SEMESTER</td><td>V</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">DC Machines and Transformers, Synchronous and Induction Machines, and Power Electronics</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 know about the Analyze the operation of the chopper fed dc drive, both qualitatively and quantitatively.</td></tr>
<tr><td>2.</td><td colspan="6">To understand the Operation and performance of AC motor drives.</td></tr>
<tr><td>UNIT I</td><td colspan="2">DC MOTOR CHARACTERISTICS & CHOPPER FED DC DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT II</td><td colspan="2">MULTI-QUADRANT & CLOSED-LOOP CONTROL OF DC DRIVE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT III</td><td colspan="2">INDUCTION MOTOR CHARACTERISTICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT IV</td><td colspan="2">CONTROL OF SLIP RING INDUCTION MOTOR</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT V</td><td colspan="2">CONTROL OF SRM AND BLDC MOTOR DRIVES.</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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 controlled Brushless dc motor drive</td></tr>
<tr><td colspan="7">Total (45L+0T)= 45 Periods</td></tr>
</table>

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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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**	**-**

22EE505	POWER SYSTEM ANALYSIS AND STABILITY		SEMESTER			V
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
Circuit Theory, Electrical Machines, Power Generation, Transmission and Distribution System		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**1**	**0**	**3**

Course Objectives:

1. To model the power system under steady state operating condition
2. To apply efficient numerical methods to solve the power flow problem
3. To model and analyse the power systems under abnormal (or) fault conditions
4. To model and analyse the transient behaviour of power system when it is subjected to a fault.

UNIT I	**POWER SYSTEM OVERVIEW AND MODELLING**	**6**	**3**	**0**	**9**

Basic components of modern power system - Per-phase analysis: Generator model - Synchronous motor model- Three-phase transformer model - Three-winding transformer model - Line model, Load model- Per unit quantities :- Changing the base of per-unit quantities - Single line diagram -Impedance and reactance diagrams.

UNIT II	**POWER FLOW ANALYSIS**	**6**	**3**	**0**	**9**

Bus classification – Bus admittance matrix Formulation: Direct inspection method and Singular transformation method - Development of power flow model - solution of load flow equations: Gauss Seidel method - Newton Raphson method- Fast decoupled method – Flowcharts – Comparison of the three power flow solution methods.

UNIT III	**FAULT ANALYSIS - BALANCED FAULT**	**6**	**3**	**0**	**9**

Importance of short circuit studies-Assumptions in short circuit analysis – Balanced three phase fault – Short circuit capacity - Algorithm for formation of the bus impedance matrix- Systematic fault analysis using bus impedance matrix - Post fault bus voltages – Fault level - Current limiting reactors - Selection of circuit breakers.

UNIT IV	**FAULT ANALYSIS - UNBALANCED FAULT**	**6**	**3**	**0**	**9**

Fundamentals of symmetrical components – Sequence impedances – Construction of sequence networks – Unsymmetrical faults on power system: Single line-ground fault, line-line fault – Double line-ground fault- Unbalanced fault analysis using Thevenin's theorem and Z-bus computation of post fault currents in symmetrical component and phasor domains .

UNIT V	**STABILITY STUDIES**	**6**	**3**	**0**	**9**

Importance of stability studies – Classification of power system stability – Stability limits – Power angle equation- Inertia constant- Swing equation of single-machine connected to infinite bus – Solution of swing equation by step-by-step method-II – Modified Euler's method – Runge-Kutta method – Equal area criterion – Critical clearing angle and time -Factors affecting transient stability – Techniques for transient stability improvement.

Total (30L+15T)= 45 Periods

Text Books:

1. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Publishers, New Delhi, 3rd edition, 2011.
2. D.P.Kothari, and I.J.Nagrath, "Modern Power System Analysis", Tata McGraw Hill Education Private limited, New Delhi, Fourth Edition, 2019.

Reference Books:

1. John J. Grainger and W.D. Stevenson Jr., "Power System Analysis", McGraw Hill Inc., New Delhi, 2017.
2. B.R. Gupta, "Power System Analysis and Design", S.Chand& Co. Ltd., New Delhi, 2012 .
3. C. L. Wadhwa, "Electrical Power Systems", New Age International Publishers, New Delhi, 2021.

E-Reference

1 https://onlinecourses.nptel.ac.in/, for power system analysis course, IIT Kharagpur

2 NPTEL courses on Power System Generation, Transmission and Distribution, IIT Delhi.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Develop the single line diagram for the power system.	L3: Applying
CO2	:	Perform and analyse load flow computations using bus admittance matrix	L4: Analysing
CO3	:	Perform and analyse balanced fault using bus impedance matrix	L4: Analysing
CO4	:	Develop computational models for unsymmetrical fault analysis in power systems	L6: Creating
CO5	:	Demonstrate the transient stability studies.	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	2	1	3	1	2								2	2	1
CO2	2	2	3	2	1							1	2	3	1
CO3	2	2	3	2	1							1	2	3	1
CO4	2	2	3	2	2							1	2	3	1
CO5	2	2	3	2	2							1	2	3	1
Avg	**2**	**1.8**	**3**	**1.8**	**1.6**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2.8**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EE506</td><td colspan="2">SOLAR AND WIND ENERGY CONVERSION SYSTEMS</td><td colspan="3">SEMESTER</td><td>V</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Engineering Physics, Electrical Machines and Power Electronics</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 understand the concepts of power generation through Solar and Wind Power</td></tr>
<tr><td>2.</td><td colspan="6">To learn the optimal extraction of renewable power and their integration to grid</td></tr>
<tr><td>UNIT I</td><td colspan="2">FUNDAMENTALS OF SOLAR ENERGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.</td></tr>
<tr><td>UNIT II</td><td colspan="2">FUNDAMENTALS OF WIND ENERGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.</td></tr>
<tr><td>UNIT III</td><td colspan="2">SOLAR PHOTOVOLTAICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT- P&O, Incremental conductance) algorithms - Converter Control.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">WIND GENERATOR TOPOLOGIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power converters. Generator- Converter configurations, Converter Control.</td></tr>
<tr><td>UNIT V</td><td colspan="2">GRID INTEGRATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Overview of grid code technical requirements. Fault ride-through for wind farms – real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.</td></tr>
<tr><td colspan="7">Total (45L+0T) = 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Chetan Singh Solanki, Solar Photovoltaics, “Fundamentals, Technologies and Applications”, PHI Learning Private Limited, New Delhi, 2009.</td></tr>
<tr><td>2.</td><td>T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2012, 2nd edition.</td></tr>
<tr><td>3</td><td>Bimbhra, P.S, “Power Electronics”, Khanna Publishers, New Delhi, 4th Edition, 2018.</td></tr>
<tr><td>4.</td><td>Rashid M.H., “Power Electronics: Circuits, Devices and Applications”, Pearson, 3rd Edition, 2013.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>Rai. G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2011.</td></tr>
<tr><td>2.</td><td>G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2013.</td></tr>
<tr><td>3.</td><td>G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.</td></tr>
<tr><td>4.</td><td>H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley India Sons Ltd.,2006.</td></tr>
<tr><td>5.</td><td>Mohan. N. et al. “Power Electronics: Converters, Application and Design”, Wiley India (P) Ltd, New Delhi, 2008.</td></tr>
<tr><td colspan="2">E – References:</td></tr>
<tr><td>1.</td><td>www.onlinecourses.nptel.ac.in</td></tr>
<tr><td>2.</td><td>www.class-central.com</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the physics behind the solar and wind power generation	L2: Understanding
CO2	:	Implement the optimal extraction techniques in renewable power generation	L3: Applying
CO3	:	Apply power electronics to renewable power optimization	L3: Applying
CO4	:	Understand integration techniques used, power quality issues and their mitigation	L2: Understanding
CO5	:	Device methods to create an approximate energy conversion systems.	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**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	1	1	1								1		
CO2	3	3	3	3	2		3						1	2	
CO3	2	2	2	2	2		2						1	2	
CO4	2	1	2	2	2		2						1	2	
CO5	2	2	2	1	3		1						1	1	
Avg	**2.6**	**2**	**2**	**1.8**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1.75**	**-**

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

22EE507	POWER ELECTRONICS AND ENERGY SYSTEMS LABORATORY		SEMESTER			V
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
Power Electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1. To simulate and analyze the performance of different power electronic converter circuits
2. To conduct an experiments for power devices and basic power converter circuits

LIST OF EXPERIMENTS:

1 V-I Characteristics of power diode and SCR
2 Characteristics of Power MOSFET and IGBT
3 Single phase AC to DC fully controlled converter
4 Single phase PWM rectifiers
5 Buck and Boost Converters
6 MOSFET based single-phase PWM inverter
7 IGBT based three-phase PWM inverter
8 Single phase AC voltage controller
9 Simulation for Single phase and three phase dual converters
10 Simulation of Matrix Converter and SEPIC converter
11 Simulation study on Solar PV Energy System
12 Simulation of Grid connected Solar PV Energy System
13 Simulation study on Wind Energy Conversion System
14 Simulation on Performance Assessment of Fuel Cell energy conversion system.

Total (0L+45P)= 45 Periods

Text Books:

1. M.H.Rashid, ‘Power Electronics: Circuits, Devices and Applications’, Pearson Education, PHI Third Edition, New Delhi, 2009.
2. P.S.Bimbra “Power Electronics” Khanna Publishers, New Delhi 2016.

Reference Books:

1. Ned Mohan, Tore. M. Undel and, William. P. Robbins, ‘Power Electronics: Converters, Applications and Design’, John Wiley and sons, 2007.
2. M.D. Singh and K.B. Khanchandani, “Power Electronics,” McGraw Hill India, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Level**
CO1	:	Analyze the characteristics of MOSFET, SCR and IGBT.	L4: Analyzing
CO2	:	Examine the performance of DC-DC Converters and inverters.	L3: Applying
CO3	:	Design and control of inverters with different modulations.	L3: Applying
CO4	:	Analyze the performance of power converters with simulation studies	L4: Analyzing
CO5	:	Demonstrate the operation of Solar and wind energy conversation 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	1	2		3	1	2			1		1	1	1	2	1
CO2	2		3	1		1			1		1	2	1	2	1
CO3	2	1	2		2				2			1	1	3	
CO4	1		1	3		1			1		2		1	3	1
CO5	2	2			2				2		3	2	1	2	2
Avg	**1.6**	**1.67**	**2**	**2.33**	**1.67**	**1.33**	**-**	**-**	**1.16**	**-**	**1.75**	**1.5**	**1**	**2.4**	**1.25**

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

22EE508	MICROPROCESSOR AND MICROCONTROLLER LABORATORY			SEMESTER		V
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
Analog and Digital Integrated Circuits, Microprocessor and Microcontroller		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**1.5**

Course Objectives:

1.	Able to write own programs for different applications and interface the programs for interconnected digital systems

LIST OF EXPERIMENTS:

1	Simple arithmetic operations: addition / subtraction / multiplication / division.
2	Programming with control instructions: a. Ascending / Descending order, Maximum / Minimum of numbers b. Programs using Rotate instructions c. Hex / ASCII / BCD code conversions.
3	Interface Experiments: with 8085 a. A/D Interfacing. & D/A Interfacing.
4	Traffic light controller.
5	I/O Port / Serial communication
6	Programming Practices with Simulators/Emulators/open source
7	Keyboard interfacing
8	LCD interfacing 4bit/8bit mode
9	Demonstration of basic instructions with 8051 Micro controller execution, including: a. Conditional jumps, looping b. Calling subroutines.
10	Programming I/O Port 8051 a. Interface with external A/D & D/A b. Interface with stepper motor
11	Interrupt programming with external sensors/ devices
12	Programming for communication using Zigbee protocol.

Total (0T+45P)= 45 Periods

Reference Books:

1.	R. S. Gaonkar, “Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996
2.	K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.
3.	M.A.Mazidi, J.G. Mazidi and R. D. McKinlay, “The 8051Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education, 2007.
4.	R. Kamal, “Embedded System”, McGraw Hill Education,2009
5.	D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Write coding to implement different types of algorithms	L1: Remembering
CO2	:	Design and implement simple controllers	L3: Applying
CO3	:	Use simulators and emulators for debugging and verifying codes	L3: Applying
CO4	:	Write efficient codes using interrupts for time critical applications	L4: Analyzing
CO5	:	Interface any application module to microprocessor/microcontroller.	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	1	1	1	3	1							1	2	2	
CO2	1	1	3	3	1							1	3	2	
CO3	1	1	1	1	3							2	3	2	
CO4	1	1	2	2	1							1	3	2	
CO5	1	1	1	2	1							2	3	2	1
Avg	**1**	**1**	**1.6**	**2.2**	**1.4**	**-**	**-**	**-**	**-**	**-**	**-**	**1.4**	**2.8**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE509	CONTROL AND INSTRUMENTATION LABORATORY		SEMESTER		V
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**1.5**
Control systems	**Hours/Week**	**L**	**T**	**P**	**TH**
		0	**0**	**3**	**1.5**

Course Objectives:	
1.	To measure physical quantity using Transducer.
2.	To measure the electrical parameters of resistance, capacitance and inductance using bridges.
3.	To develop the transfer function models for the electro mechanical system.
4.	To design the compensator and PID controller for a feedback control system.

LIST OF EXPERIMENTS	
1.	Measurement of three phase power and power factor.
2.	Instrumentation amplifiers.
3.	A/D converters and D/A converters.
4.	Measurement of displacement using LVDT transducers.
5.	Measurement of inductance by Maxwell's bridge.
6.	Measurement of resistance by Wheatstone bridge.
7.	Measurement of capacitance by Schering bridge.
8.	Transfer function of DC servo-motor (Armature voltage / Field current control).
9.	Transfer function of AC servo-motor.
10.	Study of Synchros
11.	Study of DC Stepper motor control
12.	Design of Lag, Lead and Lag-Lead Compensators
13.	Design of P, PI and PID controllers
14.	Study of DC Position Control Systems
15.	Analysis of LTI control system in simulation platform (Time response, polar plot, bode plot, nyquist plot and root locus)
	Total (0 + 45)=45 Periods

Reference Books:	
1	Department Lab Manual, Control system Laboratory , 1st Edition.
2	Department Lab Manual, Measurements and Instrumentation Laboratory , 1st Edition.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Measure the power and power factor in three phase AC system.	L2: Understanding
CO2	:	Measure the electrical quantities (R,L,C) using DC and AC Bridges and understand the importants of instrumentation amplifier.	L3: Applying
CO3	:	Determine the transfer function of DC and AC servo motors.	L5: Evaluating
CO4	:	Design of compensator / controller for a feedback control system.	L3: Applying
CO5	:	Analyze the LTI control system in simulation platform	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	2	1	2	1				2	1		1	2	2	1
CO2	3	2	3	2	2				2	1		1	2	2	1
CO3	2	2	3	2	1				2	1		1	2	2	1
CO4	3	2	3	3	1				2	1		1	2	2	1
CO5	2	2	3	3	3				2	2		1	2	2	1
Avg	**2.6**	**2**	**2.6**	**2.4**	**1.6**	**-**	**-**	**-**	**2**	**1.2**	**-**	**1**	**2**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE601	**MINI PROJECT**		**SEMESTER**			**VI**
PREREQUISITE:		**CATEGORY**	**EE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**6**	**3**

COURSE OBJECTIVES:

1.	Opportunity to design and develop small working models.
2.	Develop experimental or simulation solutions to small industrial problems.
3.	Facilitate problem identification, formulation and solution.
4.	Work collaboratively in small groups.

The students may be grouped into groups of about 2 to 4 members per group and work under a project supervisor. The device / system / component(s) to be designed/ fabricated / investigated / analyzed may be decided in consultation with the supervisor. A project report to be submitted by the group and the fabricated model /investigation / analysis to be reviewed and evaluated continuously by a committee constituted by the head of the department / program coordinator.

HARDWARE PROJECT GUIDELINES

a. Circuit Hardware Working Models
b. Day-life Usage Project
c. New Scientific Invention
d. Implementation of Electrical / Electronics Principle

Total(0L+30P) = 30 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Initiate the students to come out with innovative ideas for various applications.	L6:Creating
CO2	Create an environment to convert the ideas into design of prototype for useful industrial, agricultural and social applications.	L6:Creating
CO3	Familiarize the feasibility study and manage activities to complete task in specified duration.	L2:Understanding
CO4	Assign and undertake tasks in a team as per team discussion.	L5:Evaluate
CO5	Do presentation and write technical reports for effective communication within and outside the team.	L6:Creating

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	3	3	1	3		2		3	3	3
CO2	3	3	3	3	2	3	3		3		1		3	3	
CO3	2	2	2	2	2	1	1	1	3	1	2	3	3	3	
CO4	3	2	2	1	1	1	2	3	3	3		3	3	3	
CO5					2	2		1	3	3		2	3		3
Avg	**2.75**	**2.5**	**2.5**	**2.25**	**1.8**	**2**	**2.25**	**1.5**	**3**	**1.75**	**1.67**	**2.6**	**3**	**3**	**3**

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>
</table>

Course Learning Objectives

1	To learn basic concepts of Embedded Systems by familiarizing the functionalities of embedded platforms with development boards.
2	To understand the core concepts of GPIO Pins, Functionality of peripherals, Selection of I/O devices , Usage of Internal functions, and Communication protocols.
3	To familiarize the current technologies and protocols used in the Internet of Things (IoT) and to learn the Cloud services.

Unit I	**BASICS OF EMBEDDED SYSTEM**	**9**	**0**	**0**	**9**

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.

Unit II	**BASICS OF RASPBERRY PI**	**9**	**0**	**0**	**9**

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.

Unit III	**SENSORS AND ACTUATORS**	**9**	**0**	**0**	**9**

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.

Unit IV	**COMMUNICATION PROTOCOLS**	**9**	**0**	**0**	**9**

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.

Unit V	**INTERNET OF THINGS**	**9**	**0**	**0**	**9**

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.

Total = 45 Periods

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)**

<table>
<tr><td>22PSPE03</td><td colspan="2">INDUSTRIAL AUTOMATION</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">Acquire conceptual knowledge in Industrial Controllers by scaling of on-board devices and embedded board interfacing with various I/O peripherals.</td></tr>
<tr><td>2</td><td colspan="6">Learn PLC by working on internal features and also interfacing with Sensors and actuators along HMI concept using SCADA and standard communication protocols.</td></tr>
<tr><td>3</td><td colspan="6">To work with FPGA boards and RT controllers for reprogrammable embedded applications using LabVIEW</td></tr>
<tr><td>4</td><td colspan="6">Understand the concepts and design electronics circuits</td></tr>
<tr><td>Unit I</td><td colspan="2">INDUSTRIAL CONTROLLERS - I</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>Unit II</td><td colspan="2">INDUSTRIAL CONTROLLERS - II</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>Unit III</td><td colspan="2">INDUSTRIAL COMMUNICATION PROTOCOLS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit IV</td><td colspan="2">FPGA AND RT CONTROLLER PROGRAMMING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit V</td><td colspan="2">INDUSTRIAL CIRCUIT BOARD DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td colspan="7">Total = 45 Periods</td></tr>
</table>

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)**

22EE701	**POWER SYSTEM PROTECTION AND SWITCH GEAR**	**SEMESTER**			**VII**
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**3**
Power Generation, Transmission and Distribution systems, Measurements and Instrumentation.	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1.	To acquire knowledge about the power system protection and switchgear components.
2.	To understand the concepts of various protection schemes for power system equipment.
3.	To study the functioning of static relays and numerical protection schemes.

UNIT I	**PROTECTION AND RELAYS**	**9**	**0**	**0**	**9**

Need for protective system – Protection system components – Zones of protection – Primary and Backup protection - Essential qualities of protection – Basic principle of operation of relays – classifications of relays - Universal torque equation – Basic Relay terminology : relay time, pick up and reset current, PSM and TSM – calculation of relay operating time- construction and principle of operation: Electromagnetic relays – directional and non-directional over current relays – Distance relays: Impedance, reactance and mho type – Differential relays – Translay relay – Negative sequential relays and under frequency relays.

UNIT II	**CIRCUIT BREAKERS**	**9**	**0**	**0**	**9**

HRC fuses : construction, working, characteristics, and applications - Physics of arcing phenomenon and arc interruption theories –recovery voltage and restriking voltage – expression for RRRV – current chopping – interruption of capacitive current – Resistance switching - Types of circuit breakers - Minimum oil, Air-blast , air break, SF_6, MCBs, MCCBs and Vacuum circuit breakers - Problems of circuit interruption: - Rating of circuit breakers – Testing of circuit breakers – Selection of circuit breakers - HVDC circuit breakers.

UNIT III	**ALTERNATOR AND TRANSFORMER PROTECTION**	**9**	**0**	**0**	**9**

Alternator protection: Stator protection : Differential protection- Percentage differential relays, balanced earth-fault protection, Stator inter turn protection - Field ground fault protection - Protection of stator windings by overvoltage relays - Protection against stator open circuits, loss of synchronism, loss of excitation, rotor fault protection - numerical problems on % winding unprotected.

Transformer protection: differential protection – biased differential protection-numerical problem on design of CTs ratio - restricted earth fault relay -Buchholz relay protection- harmonic restraint relay.

UNIT IV	**MOTOR, BUS BAR AND TRANSMISSION LINE PROTECTION**	**9**	**0**	**0**	**9**

AC Motor protection against short circuit, overload, and single phasing.
Bus bar protection: Differential and Fault bus protection – Transmission line protection: Over Current, Carrier Current, distance or impedance relay, Translay Relay.

UNIT V	**STATIC RELAYS AND NUMERICAL PROTECTION**	**9**	**0**	**0**	**9**

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, distance protection of transmission line.

Total (45L+0T)= 45 Periods

Text Books:

1.	Sunil S.Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi, Fourth Edition, 2010.
2	Badri Ram and Vishwakarma D N, “Power System Protection and Switchgear”, Tata McGraw Hill, 2015
3	Chakrabarti A, Soni, M L, Gupta P V, and Bhatnagar, “ A Text Book on Power System Engineering”, Dhanpat Rai & Co. (Pvt.) Ltd., Delhi, Second Revised Edition 2017.
4	Ravindranath. B and Chander, N, “Power System Protection and Switchgear”, New Age International (P) Ltd, Second Edition, 2018.

Reference Books:

1	Arun Ingole, “Switchgear and Protection”, Pearson Education India, 2017.
2	Madhav Rao, T. S., “Power System Protection Static Relays with Microprocessor Applications”, Tata McGraw-Hill, 1998.
3	Paithankar, Y. G and Bhide, S. R, “Fundamentals of Power System Protection”, Prentice Hall of India Private Ltd, New Delhi, 2010.
4	C.L.Wadhwa, “Electrical Power Systems”, 6th Edition, New Age International (P) Ltd., 2010.

E-References:

1.	NPTEL Course: Power System Protection - Prof. S.A. Soman, IIT-B.
2.	NPTEL Course: Power System Protection – organized by IIT-B.

3.	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	:	Analyse the characteristics and functions of protective relays.	L3: Applying
CO2	:	Acquire knowledge on functioning of circuit breaker.	L2: Understanding
CO3	:	Assess the protection schemes of alternator and transformer.	L1: Remembering
CO4	:	Assess the protection schemes of motor, bus bar and transmission lines.	L1: Remembering
CO5	:	Develop the knowledge on static and numeric type relays.	L4: Analysing

COURSE ARTICULATION MATRIX

COs/ Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3		1	2	1	1			1		1		3	2	1
CO2	3		1	2	1	1			1		1		3	2	1
CO3	3		1	2	1	1			1		1		3	2	1
CO4	3		1	2	2	1			1		1		3	2	1
CO5	3		1	2	2	1			1		1		3	2	1
Avg	**3**	**-**	**1**	**2**	**1.4**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**3**	**2**	**1**

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

<table>
<tr><td>22EE702</td><td colspan="2">SMART GRID TECHNOLOGIES</td><td colspan="3">SEMESTER</td><td>VII</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" 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="7">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="6">To learn communication and automation technologies and high-performance computing for smart operation of power grid.</td></tr>
<tr><td>UNIT I</td><td colspan="2">SMART GRID ARCHITECTURE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction-Conceptual model of Smart Grid, Smart Grid architecture and Components, Smart Grid Control, Smart Grid Characteristics , Smart Grid Enabling Technologies, Stages for Grid Modernization, Smart Grid Benefits and Challenges</td></tr>
<tr><td>UNIT II</td><td colspan="2">COMMUNICATION AND INFORMATION SECURITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Requirements of Smart Grid Communications, Communication infrastructure for the Smart Grid, communication technologies for Smart Grid, Information Layer of Smart Grid, SG Security Objectives, Cyber Security Requirements for Smart Grid,</td></tr>
<tr><td>UNIT III</td><td colspan="2">CONTROL AND AUTOMATION TECHNOLOGIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Smart metering: Benefits, Architecture, Key components and operation, communications architecture for smart metering, Demand-side integration (DSI): Definitions and services provided by DSI, Substation automation equipment: architecture, components and functions, Intelligent electronic devices (IED), Relay IED, Bay controller.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">SMART TRANSMISSION AND DISTRIBUTION MANAGEMENT SYTSEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Structure of Energy management systems- Phasor Measurement Unit(PMU) - Wide-Area Measurement (WAM) for transmission Systems- Structure and main components of Distribution Management System- Supervisory Control and Data Acquisition (SCADA)- Customer information system</td></tr>
<tr><td>UNIT V</td><td colspan="2">CLOUD COMPUTING AND DATA MANAGEMENT IN SMART GRID</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Relationship between Smart Grid, cloud computing, and big data, Cloud Computing Characteristics in Improving Smart Grid, Cloud Computing Service Models, Cloud computing platform coupled with Smart Grid, Cloud Applications for Energy Management, Privacy Information Impacts on Smart Grid, Meter Data Management for Smart Grid</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T)= 45 Periods</td></tr>
</table>

Text Books:	
1.	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “SmartGrid: Technology and Applications”, Wiley, 2012
2.	Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase, CRC, 2018.
Reference Books:	
1.	James Momoh “Smart Grid Fundamentals of Design and Analysis”, Wiley, 2012.
E-Reference:	
1	https://archive.nptel.ac.in/courses/108/107/108107113/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Describe the Smart Grid modernization process and its present developments.	L1: Remembering
CO2	:	Select the suitable communication networks for smart grid applications	L4: Analyzing
CO3	:	Use a suitable smart device for Smart Grid operation	L3: Applying
CO4	:	Illustrate a smart transmission and distribution system using PMU, WAM and SCADA	L4: Analyzing
CO5	:	Explain the need of high end computing and big data analytics in smart grid	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	1			3	1	2				2		1	1	2	1
CO2	2	2	3	1		1				1		2	2	1	1
CO3	1	3	2		2					2			1	3	
CO4	2	1	2	1	3	1				1		2	1	2	
CO5	1			2	1	2				1		1	2	2	1
Avg	**1.4**	**2**	**2.33**	**1.75**	**1.75**	**1.5**	**-**	**-**	**-**	**1.75**	**-**	**1.5**	**1.4**	**2**	**1**

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

22EE703	**HIGH VOLTAGE ENGINEERING**	**SEMESTER**			**VII**
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**3**
Measurements and Instrumentation, Power Generation, Transmission and Distribution system	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1.	To expose the various types of over voltage transients and their effect on power system.
2.	To introduce the concept of insulation co-ordination technique.
3.	To provide an overview of solid, liquid and gaseous dielectrics breakdown mechanism
4.	To show how to generate over voltages in the HV testing laboratory
5.	To show how to measure of high voltage and current quantity in HV testing laboratory
6.	To introduce testing procedure of HV power apparatus.

UNIT I	**OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS AND INSULATION CO-ORDINATION**	**9**	**0**	**0**	**9**
Causes of over voltages and its effect on power system – Lightning, switching surges and temporary over voltages – Reflection and Refraction of travelling waves – Bewley lattice diagram-protection against over voltages; Principle of Insulation Coordination on High voltage and Extra high voltage power systems.					
UNIT II	**DIELECTRIC BREAKDOWN**	**9**	**0**	**0**	**9**
Properties of Dielectric materials- Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown - Conduction and Breakdown in pure and commercial liquids dielectrics – Breakdown mechanisms in solid and composite dielectrics- Application of insulating materials in electrical equipment.					
UNIT III	**GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS**	**9**	**0**	**0**	**9**
Generation of High DC voltages: Rectifiers, voltage multipliers and Van de Graff generator- Generation of High AC voltages: cascaded transformer, resonant transformer and tesla coil- Generation of High impulse voltages: single and multistage Marx circuits - Generation of switching voltages - Generation of impulse currents. Tripping and control of impulse generators.					
UNIT IV	**MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS**	**9**	**0**	**0**	**9**
Measurement of high DC, AC, impulse voltages – Measurement of high currents: Direct, Alternating and Impulse – digital techniques in impulse voltage and current measurements.					
UNIT V	**HIGH VOLTAGE TESTING OF ELECTRICAL POWER APPARATUS**	**9**	**0**	**0**	**9**
Overviews of International and Indian standards- laboratory test procedure: multi-level method, Up and Down method - HV Testing of Insulators, Bushings, Circuit Breakers, Power transformers, Surge Arresters, Power capacitors and Cables.					
					Total (45L+0T)= 45 Periods

Text Books:

1.	M.S. Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill Publishing Company Ltd, New Delhi ,Fifth Edition, 2013.

Reference Books:

1.	E. Kuffel W.S. Zaengl, and J.Kuffel , 'High Voltage Engineering Fundamentals', Newnes Publishers, Second Edition, Elsevier, New Delhi, 2005.
2.	C.L. Wadhwa, ‘High Voltage Engineering’, New Age International (P) Ltd Publishers, Fourth Edition, 2020.
3.	Rakosh Das Begamudre, ‘Extra High Voltage AC Transmission Engineering’, New Age International (P) Ltd Publishers, Third Edition, 2006.

E-references

1	www.onlinecourses.nptel.ac.in/noc18_ee41
2	NPTEL courses on High Voltage Engineering, IIT Kanpur.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the various over voltages and its effect on power system.	L2: Understanding
CO2	:	Understand high voltage breakdown phenomena in insulating materials.	L2: Understanding
CO3	:	Explain the method of generating high DC, AC and impulse voltages	L3: Applying
CO4	:	Use appropriate procedure for measurement of high DC, AC and impulse currents.	L3: Applying
CO5	:	Comprehend the HV test procedures on electrical apparatus as per the Indian standards.	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	2											2		
CO2	3	2		1									2	1	
CO3	2	2	3	1							2	3	3	1	2
CO4	2	2	3	1								3	3	1	2
CO5	1	2	3	1				1	1			3	3	2	2
Avg	**2**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**-**	**2**	**3**	**2.6**	**1.3**	**2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE704	**INDUSTRIAL MANAGEMENT AND ECONOMICS**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
Mathematics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
1.	To understand the concept of management, economics and Indian financial system					
UNIT I	**MODERN CONCEPT OF MANAGEMENT**		**9**	**0**	**0**	**9**
Scientific management-Functions of management-Planning-Organising- Staffing-Directing- Motivating- Communicating- Co-ordinating- Controlling-Organizational structures- Line, Line and staff and Functional relationships- Span of control-Delegation- Management by Objectives.						
UNIT II	**PERSONNEL MANAGEMENT**		**9**	**0**	**0**	**9**
Objectives and functions of personnel management- Recruitment-Selection and training of workers- Labour Welfare- Industrial Fatigue- Industrial disputes-Trade Unions- Quality circles. Formation of companies: Proprietory-Partnership-Joint stock companies- Public sector- Joint sector and Co-operative sector.						
UNIT III	**MARKETING MANAGEMENT**		**9**	**0**	**0**	**9**
Pricing- Promotion- Channels of distribution- Market research-Advertising. Production Management: Batch and mass production- Inventory control- EOQ-Project planning by PERT/CPM- Construction of Network (Basic ideas only).						
UNIT IV	**BASICS OF ECONOMICS**		**9**	**0**	**0**	**9**
Theory of demand and supply- Price mechanism- Factors of production- Land, labour, capital and organization- National income- Difficulties in estimation- Taxation- Direct and indirect taxes- Progressive and regressive- Black money- Inflation-Causes and consequences.						
UNIT V	**INDIAN FINANCIAL SYSTEM**		**9**	**0**	**0**	**9**
Reserve bank of India: Functions- Commercial banking system-Development financial institutions- IDBI- ICICI- SIDBI- IRBI-NABARD- Investment institutions-UTI- Insurance companies- Indian capital market- Stock market- Functions- Role of the public sector- Privatisation- Multinational corporations and their impact on the Indian economy						
						Total (45L+0T)= 45 Periods

Text Books:	
1.	O P Khanna , “Industrial Management” , Dhanpat Rai Publications,4th edition, 1980.
2.	Philip Kotler, Kevin Lane Keller, SweeHoon Ang, Chin Tiong Tan, Siew Meng Leong, “Marketing Management: An Asian Perspective” Pearson Education Limited, 7th Edition, 2017
3.	A. N. Agrawal, “Indian Economy”,Vikas Publishing House PVT, 4th edition, 1978.
Reference Books:	
1.	K. K. Ahuja, “Industrial management” Khanna Publishers, 1978.
2.	K.K Dewett, ShyamLal , “Modern economic theory” S Chand and Company Limited, 2008
E-Reference:	
1	www.onlinecourses.nptel.ac.in/
2	www.class-central.com

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the concepts of management	L2: Understanding
CO2	:	Remember various types of management.	L1: Remembering
CO3	:	Analyze the Indian economics	L4: Analyzing
CO4	:	Create an organization efficiently for its upliftment	L6: Creating
CO5	:	Apply marketing concept to any organization to earn more profit.	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1			1			2	1		3	2	3	2	1	1	1
CO2			1			2	1		3	2	3	2	1	1	1
CO3				1		1		2				1	1		1
CO4			1			2		1	3	2	3	2	1	1	1
CO5			1			2		1	3	2	3	2	1	1	1
Avg.	**-**	**-**	**1**	**1**	**-**	**1.8**	**1**	**1.33**	**3**	**2**	**3**	**1.8**	**1**	**1**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE705	**POWER SYSTEMS LABORATORY**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
Power generation , Transmission and Distribution System; Power System Analysis and Stability		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1.	To study hands-on and computational experiments related to various power system problems.
2.	To understand programming of numerical methods for solution of various power system operation and control problems.

LIST OF EXPERIMENTS

1. Formation of bus admittance matrix.
2. Bus impedance matrix formulation.
3. Load flow analysis using Gauss Seidel method.
4. Power flow analysis using Newton Raphson method.
5. Transient stability analysis: Single machine infinite bus system.
6. Transient stability analysis of multi machine power systems.
7. Load frequency control of single area and two area power systems.
8. Symmetrical fault analysis
9. Asymmetrical fault analysis
10. Economic dispatch by lambda iteration method.
11. Solution to combined economic emission dispatch problems.
12. Thermal unit commitment using priority list method.

Total (0T + 45P)= 45 Periods

Reference Books:

1.	Hadi Saadat, “Power System Analysis”, Tata McGraw Hill, 2010.
2.	Kothari D.P and Dhillon J.S, “Power System Optimization”, Prentice Hall of India, New Delhi, 2004.

E-References:

1	NPTEL Course: Power Systems Engineering – Prof. Debapriya Das, IIT-K.
2	NPTEL Course: Computer Aided Power System Analysis – Prof. Biswarup Das, IIT-R.
3.	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	:	Formulate power system network matrices.	L4: Analysing
CO2	:	Recall knowledge about power flow analysis / fault analysis	L3: Applying
CO3	:	Analyze power system stability problems.	L4: Analysing
CO4	:	Formulate and solve power system operational problems.	L3: Applying
CO5	:	Evaluate system load to various generators in the system economically.	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	3	1	1					1		1	2	2	1
CO2	2	2	3	2	1					1		1	3	3	1
CO3	2	2	3	2	1					1		1	2	3	1
CO4	2	2	3	2	1					1		1	3	3	1
CO5	2	2	3	2	1					1		1	2	3	1
Avg	**2**	**1.8**	**3**	**1.8**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**2.4**	**2.8**	1

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

22EE706	**ELECTRIC DRIVES AND CONTROL LABORATORY**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**1.5**
Power Electronics and Electrical Machines		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1.	To impart knowledge on Performance of the fundamental control practices associated with ACand DC machines (starting, reversing, braking, plugging,etc.) using power electronics.
2.	To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation.

LIST OF EXPERIMENTS

1	Thyristor controlled DC Drive using PSPICE / MATLAB / PSIM Software
2	Chopper fed DC Drive using PSPICE / MATLAB / PSIM Software
3	AC Single phase motor-speed control using TRIAC.
4	PWM Inverter fed 3 phase Induction Motor control using PSPICE / MATLAB / PSIM Software
5	VSI / CSI fed Induction motor Drive analysis using MATLAB/PSIM Software
6	V/f control operation of 3F induction motor drive
7	Permanent magnet synchronous motor drive fed by PWM Inverter
8	Regenerative / Dynamic braking operation of DC Motor and AC Motor using software
9	Study of Switched Reluctance Motor Drive
10	Study of BLDC Motor Drive

Total (0+45)= 45 Periods

Reference Books:

1.	Seung-Ki Sul, "Control of Electric Machine Drive Systems" , John Wiley & Sons, Ltd., 2011.
2.	Shaahin Filizadeh ,"Electric Machines and Drives,", CRC Press,2013.
3	Haitham Abu-Rub, Atif Iqbal, Jaroslaw Guzinski, "High Performance Control of AC Drives with Matlab/Simulink Models" John Wiley & Sons, Ltd., 2012.
4.	Werner Leonhard ,"Control of Electrical Drives", Springer, 2006.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Set up control strategies to synthesize the voltages in dc and ac motor drives	L3: Applying
CO2	:	Develop testing and experimental procedures applying basic knowledge in electronics, electrical circuit analysis, electrical machines, microprocessors, and programmable logic controllers	L3: Applying
CO3	:	Use standard methods to determine accurate modeling/simulation parameters for various general-purpose electrical machines and power electronics devices required for designing a system and solve drives related problems	L4: Analyzing
CO4	:	Combine the use of computer-based simulation tools relevant to electrical Drives with practical laboratory experimentation.	L6: Creating
CO5	:	Design VSI/CSI for induction motor using any simulation software.	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	2	2	2	1	1				1	1	2	1	2
CO2	1	2	2	2	2	1	1				1	1	2	2	2
CO3	1	2	2	2	2	1	1				1	1	2	3	2
CO4		1	2	2	2	1	1				1	1	2	3	2
CO5		1	2	2	2	1	1				1	1	2	3	2
Avg	**1**	**1.4**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**2**	**2.4**	**2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EE801	**PROJECT WORK**		**SEMESTER**		**VIII**
PREREQUISITE:	**CATEGORY**	**EE**	**Credit**		**10**
	Hours/Week	**L**	**T**	**P**	**TH**
		0	**0**	**20**	**20**

COURSE OBJECTIVES:

The student should be made to learn methodology to select a good project and able to work in a team leading to development of hardware/software product.Prepare a good technical report. Gain Motivation to present the ideas behind the project with clarity.

GUIDELINES AND EVALUATION

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The aim of the project work is to deepen Comprehension of principles by applying them to a new problem which may be the design /fabrication of any power component / circuit / sensor / Activator / Controller, a research investigation, a computer or management project or a design problem.

The students may be grouped into 2 to 4 and work under a project supervisor. The device/system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry.

The progress of the project is evaluated for internal assessment based on a minimum of three reviews. The project review committee may be constituted by the Head of the Department.The student shall be instructed to meet the supervisor periodically and to attend the review committee meetings for evaluating the progress.

A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

Total (300P) = 300 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Ability to identify, formulate, design, interpret, analyze and provide solutions to complex engineering and societal issues by applying knowledge gained on basics of science and Engineering	L6:Creating
CO2	Ability to choose, conduct and demonstrate a sound technical knowledge of their selected project topics in the field of power components, protection, high voltage, electronics, process automation, power electronics and drives, instrumentation and control by exploring suitable engineering and IT tools.	L6:Creating
CO3	Ability to understand, formulate and propose new learning algorithms to solve engineering and societal problems of moderate complexity through multidisciplinary projects understanding commitment towards sustainable development.	L2:Understanding
CO4	Ability to demonstrate, prepare reports, communicate and work in a team as amember/leader by adhering to ethical responsibilities	L6:Creating
CO5	Ability to acknowledge the value of continuing education for oneself and to stay up with technology advancements.	L5:Evaluate

COURSE ARTICULATION MATRIX

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

3/2/1 – indicates strength of correlation (3 – high, 2- medium, 1- low)

PROFESSIONAL ELECTIVE COURSES

22EEPE11	**NETWORK ANALYSIS AND SYNTHESIS**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Electric circuit Analysis		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1. To familiarize the different methods of analysis and synthesis of electrical circuits.

UNIT I	**S-DOMAIN ANALYSIS AND FREQUENCY DOMAIN ANALYSIS**	**9**	**0**	**0**	**9**

S - domain network – driving point and transfer impedances and their properties – transform network analysis– poles and zeros of network functions – time response from pole – zero plots. Immittance –loci of RLC networks – frequency response of RLC networks – frequency response from pole – zero – bode plots.

UNIT II	**NETWORK TOPOLOGY**	**9**	**0**	**0**	**9**

Network graphs, definitions, tree, co-tree, link, basic loop and basic cut sets – link currents; tie set schedules, tree branch voltages ; and cut – set schedules –incidence reduced incidence metrics – V shift and I shift – primitive impedance and admittance matrices – application to network solutions - duality and dual networks.

UNIT III	**TWO PORT NETWORKS**	**9**	**0**	**0**	**9**

Characterization of two port networks in terms of Z , Y,H and T parameters – networks equivalents – relations between network parameters –interconnections two port networks- T and π representation- Analysis of T, Ladder ,Bridged – T and lattice networks – transfer function of terminated two port networks.

UNIT IV	**ELEMENTS OF NETWORK SYNTHESIS**	**9**	**0**	**0**	**9**

Reliability of one port network – Hurwitz polynomials and properties – Positive Real functions and properties – frequency response of reactive one port – synthesis of one port network using Foster and Cauer methods - synthesis of RL, RC network using Foster and Cauer methods – synthesis of LC one port network.

UNIT V	**DESIGN OF FILTERS**	**9**	**0**	**0**	**9**

Classification of Filters – pass band and stop band filters; classification and characteristic impedance – design of constant – K, M – derived and composite filters – qualitative treatment of active filters – Butterworth and Chebyshev filters. Attenuators; T type, π type, lattice, bridged T and L type attenuators.

Total (45L+0T)= 45 Periods

Text Books:

1.	Franklin F. Kuo, 'Network Analysis and Synthesis', Wiley India Private Limited, Second Edition, 2006
2.	Sudhakar. A., and ShyammohanS Palli , 'Circuits and Networks: Analysis and Synthesis' McGraw Hill Education, New Delhi, Fifth edition, 2017.

Reference Books:

1.	A.Chakrabarti, 'Circuit Theory-Analysis and Synthesis', Dhanpat Rai & Co., New Delhi, Seventh revised Edition, 2018.
2.	Van Valkenburg, M.E., 'Network Analysis', Prentice Hall of India Private Ltd., New Delhi, Third Edition, 2014.

E- Reference:

1.	https:// archieve.nptel.ac.in/courses/108/102/108102042/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand about time response and frequency response of electrical circuits	L2: Understanding
CO2	:	Apply graph theory to network solutions	L3: Applying
CO3	:	Characterize two port networks	L4: Analyzing
CO4	:	Choose appropriate method for network synthesis	L5: Evaluating
CO5	:	Design of filters and attenuator networks.	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**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	2	1	1							1	3	2	1
CO2	3	3	2	1	1							1	3	2	1
CO3	3	3	2	1	1							1	3	2	1
CO4	3	3	2	1	1							1	3	2	1
CO5	3	3	2	1	1							1	3	2	1
Avg	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE12	ADVANCED CONTROL SYSTEMS	SEMESTER	VI

PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Signals and Systems, Control systems	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1. To gain knowledge in the analysis of non-linear system
2. To gain knowledge in the analysis of digital control of linear system.

UNIT I	**NON-LINEAR SYSTEM – DESCRIPTION & STABILITY**	**9**	**0**	**0**	**9**
	Linear vs non-linear – Examples – Incidental and Intentional – Mathematical description - Equilibria and linearization - Stability – Lyapunov function – Construction of Lyapunov function.				
UNIT II	**PHASE PLANE AND DESCRIBING FUNCTION ANALYSIS**	**9**	**0**	**0**	**9**
	Construction of phase trajectory – Isocline method – Direct or numerical integration – Describing function analysis – Computation of amplitude and frequency of oscillation.				
UNIT III	**Z - TRANSFORM AND DIGITAL CONTROL SYSTEM**	**9**	**0**	**0**	**9**
	Z transfer function – Block diagram – Signal flow graph – Discrete root locus – Bode plot.				
UNIT IV	**STATE-SPACE DESIGN OF DIGITAL CONTROL SYSTEM**	**9**	**0**	**0**	**9**
	State equation – Solutions – Realization – Controllability – Observability – Stability – Jury's test.				
UNIT V	**MUTLI INPUT MULTI OUTPUT (MIMO) SYSTEM**	**9**	**0**	**0**	**9**
	Models of MIMO system – Matrix representation – Transfer function representation – Poles and Zeros – Decoupling – Introduction to multivariable Nyquist plot and singular values analysis – Model predictive control.				
	Total (45L+0T)= 45 Periods				

Text Books:

1. Benjamin C. Kuo, 'Digital Control Systems', Oxford University Press, 2010.
2. I.J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2021.

Reference Books:

1. Raymond T. Stefani & Co., 'Design of feedback Control systems', Oxford University, 2010.
2. George J. Thaler, 'Automatic Control Systems', Jaico Publishers, 2011.

E-Reference

1. https://nptel.ac.in/courses/108103007
2. https://www.google.co.in/books/edition/Advanced_Control_Systems/k7AVfjnoS7IC?hl=en&gbpv=1&dq=advanced+control+system&printsec=frontcover

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Use the conventional technique of non-linear system analysis.	L2:Understanding
CO2	:	Solve the problems in digital control systems using Z transform.	L5:Evaluating
CO3	:	Analyze discrete time systems using conventional techniques.	L3:Applying
CO4	:	Analyze the digital control system using state-space formulation.	L3:Applying
CO5	:	Know the formulation and analysis of MIMO systems.	L6:Creating

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2		1	1					1	1	1
CO2	3	3	3	3	2		1	1					2	2	1
CO3	3	3	3	3	3		1	1					2	2	1
CO4	2	3	3	3	3		1	1					2	2	1
CO5	1	1	1	3	2		1	1					2	2	1
Avg	**2.4**	**2.6**	**2.4**	**2.6**	**2.4**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**1.8**	**1.8**	**1**

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

22EEPE13	**DISCRETE CONTROL SYSTEMS**			**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**		**PE**	**Credit**		**3**
Control Systems		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To understand the digital signal processing.
2.	To study the design of sampled data control systems in state space.
3.	To impart knowledge on digital control algorithms and stability study.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Review of frequency and time response analysis and specifications of continuous time systems - need for controllers - continuous time compensations - continues time PI, PD, PID controllers, Realization of basic compensators: Lag, Lead and Lag-Lead compensation schemes - problems.

UNIT II	**SIGNAL PROCESSING IN DIGITAL CONTROL**	**9**	**0**	**0**	**9**

Need for digital control – Configuration of basic digital control scheme – Principles of signal conversion – Basic discrete-time signals – Time domain and frequency domain models for discrete-time systems - Aliasing – Reconstruction of analog signals – Practical aspects of the choice of sampling rate – Discretization based on bilinear transformation.

UNIT III	**MODELING AND ANALYSIS OF SAMPLED DATA CONTROL SYSTEM**	**9**	**0**	**0**	**9**

Differential equation description – Z-transform method of description– Z-transform analysis of sampled data control systems – Jury’s stability test – Routh stability criterion on the r-plane – State variable concepts: First companion – Second companion – Jordan canonical models – Discrete state variable models – Elementary principles.

UNIT IV	**DESIGN OF DIGITAL CONTROL ALGORITHMS**	**9**	**0**	**0**	**9**

Introduction – z-plane specifications of control system design –Digital lead, lag and lag-lead compensator design using frequency response plots - Digital lead lag compensator design using Root locus plots – z-plane synthesis – Digital controllers for deadbeat performance - Examples.

UNIT V	**PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS**	**9**	**0**	**0**	**9**

Development and implementation of digital PID control algorithms – Tunable PID controllers - Digital temperature control system: Control algorithm – Digital position control system: Digital measurement of shaft position/speed, control algorithm – Stepping motors and their controls: Torque-speed curves, Interfacing of stepper motors to microprocessors

Total (45L+0T)= 45 Periods

Text Books:

1.	M.Gopal, "Digital Control and Static Variable Methods", Tata McGraw Hill, New Delhi, 2009.
2.	I.J.Nagrath&M.Gopal, "Control Systems Engineering", New Age International Publishers, New Delhi, 2021.

Reference Books:

1.	B.C.Kuo, Digital Control Systems,Oxford University Press,2nd Edition,2007.
2.	K. Ogata, Modern Control Engineering, Pearson Education, 2002.
3.	Kenneth J. Ayala, "The 8051 Microcontroller- Architecture, Programming and Applications", Penram International, 2nd Edition, 1996.

E-References:

1.	https://nptel.ac.in/courses/108103008/
2.	https://www.sciencedirect.com/topics/engineering/digital-control-system

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Outline sampling techniques to control systems.	L1: Remembering
CO2	:	Design the various digital control algorithms.	L4: Analyzing
CO3	:	Predict the performance of various types of digital controllers.	L4: Analyzing
CO4	:	Identify the various types of digital compensators.	L2: Understanding
CO5	:	Illustrate applications of digital control.	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	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2		1	1					3	3	1
CO2	3	3	3	3	2		1	1					2	2	1
CO3	3	3	3	3	3		1	1					2	3	1
CO4	2	3	3	3	3		1	1					2	2	1
CO5	1	1	1	3	2		1	1					2	3	1
Avg	**2.4**	**2.6**	**2.4**	**2.6**	**2.4**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**2.2**	**2.6**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEPE14</td><td colspan="2">BIOMEDICAL INSTRUMENTATION</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">Basic Electrical and Electronics Engg, Measurements and Instrumentation</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 provide an adequate knowledge of the human physiology systems.</td></tr>
<tr><td>2.</td><td colspan="6">To introduce different transducers for Biomedical applications.</td></tr>
<tr><td>3.</td><td colspan="6">To introduce the student to the various sensing and measurement devices of bio-medical electrical systems.</td></tr>
<tr><td>4.</td><td colspan="6">To provide awareness of electrical safety of medical equipment.</td></tr>
<tr><td>UNIT I</td><td colspan="2">HUMAN PHYSIOLOGICAL SYSTEMS AND BIO POTENTIAL ELECTRODES AND TRANSDUCERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Cells and their structure – Nature of Cancer cells – Transport of ions through the cell membrane – resting and action potential – bio-electric potential – nerve tissues and organs – difference systems of human body. Physiology of Human body- Brain, heart, lungs-Cardiovascular system- Respiratory system- nervous system. Design of medical instruments components of biomedical instrument systems – electrodes - transducers.</td></tr>
<tr><td>UNIT II</td><td colspan="2">BIO SIGNAL ACQUISITION BIO POTENTIAL RECORDERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Physiological signal amplifiers – isolation amplifiers – medical pre amplifier design – bridge amplifiers – line drive amplifiers – current amplifiers – chopper amplifiers – bio signal analysis – signal recovery and data acquisition – drift compensation in operational amplifiers – pattern recognition. Characteristics of recording system – Electrocardiography(ECG) – Electroencephalography(EEG) – Electromyography(EMG) – Electroretinography(ERG) & Electrooculography(EOG) – recorders for offline analysis.</td></tr>
<tr><td>UNIT III</td><td colspan="2">SPECIALIZED MEDICAL EQUIPMENT AND BIO-TELEMETRY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Blood cell counter – Electron microscope – radiation detectors – photo meters and colorimeters – digital thermometer – audio meters – X-ray tube – X-ray machine – Radiography and fluoroscopy – image intensifiers – angiography – applications of X-ray examination. Biotelemetry</td></tr>
<tr><td>UNIT IV</td><td colspan="2">PHYSIOLOGICAL ASSIST DEVICES AND OPERATION THEATRE EQUIPMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Pacemakers – Pacemaker batteries – artificial heart walls – Defibrillators – nerve and muscle stimulators – heart lung machine – kidney machine. Surgical diathermy – short wave diathermy – microwave diathermy – ultrasonic diathermy – therapeutic effect of heat – range and area of irritation of different diathermy techniques – Ventilators – Anesthesia machines – blood flow meters – Cardiac output measurements – Pulmonary function analyzers – Blood gas analyzers – oxymeters – elements of intensive care monitoring.</td></tr>
<tr><td>UNIT V</td><td colspan="2">SAFETY INSTUMENTATION AND ADVANCES IN BIOMEDICAL INSTRUMENTATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Radiation safety instrumentation – physiological effects due to 50 Hz current passage – Micro shock and macro shock – electrical accidents in hospitals – Devices to protect against electrical hazards – hospital architecture. Computers in medicine – lasers in medicine – endoscope – Cryogenic surgery – Nuclear imaging techniques – computer tomography – thermography – ultrasonic imaging system – Magnetic resonance imaging – Positron emission tomography – digital subs traction angiography.</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T)= 45 Periods</td></tr>
</table>

Text Books:

1.	U. Satyanarayana “Biochemistry”-5th edition – Sri Padmavathi Publications Ltd.,2017.
2.	N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “Biology: Aglobal approach”, Pearson Education Ltd, 2014.
3.	Dr.M.Arumugam, ‘Bio-Medical Instrumentation’, Anuradha Agencies, 2012.
4.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, ‘Bio-Medical Instrumentation and Measurements’, II edition, Pearson Education, 2011 / PHI.

Reference Books:

1.	R.S.Khandpur, ‘Hand Book of Bio-Medical instrumentation’, Tata McGraw Hill Publishing Co Ltd.,2012.
2.	L.A. Geddes and L.E.Baker, ‘Principles of Applied Bio-Medical Instrumentation’, John Wiley &Sons, 2011.
3.	C.Rajarao, ‘Medical Instrumentation’, John Wiley & Sons,2013.

4.	C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2012.
E-Reference:	
1	www.onlinecourses.nptel.ac.in

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Remember the purpose & methods of measurement.	L1: Remembering
CO2	:	Understand different display and recording devices for various applications.	L2: Understanding
CO3	:	Evaluate electrical & non electrical physiological measurements and bio amplifier.	L5: Evaluating
CO4	:	Apply physiological assist devices and operational theatre equipment.	L3: Applying
CO5	:	Design biomedical equipment as it is a challenging interdisciplinary process	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	2	1	1	1	2	1	1	1	1	1	1	1	2	1	2
CO2	3	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO3	1	2	2	1	1	1	1	1	1	1	1	1	2	1	2
CO4	3	1	1	3	2	1	1	1	1	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	1	1	1	2	1	2
Avg	**2.2**	**1.2**	**1.2**	**2**	**1.4**	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1.6**	**1**	**1.6**

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

<table>
<tr><td colspan="2">22EEPE15</td><td colspan="2">BIOLOGY FOR ELECTRICAL ENGINEERS</td><td colspan="3">SEMESTER</td><td>VI</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">Basic Science</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 understand biological mechanisms of living organisms from the perspective of engineers.</td></tr>
<tr><td>2.</td><td colspan="7">To understanding the function and regulation of human system and acquire knowledge about biological problems that requires engineering expertise to solve them.</td></tr>
<tr><td>3.</td><td colspan="7">To Understand the basics of molecular biology and genetics.</td></tr>
<tr><td>4.</td><td colspan="7">To know about the cell injury and repair.</td></tr>
<tr><td>5.</td><td colspan="7">To teach the microbiology and immunopathology.</td></tr>
<tr><td colspan="2">UNIT I</td><td colspan="2">BIOMOLECULES AND METABOLISM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Carbohydrates- classification - Glycolysis- definition- flow chart- steps involved in glycolysis- preparatory phase and pay off phase- kinds of reactions in glycolysis. Photosynthesis- definition- significance photosynthetic- pigments types.</td></tr>
<tr><td colspan="2">UNIT II</td><td colspan="2">BASICS OF ENZYMES, MACROMOLECULES AND NUCLEIC ACIDS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Proteins- classification- structure of proteins - properties of proteins- protein synthesis. Types-Structural components of nucleic acids- acid, pentose sugar and nitrogenous base- nucleoside – nucleotide and its functions - single and double helical structure of DNA-comparison between DNA and RNA- types of RNA -mRNA, tRNA and rRNA and their function.</td></tr>
<tr><td colspan="2">UNIT III</td><td colspan="2">FUNDAMENTALS OF BIOCHEMISTRY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes.</td></tr>
<tr><td colspan="2">UNIT IV</td><td colspan="2">CELL DEGENERATION, REPAIR AND NEOPLASIA</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Cells and their structure – Cell injury - cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.</td></tr>
<tr><td colspan="2">UNIT V</td><td colspan="2">FUNDAMENTALS OF MICROBIOLOGY AND IMMUNOPATHOLOGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Structure of Bacteria and Virus - Morphological features and structural organization - List of common bacterial, fungal and viral diseases of human beings. Basics of Microscopes : Light microscope, Electron microscope (TEM & SEM). - Natural and artificial immunity - Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.</td></tr>
<tr><td colspan="8" align="right">Total (45L+0T)= 45 Periods</td></tr>
</table>

Text Books:

1.	FJ.L.Jain, Sanjay jain and Nitin jain- “Fundamentals of Biochemistry” - Sixth edition, S.Chand and company Ltd., Ram nagar, 2005.
2.	Dr.A.V.S.S.Rama Rao-“ Text book of Biochemistry”- Text book of Biochemistry- First edition- UBS Publishers' Distributors Pvt. Ltd., 2008
3.	U. Satyanarayana –“ Biochemistry”-5th edition – Sri Padmavathi Publications Ltd.,2017.
4.	N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “Biology: A global approach”, Pearson Education Ltd, 2014.
5.	RAFI MD “Text book of biochemistry for Medical Student” Fourth Edition, Universities Press, Orient Blackswan Private Limited - New Delhi 2021.
6.	Dubey RC and Maheswari DK. “A Text Book of Microbiology” Chand & Company Ltd, 2007 4.
7.	Prescott, Harley and Klein, “Microbiology”, 10th edition, McGraw Hill, 2017

Reference Books:

1.	Stent, G. S.; and Calender-“ Molecular Genetics”- Second edition - R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
2.	By Nelson, D. L.; and Cox- “Principles of Biochemistry”- V Edition- M. M.W.H. Freeman and Company

3.	Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H-“ Outlines of Biochemistry”- John Wiley and Sons
4.	Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, ‘Biological Science’, Pearson Education India, 2016.
5.	Reinhard Renneberg, Viola Berkling and Vanya Loroch, ‘Biotechnology for Beginner’s’, Academic Press, 2017.
6.	S Balaji, S Lakshminarayanan, “Conceptual comparison of metabolic pathways with electronic circuits”, Journal of Bionics Engineering, Vol 1, Issue 3, pg 175-182, 2004
E-Reference	
1	www.onlinecourses.nptel.ac.in/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Be aware that all types of life have the identical structural units.	L1: Remembering
CO2	:	Explain, analyze, diagnose, and develop new therapies to treat disease and heal damaged tissues and organ systems.	L4: Analyzing
CO3	:	Teach the fundamentals of microbiology and immunopathology.	L3: Applying
CO4	:	Explain human biological systems.	L3: Applying
CO5	:	Share knowledge in genetics and molecular biology.	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**	**PSO 3**
CO1	2	1	1	1	2	1	1	1	1	1	1	1	1		1
CO2	3	1	1	3	1	1	1	1	1	1	1	1	1		1
CO3	1	2	2	1	1	1	1	1	1	1	1	1	1		1
CO4	3	1	1	3	2	1	1	1	1	1	1	1	1		1
CO5	2	1	1	2	1	1	2	1	1	1	1	1	1		1
Avg	**2.2**	**1.2**	**1.2**	**2**	**1.4**	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**1**

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

22EEPE16	**ADAPTIVE CONTROL**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Control systems		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To impart knowledge on how to recursively estimate the parameters of discrete input– output models using recursive parameter estimation methods
2.	To make the student understand the principles of STR, MRAC and Gain scheduling.
3.	To make the student design simple adaptive controllers for linear systems using STR, MRAC and Gain scheduling

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction - Adaptive Schemes - The adaptive Control Problem – Applications-Parameter estimation: -LS, RLS: and ERLS.					
UNIT II	**GAIN SCHEDULING**	**9**	**0**	**0**	**9**
Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations - application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback.					
UNIT III	**DETERMINISTIC SELF-TUNING REGULATORS**	**9**	**0**	**0**	**9**
Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics					
UNIT IV	**STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS**	**9**	**0**	**0**	**9**
Introduction – Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators					
UNIT V	**MODEL – REFERENCE ADAPTIVE SYSTEM**	**9**	**0**	**0**	**9**
Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory – Design of MRAS using Lyapunov theory – Relations between MRAS and STR.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	K.J. Astrom and B. J. Wittenmark, “Adaptive Control”, Second Edition, Pearson Education Inc., Second Edition, 2013.
Reference Books:	
1.	T. Soderstorm and Petre Stoica, “System Identification”, Prentice Hall International (UK) Ltd., 1989, 1st Edition.
2.	Lennart Ljung, “System Identification: Theory for the User”, Second Edition, Prentice Hall, 1999.
E-references:	
1	https://archive.nptel.ac.in/courses/108/102/108102113/
2	https://in.mathworks.com/help/slcontrol/adaptive-control-design.html
3	https://in.mathworks.com/videos/nonlinear-model-based-adaptive-robust-controllerin-an-oil-and-gas-wireline-operation-1637577967956.html
4	https://www.dynalog-us.com/adaptive-robot-control.htm
5	https://www.vlab.co.in/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Ability to apply the estimation algorithm to estimate the parameters of the process.	L3: Applying
CO2	:	Ability to apply the adaptive control concepts to control a process.	L3: Applying
CO3	:	Use appropriate software tools for design of adaptive controllers and analysis of the process.	L5: Evaluating
CO4	:	Identify, formulate, carry out research by designing suitable adaptive schemes for complex instrumentation problem.	L5: Evaluating
CO5	:	Apply the concepts/techniques to design adaptive control for multidisciplinary problem	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1		1	1					2	2	
CO2	3	2	2	2	1		1	1					2	2	
CO3	3	3	3	3	1		1	1					2	2	
CO4	3	3	3	3	1		1	1					2	2	
CO5	3	2	2	2	1		1	1					2	2	
Avg.	**3**	**2.4**	**2.4**	**2.4**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE21	**HVDC TRANSMISSION SYSTEMS**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power System Generation, Transmission and Distribution Systems		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the concept, planning of DC power transmission and comparison with AC power transmission.
2.	To analyze the converters used in HVDC system.
3.	To study about the HVDC system control.
4.	To understand the reactive power requirements of the converter and Static VAR control methods.
5.	To understand the harmonics generation in HVDC system and design of harmonics filters.
6.	To impart knowledge on modelling and analysis of HVDC systems.

UNIT I	**DEVELOPMENT OF HVDC TECHNOLOGY**	**9**	**0**	**0**	**9**
Introduction – Comparison of AC and DC transmission – Applications of DC transmission – HVDC system configurations and components – Planning for HVDC transmission – Modern trends in HVDC technology - DC breaker - Operating problems - HVDC transmission based on voltage source converter - MTDC System: types and applications					
UNIT II	**ANALYSIS OF HVDC CONVERTERS**	**9**	**0**	**0**	**9**
Line commutated converter - Pulse number – Choice of best topology for HVDC – Analysis of six pulse bridge converter without overlap, and with overlap less than 60° - Equivalent circuit model - Converter bridge characteristics – Analysis of 12 pulse converters - Analysis of Capacitor Commutated Converter (CCC) - Analysis of VSC based HVDC Converter.					
UNIT III	**CONTROL OF HVDC SYSTEMS**	**9**	**0**	**0**	**9**
Basic principles of DC link control – Converter control characteristics – System Control Hierarchy – Firing angle control – Current and Extinction angle control – Starting and stopping of DC link and power control – Higher level controllers – Control of VSC based HVDC link.					
UNIT IV	**REACTIVE POWER CONTROL, HARMONICS AND FILTERS**	**9**	**0**	**0**	**9**
Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM. Generation of Harmonics: characteristic and non-characteristics harmonics – Troubles caused by harmonics - Design of AC filters – Design of DC Filters –Active filters.					
UNIT V	**MODELLING AND ANALYSIS OF HVDC SYSTEMS**	**9**	**0**	**0**	**9**
System models: converter – converter controllers – DC networks and AC networks; System simulation: Philosophy and tools – Physical model (HVDC simulator) and Parity simulator – Modelling of DC systems for digital dynamic simulation - Transient simulation of DC and AC networks.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	Padiyar, K.R., “HVDC Power Transmission Systems”, New Age International Publishers, New Delhi, Third Edition, 2015.
2.	Edward Wilson Kimbark, “Direct Current Transmission”, Vol. I, Wiley Interscience, New York, 1971.
Reference Books:	
1.	Colin Adamson and N.G.Hingorani, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, First edition, 1960.
2	Arrillaga, J., “HVDC Transmission”, Peter Peregrinus, London, 1983
3	Erich Uhlmann, “Power Transmission by Direct Current”, B.S. Publications, 2004.
4	Kamakshaiah, S. & Kamaraju, V, “HVDC Transmission”, First Edition, Tata McGraw Hill, 2011.
E-Reference:	
1.	www.onlinecourses.nptel.ac.in/noc18_ee41

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Outline the concept of HVDC technology and MTDC systems.	L2: Understanding
CO2	:	Analyze the converters used in HVDC system	L4: Analyzing
CO3	:	Acquire knowledge about basic principles of HVDC system control	L2: Understanding
CO4	:	Design of static VAR systems for reactive power control and filters for harmonic mitigation in HVDC system.	L3: Applying
CO5	:	Develop the modelling and Analysis of HVDC systems.	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											1		
CO2	3	3	1										1	2	
CO3	3	1	1										1	1	1
CO4	3	2	2	2	1								2	1	1
CO5	3	3	3	1	1								2	1	1
Avg	**3**	**2**	**1.75**	**1.5**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.4**	**1.25**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE22	**EHVAC TRANSMISSION SYSTEMS**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution System		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
1.	To emphasize the fundamental concept of EHVAC transmission, electrostatic effects, corona effects and voltage controller for an EHVAC transmission system					
UNIT I	**INTRODUCTION**		**9**	**0**	**0**	**9**
Necessity of EHV AC transmission, benefits and challenges, power handling capacity and line losses, mechanical considerations, resistance of conductors, temperature rise of conductors and current-carrying capacity, properties of bundled conductors – numerical problems.						
UNIT II	**LINE AND GROUND REACTIVE PARAMETERS**		**9**	**0**	**0**	**9**
Inductance of EHV line configurations, line capacitance calculation, sequence inductances and capacitances, line parameters for modes of propagation, resistance and inductance of ground return.						
UNIT III	**VOLTAGE GRADIENTS OF CONDUCTORS**		**9**	**0**	**0**	**9**
Electrostatics, field of sphere gap, field of line changes and properties, charge – potential relations for multi-conductors lines, surface voltage gradient on conductors, distribution of voltage gradient on sub-conductors of bundle, effect of high electro static field on humans, animals and plants.						
UNIT IV	**CORONA EFFECTS**		**9**	**0**	**0**	**9**
Power loss and corona loss, charge-voltage (q–V) diagram and corona loss, attenuation of travelling waves due to corona loss, audible noise: generation and characteristics, limits for audible, audible noise measurement and meters, formulae for audible noise and its use in design, relation between single-phase and three-phase AN levels example						
UNIT V	**POWER FREQUENCY VOLTAGE CONTROL**		**9**	**0**	**0**	**9**
Power circle diagram and its use - voltage control using synchronous condensers - cascade connection of shunt and series compensation - sub synchronous resonance in series capacitor - compensated lines - static VAR compensating system						
						Total (45L + 0T) = 45 Periods

Text Books:	
1.	R. D. Begamudre, “EHVAC Transmission Engineering” New Age International (P)Ltd., Fourth Edition, 2011.
2.	Sunil. S. Rao,“HVAC and DC Transmission practice”, Khanna Publishers, Delhi, 2023.
Reference Books:	
1.	Shobhit Gupta and Deepak Gupta,“ EHV AC/DC Transmission Engineering Books Publishers, 2014.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Summarize the trends in EHVAC Transmission and calculate Line inductance and capacitances of bundled conductors.	L2: Understanding
CO2	:	Analyze the transmission line parameters.	L4: Analysing
CO3	:	Recall the electrostatic effects and corona effects.	L1: Remembering
CO4	:	Select the appropriate voltage control devices.	L4: Analysing
CO5	:	Apply the compensation techniques.	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	2	2	2	2	1	1	1					2	1	
CO2	2	3	3	2	2	1	1	1					3	1	
CO3	3	2	2	2	3	1	1	1					2	2	
CO4	2	2	2	2	2	1	1	1					2	1	
CO5	2	3	3	2	2	1	1	1					3	1	
Avg	**2.4**	**2.4**	**2.4**	**2**	**2.2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**2.4**	**1.2**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE23	**FLEXIBLE AC TRANSMISSION SYSTEMS**			**SEMESTER**			**VI**
PREREQUISITES			**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution System			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:	
1.	To introduce the reactive power control techniques.
2.	To educate on static VAr compensators and their applications
3.	To provide knowledge on thyristor controlled series capacitors
4.	To study about STATCOM devices
5.	To acquire knowledge on FACTS controllers

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Reactive Power Control in Electrical Power Transmission Lines -Uncompensated Transmission Line – Series Compensation – Basic Concepts of Static Var Compensator (SVC) – Thyristor Controlled Series Capacitor (TCSC) – Unified Power Flow Controller (UPFC).					
UNIT II	**STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS**	**9**	**0**	**0**	**9**
Voltage Control by SVC – Advantages of Slope in Dynamic Characteristics – Influence of SVC on System Voltage – Design of SVC Voltage Regulator –Modelling of SVC for Power Flow and Fast Transient Stability – Applications: Enhancement of Transient Stability – Steady State Power Transfer – Enhancement of Power System Damping.					
UNIT III	**THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS**	**9**	**0**	**0**	**9**
Operation of the TCSC – Different Modes of Operation – Modelling of TCSC – Variable Reactance Model – Modelling for Power Flow and Stability Studies. Applications: Improvement of the System Stability Limit – Enhancement of System Damping					
UNIT IV	**VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS**	**9**	**0**	**0**	**9**
STATCOM – Principle of Operation – V-I Characteristics. Applications: Steady State Power Transfer-Enhancement of Transient Stability – Prevention of Voltage Instability. SSSC-Operation of SSSC and the Control of Power Flow –Modelling of SSSC In Load Flow and Transient Stability Studies.					
UNIT V	**CO-ORDINATION OF FACTS CONTROLLERS**	**9**	**0**	**0**	**9**
Controller Interactions – SVC – SVC Interaction – Co-ordination of Multiple Controllers using Linear Control Techniques – Control Coordination using Genetic Algorithm.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	R.Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers For Electrical Transmission Systems", IEEE Press And John Wiley & Sons, Inc, 2002.
2.	Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi- 110 006, 2011.
3.	K.R.Padiyar, " FACTS Controllers in Power Transmission and Distribution", New Age International Publishers New Delhi, second edition, 2016
Reference Books:	
1.	A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
2.	V.K.Sood,"HVDC And FACTS Controllers – Applications of Static Converters in Power System", APRIL 2004 , Kluwer Academic Publishers, 2004.
3.	Xiao – Ping Zang, Christian Rehtanz And Bikash Pal, "Flexible AC Transmission System: Modelling and Control" Springer, 2012.
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	:	Identify suitable compensator for reactive power compensation.	L3: Applying
CO2	:	Analyse the impacts in network operations due to SVC placement.	L4: Analyzing
CO3	:	Visualise the significance of TCSC in network operation.	L3: Applying
CO4	:	Evaluate the performance of steady state and transients of FACTS controllers.	L5: Evaluating
CO5	:	Elaborate the features of coordination of FACTS controllers.	L3: Applying

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	1										1	1	
CO2	3	3	2	1									2	2	
CO3	2	2	1	1									2	2	
CO4	2	1	1	3									2	2	
CO5	1	1	1	1	1								2	2	
Avg	**2**	**1.6**	**1.2**	**1.2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.8**	**1.8**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEPE24</td><td colspan="2">POWER SYSTEM OPERATION AND CONTROL</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">Power Generation, Transmission and Distribution Systems; Power System Analysis and Stability</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 familiarize the significance of power system operation and control.</td></tr>
<tr><td>2.</td><td colspan="6">To understand the concepts of real power – frequency control, and reactive power – voltage control.</td></tr>
<tr><td>3.</td><td colspan="6">To acquire knowledge on economic power system operations, and computer aided control of power system.</td></tr>
<tr><td>UNIT I</td><td colspan="2">OVERVIEW OF POWER SYSTEM OPERATION AND CONTROL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Power scenario in Indian grid – National and Regional load dispatching centers – requirements of good power system - necessity of voltage and frequency regulation. System load variation: System load characteristics, load curves -daily, weekly and annual, load-duration curve, load factor, diversity factor. Reserve requirements: Installed, spinning, cold and hot reserves. Basic concepts of economic dispatch, unit commitment, load shedding and islanding, deregulation, governor control, LFC, AVR, system voltage control and security control - Tariff: characteristics and types.</td></tr>
<tr><td>UNIT II</td><td colspan="2">REAL POWER - FREQUENCY CONTROL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Fundamentals of speed governing mechanism and modeling: Speed-load characteristics – Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases; Multi-area systems: Two-area system modeling: static analysis, uncontrolled case, tie-line with frequency bias control; state variable model- integration of economic dispatch control with LFC.</td></tr>
<tr><td>UNIT III</td><td colspan="2">REACTIVE POWER–VOLTAGE CONTROL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis – stability compensation – voltage drop in transmission line - methods of reactive power injection - tap changing transformer, SVC and STATCOM for voltage control.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">ECONOMIC DISPATCH AND UNIT COMMITMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Statement of economic dispatch problem - input and output characteristics of thermal plant Incremental cost curve, co-ordination equations with and without loss, solution by direct method and Lambda -iteration method (No derivation of loss coefficients)- Base point and participation factors method.
Statement of Unit Commitment problem- Constraints in Unit Commitment: spinning reserve- thermal unit constraints- hydro constraints- fuel constraints and other constraints; Unit Commitment solution methods: Priority-list methods, forward dynamic programming approach, numerical problems only in priority-list method using full-load average production cost.</td></tr>
<tr><td>UNIT V</td><td colspan="2">COMPUTER CONTROL OF POWER SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">EMS functions - Energy control centre functions: Monitoring, data acquisition and control, energy control centre levels - SCADA: system hardware configuration –master station-remote terminal units- and functions; Network topology determination- state estimation, security analysis and control - Various operating states: normal, alert, emergency, extremis and restorative; State transition diagram showing various state transitions and control strategies.</td></tr>
<tr><td colspan="7">Total (45 L + 0 T) = 45 Periods</td></tr>
</table>

Text Books:	
1.	Allen J. Wood and Bruce F.Wollenberg, “Power Generation, Operation and Control”, Wiley India Ltd, New Delhi, Second Edition, Reprint 2016.
2.	Olle. I. Elgerd, “Electric Energy Systems Theory – An Introduction”, Tata McGraw Hill Publishing Company Ltd, New Delhi, 34th reprint 2010.
3.	Kundur. P, “Power System Stability & Control”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint 2010.
Reference Books:	
1.	Kothari, D.P., and Nagrath, I.J., “Modern Power System Analysis”, Fourth, Tata McGraw Hill Education Pvt., Limited, New Delhi, 2011.
2.	Grigsby, L.L.,”The Electric Power Engineering, Hand Book”, CRC Press & IEEE Press, 2001.
3.	Weedy, B.M. and Cory, B.J., “Electric Power systems”, Wiley, 2012.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize the fundamentals of power system operation and control.	L2: Understanding
CO2	Interpret the control action to meet the real power demand variations.	L3: Applying
CO3	Employ the reactive power injections for voltage profile improvement.	L3: Applying
CO4	Formulate the economic scheduling problems in power system.	L4: Analysing
CO5	Examine the need of computer aided control for power system operations and control.	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	3	3	3	2	2		2					2	3	3	1
CO2	3	3	3	3	2		2					3	3	3	1
CO3	3	3	2	3	3		3					3	2	3	1
CO4	2	3	3	2	3		2					2	2	2	1
CO5	2	2	2	2	2		3					2	2	2	1
Avg	**2.6**	**2.8**	**2.6**	**2.4**	**2.6**	**-**	**2.4**	**-**	**-**	**-**	**-**	**2.4**	**2.4**	**2.6**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE25	**UNDERGROUND CABLE ENGINEERING**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution Systems .		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives: To impart knowledge on the following topics

1. Understanding Power Cable Characteristics and Applications.
2. Cable Manufacturing.
3. Installation of Underground power cables.
4. Underground cable System Fault Locating.
5. Testing and maintenance of Underground cable system.
6. Cable Performance and Field Assessment of Power Cables.

UNIT I	**INTRODUCTION TO ELECTRICAL POWER CABLES**	**9**	**0**	**0**	**9**

Development of Underground Cables - Electric Lighting- Distribution of Energy for Lighting- - Paper Insulated Cables - Underground Residential Distribution Systems- Medium Voltage Cable Development.

UNIT II	**CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS**	**9**	**0**	**0**	**9**

Architecture of Underground Cabling System - Basic Dielectric Theory of Cable – Conductors -Armour and Protective Finishes - Cable Characteristics: Electrical- Fundamentals of Electrical Insulation Materials - Electrical Properties of Cable Insulating Materials - Cable Standards and Quality Assurance - Cable design parameters- Current Carrying Capacity - Short-circuit Ratings.

UNIT III	**SUPPLY DISTRIBUTION SYSTEMS AND CABLES**	**9**	**0**	**0**	**9**

Supply Distribution Systems - Distribution Cable Types, Design and Applications – Paper Insulated Distribution Cables - PVC Insulated Cables - Polymeric Insulated Distribution Cables for 6-30 kV - Manufacture of Distribution Cables - Joints and Terminations for Distribution Cables - Testing of Distribution Cables

UNIT IV	**TRANSMISSION SYSTEMS AND CABLES**	**9**	**0**	**0**	**9**

Basic Cable Types for A.C. Transmission - Self-contained Fluid-filled Cables – Gas Pressure Cables - High Pressure Fluid-filled Pipe Cables - Polymeric Insulated Cables for Transmission Voltages - Techniques for Increasing Current Carrying Capacity - Transmission Cable Accessories and Jointing for Pressure-assisted and Polymeric cables.

UNIT V	**CABLE INSTALLATION, TESTING, MAINTENANCE**	**9**	**0**	**0**	**9**

Installation of Transmission Cables -Splicing, Terminating, and Accessories – Sheath Bonding and Grounding-Testing of Transmission Cable Systems - Underground System Fault Locating - Field Assessment of Power Cable Systems- Condition monitoring tests – PD measurements.

Total (45L+0T)= 45 Periods

Text Books:

1. William Thue, ‘Electrical Power Cable Engineering’, CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742, 3rd Edition, 2017.
2. G. F. Moore, ‘Electric Cables Handbook’ -Third edition, Blackwell Science Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK., January 2017.

Reference Books:

1. Leonard L. Grigsby, ‘Electrical Power Cable Engineering’ - CRC Press, Marcel Dekker, 3rd Edition 2012.
2. Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in Underground Transmission Systems (Springer Theses), 2014, March.
3. https://kafactor.com/content/technical-resources/kerite-underground-cable-engineeringhandbook.Pdf
4. Hand book on Cable Fault Localization (April 2020) https://rdso.indianrailways.gov.in/works/uploads/File/Handbook %20 on %20 Cable %20 Fault % 20 Localization (2).pdf
5. K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LVDN: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279, June 2022.
6. R. W. Deltenre, J. J. Schwarz, and H. J. Wagnon, ‘‘Underground cable fault location: A handbook to TD-153,’’ BDM Corp., Albuquerque, NM, USA, Final Rep. EPRI EL-363, 1977. [Online]. Available: https://www.osti.gov/servlets/purl/7233049, doi: 10.2172/7233049, January 1997

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the fundamentals of underground cable system.	L1: Understanding
CO2	:	Gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.	L4: Analyzing
CO3	:	Understand different types of cable used in distribution system.	L2: Understanding
CO4	:	Acquire knowledge on Underground cables used in transmission system.	L3: Applying
CO5	:	Understand the cable installation, theory/methodology of testing and maintenance.	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	2					2	1			2	1	3		1
CO2	3	2					2	1			2	1	3		1
CO3	3	2					2	1			2	1	3		1
CO4	3	2	3				2	1			2	1	3		1
CO5	3	3	3	3			2	1			2	1	3	2	1
Avg.	**3**	**2.2**	**3**	**3**	**-**	**-**	**2**	**1**	**-**	**-**	**2**	**1**	**3**	**2**	**1**

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

22EEPE26	**POWER SYSTEM STATE ESTIMATION AND SECURITY CONTROL**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution System; Power System Analysis and Stability		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To acquire fundamental knowledge on power system state estimation.
2.	To familiarise on network observability analysis.
3.	To get conceptual aspects in power system state estimation and strategies to enhance the secure power system operations.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
State estimation- Energy management system- SCADA system- Energy control centers- Security monitoring and control- Concepts of reliability, security and stability - State transitions and control strategies- Data acquisition systems - Modulation techniques, MODEMS, Power line carrier communication.					
UNIT II	**POWER SYSTEM STATE ESTIMATION**	**9**	**0**	**0**	**9**
Static state estimation: Active and reactive power bus measurements – Line flow measurements - Line current measurements – Bus voltage measurements - Measurement model and assumptions - Weighted least square state estimation algorithm- Maximum likelihood estimation - Decoupled formulation of WLS state estimation- Fast decoupled state estimation.					
UNIT III	**NETWORK OBSERVABILITY ANALYSIS**	**9**	**0**	**0**	**9**
Tracking state estimation: Algorithm - Computational aspects – Measurement redundancy - Accuracy and variance of measurements - Variance of measurement residuals- Detection, identification and suppression of bad measurements - Pseudo measurements- Virtual measurements- External system equivalencing- Network observability - Observability analysis using phasor measurement units.					
UNIT IV	**DISTRIBUTION SYSTEM STATE ESTIMATION**	**9**	**0**	**0**	**9**
Distribution system state estimation- State of the art methods – Comparison of different DSSE algorithms- Developments in measurement system and DSSE design- Pseudo measurements- System architecture.					
UNIT V	**SECURITY ASSESSMENT AND ENHANCEMENT**	**9**	**0**	**0**	**9**
Contingency analysis: Linearized AC and DC models of power systems for security assessment - Line outage distribution factors and generation shift factors for DC and linearized AC models - Single contingency analysis using these factors. Contingency ranking and security indices-Correcting the generator dispatch for security enhancement using linearized DC models – Methods using sensitivity factors - Compensated factors. Emergency and restorative control procedures.					
					Total (45 L + 0 T)= 45 Periods

Text Books:	
1.	Ali Abur, “Power System State Estimation Theory and Implementation”, Marcel Dekker, 2004.
2.	Wood, A.J., Wollenberg, B.F., and Sheble, G.B., “Power Generation, Operation and Control”, John Wiley and Sons, 3rd Edition, 2013.
3.	Mahalanabis, Kothari and Ahson, “Computer Aided Power System Analysis and Control”, Tata McGraw Hill Publishers, 1991.
Reference Books:	
1.	Abhijit Chakrabarti and Sunita Halder, “Power System Analysis Operation and Control”, PHI Learning, 2010.
2.	G.L. Kusic, “Computer Aided Power System Analysis”, Prentice Hall of India, 1989.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the conceptual aspects in power system state estimation.	L2: Understanding
CO2	:	Demonstrate various state estimation methods.	L3: Applying
CO3	:	Acquire proficiency to perform observability analysis.	L4: Analysing
CO4	:	Demonstrate the distribution state estimation.	L3: Applying
CO5	:	Realize the security assessment and enhancement strategies.	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	3	3	1	1		1				1	2	1	3	1
CO 2	1	2	3	2	2		2				1	2	1	3	1
CO 3	1	2	3	2	2		2				1	2	1	2	1
CO 4	1	2	2	1	1		1				1	2	1	2	1
CO 5	1	2	3	2	2		2				1	2	1	1	1
Avg	**1**	**2.2**	**2.8**	**1.6**	**1.6**	**-**	**1.6**	**-**	**-**	**-**	**1**	**2**	**1**	**2.2**	**1**

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

22EEPE31	**DIGITAL SIGNAL PROCESSING**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Signals and Systems, and Control systems		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To classify signals and systems & their mathematical representation.
2.	To analyze the discrete time systems.
3.	To study about filters and their design for digital implementation.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.					
UNIT II	**DISCRETE TIME SYSTEM ANALYSIS**	**9**	**0**	**0**	**9**
Z-transform and its properties, inverse z-transforms; difference equation – Solution by z transform, application to discrete systems - Stability analysis, frequency response – Convolution – Introduction to Fourier transform – Discrete time Fourier transform.					
UNIT III	**DISCRETE FOURIER TRANSFORM AND COMPUTATION**	**9**	**0**	**0**	**9**
DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure.					
UNIT IV	**DESIGN OF DIGITAL FILTERS**	**9**	**0**	**0**	**9**
FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. Analog filter design – Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation – Warping, Prewarping – Frequency transformation.					
UNIT V	**DIGITAL SIGNAL PROCESSORS**	**9**	**0**	**0**	**9**
Introduction – Architecture of one DSP processor for motor control – Features – Addressing Formats – Functional modes - Introduction to Commercial Processors.					
					Total (45L+0T)= 45 Periods

Text Books:

1.	J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 2006.
2.	Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab", Cengage Learning, 2014.
3.	B. Venkataramani, M. Bhaskar, "Digital Signal Processor, Architecture, Programming and Application", Tata McGram Hill, New Delhi, 2003.

Reference Books:

1.	Emmanuel C Ifeachor and Barrie W Jervis, "Digital Signal Processing Principles – A Practical approach" Pearson Education, Second edition
2.	Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, " Discrete – Time Signal Processing", Pearson Education, New Delhi , 2003.
3.	Sen M.kuo, woonseng.S.gan, "Digital Signal Processors, Architecture, Implementations & Applications, Pearson,2013.
4.	S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', McGraw Hill Edu, 2013.

E-Reference

1.	https://nptel.ac.in/courses/108105055/34
2.	https://books.google.co.in/books?isbn=8131710009

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the types of systems and signals.	L2: Understanding
CO2	:	Solve problems in digital system using Z transform.	L5: Evaluating
CO3	:	Apply Fourier transforms for processing of digital signals.	L3: Applying
CO4	:	Analyze digital systems using Fast Fourier transform.	L3: Applying
CO5	:	Design digital filters algorithms in digital signal processor platforms	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	1	1	1	1	1								1	1	
CO2	3	3	2	1	2								1	1	
CO3	3	3	3	3	2								1	1	
CO4	3	3	3	3	3							1	2	2	1
CO5	2	3	3	3	3							1	2	2	1
Avg	**2.4**	**2.6**	**2.4**	**2.2**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1.4**	**1.4**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE32	EMBEDDED SYSTEM DESIGN			SEMESTER			VI
PREREQUISITES			**CATEGORY**	**PE**	**Credit**		**3**
Microprocessor and Microcontroller, C programming			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To acquaint the students the building blocks of embedded system, selection of various components for building an embedded system.
2.	To understand different communication protocols used in embedded system
3.	To study the different programming techniques used in embedded system software engineering
4.	To understand the concepts of operating systems that are exclusively used in embedded systems.

UNIT I	**INTRODUCTION TO EMBEDDED SYSTEM**	**9**	**0**	**0**	**9**
Introduction to functional building blocks of embedded systems – Embedded Hardware Core - Bus Structure - Block Diagram of Embedded System - a Microprocessor-Based System – a Microcontroller-Based System – DSP - Register, memory devices, ports, timer, interrupt controllers.					
UNIT II	**PROCESSOR AND MEMORY ORGANIZATION**	**9**	**0**	**0**	**9**
Structural units in a processor; selection of processor and memory devices; shared memory; DMA; interfacing processor, memory and I/O units; memory management – Cache mapping techniques, dynamic allocation - Fragmentation.					
UNIT III	**DEVICES AND BUSES**	**9**	**0**	**0**	**9**
Timers, Counters, serial communication using I2C, CAN, USB buses- parallel communication using ISA, PCI, PCI/X buses; interfacing with devices/ports, device drivers in a system – Serial port & parallel port.					
UNIT IV	**EMBEDDED PROGRAMMING**	**9**	**0**	**0**	**9**
Structure of Embedded C Program, C Program build process, Type, Storage Class and Scope of Variables, Building a C Program, Bitwise operations, Pointer variables and memory addresses, Functions and structures, Pointers to functions and structures, Interrupt functions in C program					
UNIT V	**REAL TIME OPERATING SYSTEM RTOS**	**9**	**0**	**0**	**9**
Introduction to basic concepts of RTOS, Context switching, pre-emptive & non-pre-emptive multitasking, semaphores - Scheduling – Thread states, pending threads, context switching, round robin scheduling, priority based scheduling, assigning priorities, deadlock, watch dog timers. –Interrupt handling, task scheduling; embedded system design issues in system development process – Action plan, use of target system, emulator, use of software tools					
					Total (45L+0T) = 45 Periods

Text Books:

1.	Daniel W. Lewis “Fundamentals of Embedded Software”, Prentice Hall of India, 2004.
2.	James K. Peckol – “Embedded System - A Contemporary Design Tool”, John Wiley, 2nd Edition, 2019
3.	Steve Heath, “Embedded System Design”, II edition, Elsevier, 2003.
4.	David E. Simon, “An Embedded Software Primer”, Pearson Education, 2004.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the basic concepts of Embedded Systems.	L2: Understanding
CO2	:	Appreciate the general organization of Embedded Systems	L1: Remembering
CO3	:	Understand various devices required for an Embedded System Design	L2: Understanding
CO4	:	Understand the implementation of Programming techniques for Embedded System	L3: Applying
CO5	:	Know the various blocks of RTOS and its implementation in Design	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	2	2	2						1	2	1	2	1
CO2	1	2	2	2	2						1	2	1	2	1
CO3	1	2	2	2	3						1	2	2	3	1
CO4	1	2	1	2	3						1	2	2	3	2
CO5	1	2	1	2	3						1	2	2	3	2
Avg	**1**	**1.8**	**1.6**	**2**	**2.6**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1.6**	**2.6**	**1.4**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE33	**ARTIFICIAL INTELLIGENCE AND COMPUTER VISION**	**SEMESTER**			**VI**
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Soft computing	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1	To understand the various characteristics of Intelligent agents
2	To learn the different search strategies in AI
3	To learn to represent knowledge in solving AI problems
4	To understand the different ways of designing software agents
5	To know about the various applications of AI
6	To provide introduction to computer vision

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 – Stochastic Games

Unit III	**KNOWLEDGE REPRESENTATION**	**9**	**0**	**0**	**9**

First Order Predicate Logic – Prolog Programming – Unification – 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	**SOFTWARE AGENTS AND AI APPLICATIONS**	**9**	**0**	**0**	**9**

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

AI applications: Language Models – Information Retrieval – Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware –Perception – Planning – Moving.

Unit V	**COMPUTER VISION**	**9**	**0**	**0**	**9**

Digital Image Processing: Image formation –image filtering- Edge detection- principal component analysis-corner detection – SIFT –Large scale image search application

Geometric techniques in computer vision: Image transformations – Camera projections- camera calibration – Depth from stereo – two view structure from motion- object tracking

Machine learning for computer vision: introduction to machine learning-Image classification – object detection – semantic segmentation

Total (45L+0T)=45 Periods

Text Books:

1.	S. Russel 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 Education Publishers Inc., 2011.
3	David A. Forsyth and Jean Ponce, “Computer Vision: A Modern Approach”, Pearson Publications, Second Edition, 2012.
4	Richard Hartley and Andrew Zisserman, ”Multiple View Geometry in Computer Vision”, Cambridge University Press , Second Vision, 2004.

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 ISO standard”, Fifth Edition, Springer , 2003.
4	Gerhard Weiss, “ Multi Agent systems”, Second Edition, MIT Press, 2013.

5	David L. Poole and Alan K.Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press 2010.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Use appropriate search algorithms for any AI problem	L3: Applying
CO2	:	Represent using first order and predicate logic	L2: Understanding
CO3	:	Provide the apt agent strategy to solve a given problem	L4: Analyzing
CO4	:	Use Artificial Intelligence for various application	L3: Applying
CO5	:	Understand to use AI techniques in computer vision	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	2	1	2	3	1	1				1		1	3	1
CO2	2	3	1	2	3	1							3	3	
CO3	2	1	1	2	3	1							2	3	
CO4	2		3	2	3	1	1				1		2	3	1
CO5	2		3	2	3	1	1				1		2	3	1
Avg	**2.2**	**2**	**2**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**2**	**3**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEPE34</td><td colspan="2">SOFT COMPUTING TECHNIQUES</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">Mathematics, ‘C’ Programming</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>
</table>

Course Objectives:

1.	To provide Basics of artificial neural network.
2.	To provide adequate knowledge of genetic algorithms and its application to economic dispatch and unit commitment problems
3.	To expose the students to the features of hybrid control systems

UNIT I	**ARTIFICIAL NEURAL NETWORK**	**9**	**0**	**0**	**9**

Review of fundamentals – Biological neuron, artificial neuron, activation function, and single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART) based network – Radial basis function network – online learning algorithms, BP through time – RTRL algorithms – Reinforcement learning.

UNIT II	**NEURAL NETWORKS FOR MODELLING AND CONTROL**	**9**	**0**	**0**	**9**

Modelling of non-linear systems using ANN – Generation of training data – Optimal architecture– Model validation – Control of non-linear systems using ANN – Direct and indirect neuro control schemes – Adaptive neuro controller – Familiarization with neural network toolbox.

UNIT III	**FUZZY SET THEORY**	**9**	**0**	**0**	**9**

Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions.

UNIT IV	**FUZZY LOGIC FOR MODELLING AND CONTROL**	**9**	**0**	**0**	**9**

Modelling of non-linear systems using fuzzy models – TSK model – Fuzzy logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification – Adaptive fuzzy systems – Familiarization with fuzzy logic toolbox.

UNIT V	**HYBRID CONTROL SCHEMES**	**9**	**0**	**0**	**9**

Fuzzification and rule base using ANN – Neuro fuzzy systems – ANFIS – Fuzzy neuron– GA – Optimization of membership function and rule base using Genetic Algorithm – Introduction to other evolutionary optimization techniques, support vector machine– Case study – Familiarization with ANFIS toolbox.

Total (45L+0T)= 45 Periods

Text Books:

1.	LauranceFausett, Englewood cliffs, N.J., ‘Fundamentals of Neural Networks’,Pearson Education, 1992
2.	S.N.Sivanandam and S.N.Deepa,’ Principles of Soft computing, Wiley India Edition, 2nd Edition, 2013
3.	Timothy J. Ross, ‘Fuzzy Logic with Engineering Applications’, Tata McGraw Hill, 1997.

Reference Books:

1.	Simon Haykin, ‘Neural Networks’, Pearson Education, 2003.
2.	Hagan, Demuth, Beale, “ Neural Network Design”, Cengage Learning, 2012.
3.	N.P.Padhy, “ Artificial Intelligence and Intelligent Systems”, Oxford, 2013.
4.	Millon W.T., Sutton R.S. and Webrose P.J., “Neural Networks for Control”, MIT press, 1992
5.	Goldberg, “Genetic Algorithm in Search, Optimization and Machine learning”, Addison Wesley Publishing Company Inc. 1989

E-Reference

1	www.onlinecourses.nptel.ac.in
2	www.class-central.com

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Ability to understand and apply basic Artificial neural network.	L2: Understanding
CO2	:	To understand and apply modelling and control of neural network.	L3: Applying
CO3	:	To remember modelling and control of fuzzy control systems.	L1: Remembering
CO4	:	Evaluate hybrid control schemes.	L5: Evaluating
CO5	:	Design a fuzzy controller.	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**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	2	2	2						2	2	1	2
CO2	1	2	3	3	3	2						2	1	1	1
CO3	1	2	2	2	2	2						2	2	1	2
CO4	1	2	2	2	2	2						2	1	1	1
CO5	1	2	3	3	3	2						2	2	1	2
Avg	**1.4**	**2**	**2.4**	**2.4**	**2.4**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**1.6**	**1**	**1.6**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE35	**INTERNET OF THINGS FOR ELECTRICAL SYSTEM**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Microprocessors and microcontrollers		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To illustrate the concept of Internet of Things (IoT).
2.	To familiarize with implementations of IoT for electrical engineering applications.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Internet of Things - Definition- IoT conceptual framework-IoT architecture and Features, Major Components of IoT System, IoT software components for device hardware, Development Tools for IoT.					
UNIT II	**IOT DEVICES**	**9**	**0**	**0**	**9**
Sensors: Sensing the Real World, Analog Sensors and Digital Sensors, Sensors for Temperature, Humidity, Distance, Light, Acceleration, Vibrations and Shocks, Orientation and Direction Compass, Magnetic Sensors/Magnetometer, Sound, Sensing the Things: Reading Barcodes, QR Code, Motion Sensors for Moving Objects, Environmental Monitoring Sensor, GPS, Actuator: Piezoelectric vibrators and sounders, Speakers, Solenoids, Servomotor, Relay switch.					
UNIT III	**IOT COMMUNICATION SYSTEM**	**9**	**0**	**0**	**9**
M2M Communication for IoT, M2M Architecture, M2M Software and Development Tools, Modified OSI Model for the IoT/M2M Systems, Near-Field Communication, RFID, Bluetooth BR/EDR and Bluetooth Low Energy, ZigBee, Wi-Fi, GPRS/GSM Cellular Networks-Mobile Internet, Differences between NFC, BT LE, ZigBee and WLAN protocols.					
UNIT IV	**IOT DATA PROCESSING AND ANALYSIS**	**9**	**0**	**0**	**9**
Data Acquiring and Storage: Data Generation, Data Acquisition, Data Validation, Data Categorization, Data Store, Data Centre Management, Server Management, Database Management System, Query Processing, SQL, NOSQL, Online Transactions and Processing, Business Intelligence, Complex Applications Integration, Online analytical processing, Analytics using Big Data in IoT/M2M, Knowledge-Management Reference Architecture.					
UNIT V	**IOT APPLICATIONS**	**9**	**0**	**0**	**9**
Industrial IoT, Automotive IoT: Connected Cars Technology, Vehicle-to-Infrastructure Technology, Predictive and Preventive Maintenances, RFID IoT Systems: RFID IoT Network Architecture and Components of an RFID System, Wireless Sensor Network IoT Applications.					
Total (45L+0T)= 45 Periods					

Text Books:

1.	Pethuru Raj & Anupama C Mohan, The Internet of Things – Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.

Reference Books:

1.	Raj Kamal, Internet of Things Architecture and Design Principles, McGraw Hill Education (India) Private Limited, 2017

E-Reference

1	https://archive.nptel.ac.in/courses/106/105/106105166/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the structure and components of IOT system.	L1: Remembering
CO2	:	Select an appropriate device to interface IOT system with physical world	L4: Analyzing
CO3	:	Apply suitable communication technologies for IOT system	L3: Applying
CO4	:	Classify the data processing schemes for IoT application	L4: Analyzing
CO5	:	Use IOT platform for real time engineering solutions	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					2	1	1	1	2	1
CO2	2	2	3	1							1	2	2	2	1
CO3	1	1	2		2					2	1		1	1	2
CO4	2	1	2	1	3						2	2	1	2	
CO5	1	3		2	1					1		1	1	2	2
Avg	**1.4**	**1.75**	**2**	**1.75**	**1.75**	**-**	**-**	**-**	**-**	**1.67**	**1.25**	**1.5**	**1.2**	**1.80**	**1.5**

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

22EEPE36	**MEMS AND NEMS**		**SEMESTER**			**VI**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To introduce the diverse technological and functional approaches of MEMS / NEMS and applications.
2.	To understand the microstructures and fabrication methods.
3.	To provide an insight of micro and nano sensors, actuators.
4.	To emphasise the need for NEMS technology.
5.	To update the ongoing trends and real time applications of MEMS and NEMS technology.

UNIT I	**INTRODUCTION TO MEMS AND NEMS**	**9**	**0**	**0**	**9**
Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Materials for MEMS and NEMS - Applications of MEMS and NEMS.					
UNIT II	**MICRO-MACHINING AND MICROFABRICATION TECHNIQUES**	**9**	**0**	**0**	**9**
Photolithography- Micro manufacturing, Bulk micro machining, surface micro machining, LIGA.					
UNIT III	**MICRO SENSORS AND MICRO ACTUATORS**	**9**	**0**	**0**	**9**
Micromachining: Capacitive Sensors- Piezoresistive Sensors- Piezoelectric actuators.					
UNIT IV	**NEMS TECHNOLOGY**	**9**	**0**	**0**	**9**
Atomic scale precision engineering- Nano Fabrication techniques – NEMS for sensors and actuators					
UNIT V	**MEMS AND NEMS APPLICATION**	**9**	**0**	**0**	**9**
Bio MEMS- Optical NEMS- Micro motors- Smart Sensors - Recent trends in MEMS and NEMS.					
					Total (45L+0T) = 45 Periods

Text Books:	
1.	Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2011, 2nd Edition.
2.	Tai-.Ran Hsu, “MEMS and Microsystems: design , manufacture, and Nanoscale”- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3.	Lyshevski, S.E. “Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering “2ndEdition, CRC Press, 2005.
4.	Julian W Gardner and Vijay K Varadan, “Microsensors, MEMS and Smart Devices”, John Wiley and Sons Ltd, 2001, 1st Edition.
Reference Books:	
1.	Marc F madou“ Fundamentals of micro fabrication” CRC Press 2002 2nd Edition Marc Madou
2.	M.H.Bao “Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 16 Oct 2000, 1st Edition.
3.	Maluf, Nadim “An introduction to Micro Electro-mechanical Systems Engineering”, AR Tech house, Boston, June 30 2004, 2nd Edition.
4.	Mohamed Gad – el – Hak, “MEMS Handbook” Edited CRC Press 2001, 1st Edition.
E-references:	
1	https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE
2	https://nptel.ac.in/courses
3.	https://www.iitk.ac.in/me/mems-fabrication
4	http://mems.iiti.ac.in/
5	https://onlinecourses.nptel.ac.in/noc22_ee36/preview

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the material properties and the significance of MEMS and NEMS for industrial automation.	L4: Analysing
CO2	:	Demonstrate knowledge delivery on micromachining and micro fabrication.	L2: Understanding
CO3	:	Apply the fabrication mechanism for MEMS sensor and actuators.	L3: Applying
CO4	:	Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.	L3: Applying
CO5	:	Improve employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.	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**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	1	1	1								2	2	
CO2	2	1	2	2	1								2	2	
CO3	2	2	2	1	3								2	2	
CO4	3	2	2	2	3								2	2	
CO5	3	2	3	3	3				1				2	2	
Avg.	**2.4**	**1.8**	**2**	**1.8**	**2.4**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**2**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE41	**POWER SYSTEM TRANSIENTS**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution Systems; Power System Analysis and Stability		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on generation of switching transients and their control.
2.	To familiarise on the mechanism of lighting strokes and the production of lighting surges.
3.	To understand the propagation, reflection and refraction of travelling waves.
4.	To acquire knowledge on voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning.					
UNIT II	**SWITCHING TRANSIENTS**	**9**	**0**	**0**	**9**
Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients - Ferro resonance.					
UNIT III	**LIGHTNING TRANSIENTS**	**9**	**0**	**0**	**9**
Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.					
UNIT IV	**TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS**	**9**	**0**	**0**	**9**
Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely’s lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.					
UNIT V	**TRANSIENTS IN INTEGRATED POWER SYSTEM**	**9**	**0**	**0**	**9**
The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - over voltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.					
	Total (45 L + 0 T) = 45 Periods				

Text Books:

1.	Allan Greenwood, “Electrical Transients in Power Systems”, Wiley Inter Science, New York, 2nd Edition, 1991.
2.	PritindraChowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., Second Edition, 2009.
3.	Indulkar, C.S., Kothari, D.P., and Ramalingam, K., “Power System Transients – A Statistical Approach”, PHI Learning Private Limited, Second Edition, 2010.

Reference Books:

1.	Naidu, M.S., and Kamaraju, V., “High Voltage Engineering”, McGraw Hill, Fifth Edition, 2013.
2.	Begamudre, R.D., “Extra High Voltage AC Transmission Engineering”, Wiley Eastern Limited, 1986.
3.	Hase, Y., “Handbook of Power System Engineering”, Wiley India, 2012.
4.	Kirtley, J.L., “Electric Power Principles, Sources, Conversion, Distribution and Use”, Wiley, 2012.
5.	Akihiro Ametani, “Power System Transient theory and applications”, CRC press, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Interpret the switching and lightning transients.	L4: Analysing
CO2	Examine the generation of switching transients and their control.	L4: Analysing
CO3	Analyse the mechanism of lightning strokes.	L4: Analysing
CO4	Recognize the importance of propagation, reflection, and refraction of travelling waves.	L1: Understanding
CO5	Review the concept of circuit breaker action, line dropping, and load rejection in an integrated power system.	L1: 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	1	3	3	2	2		1					1	3	3	1
CO2	2	2	3	2	2		1					1	2	3	1
CO3	1	2	2	2	3		2					1	2	2	1
CO4	2	3	2	3	3		3					1	3	3	1
CO5	2	3	2	3	3		3					1	3	3	1
Avg	**1.6**	**2.6**	**2.4**	**2.4**	**2.6**	**-**	**2**	**-**	**-**	**-**	**-**	**1**	**2.6**	**2.8**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEPE42</td><td colspan="2">POWER QUALITY</td><td colspan="3">SEMESTER</td><td>VII</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">Power Generation, Transmission and Distribution system, Power System Protection and Switchgear</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 introduce the power quality terms and definitions</td></tr>
<tr><td>2.</td><td colspan="6">To understand the sources and issues of various power quality problems.</td></tr>
<tr><td>3.</td><td colspan="6">To gain in-depth knowledge of the mitigation/ suppression techniques of voltages sags, interruptions and harmonics.</td></tr>
<tr><td>4.</td><td colspan="6">To introduce the computer tools for transient's analysis.</td></tr>
<tr><td>5.</td><td colspan="6">To expose the various methods of power quality monitoring.</td></tr>
<tr><td>UNIT I</td><td colspan="2">INTRODUCTION TO POWER QUALITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Terms and definitions of Power quality, General classes of power quality problems: transients- long duration voltage variations- short duration voltage variations, voltage Imbalance, waveform distortion, voltage fluctuation, Power frequency variations-International standard of power quality- Power Acceptability curves : CBEMA and ITI curves.</td></tr>
<tr><td>UNIT II</td><td colspan="2">VOLTAGE SAGS AND LONG DURATION VOLTAGE VARIATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of voltage sag Protection – voltage sag mitigation solution at the End-User level- Evaluating the economics of different ride-through alternatives – Motor Starting sags.
Long Duration voltage variations: Principles of regulating the voltage – devices for voltage regulation-utility voltage regulator application- capacitor for voltage regulation- End user capacitor application - Flicker: sources and mitigation techniques.</td></tr>
<tr><td>UNIT III</td><td colspan="2">TRANSIENT OVERVOLTAGE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Sources of transient over voltage- Principles of overvoltage Protection- Devices for mitigation of over voltages – Utility capacitor-switching transients – Utility system lightning protection - Managing Ferro resonance- switching transients problems with loads - computer tools for transients analysis: PSCAD and EMTP.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">HARMONICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Fundamentals of Harmonics: Harmonic Distortion, voltage versus current distortion, Harmonics versus transients- harmonics phase sequences- triplen harmonics -harmonic indices, harmonic sources from commercial and industrial loads. Locating harmonic sources - power system response characteristics – Effects of Harmonics Distortion –Interharmonics - harmonic distortion evaluations, Principles and devices for controlling harmonic distortion, IEEE and IEC standards on harmonics.</td></tr>
<tr><td>UNIT V</td><td colspan="2">POWER QUALITY MONITORING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Monitoring considerations - power quality measurement equipment: disturbance analyser, spectrum and harmonics analysers, flicker meters, applications of Intelligent system for power quality monitoring</td></tr>
<tr><td colspan="7">Total (45L+0T) = 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Roger. C. Dugan, Mark. F. McGranaghan, Surya Santoso, H.WayneBeaty, "Electrical Power Systems Quality", Tata McGraw Hill Publishing Company Ltd, New Delhi, Third Edition, 2012.</td></tr>
<tr><td colspan="2">Reference Books</td></tr>
<tr><td>1.</td><td>C. Sankaran ,"Power quality", CRC Press, First Indian Edition, 2009.</td></tr>
<tr><td>2.</td><td>G.T.Heydt, "Electric power quality", Stars in a Circle publishers, Second Edition, 2011.</td></tr>
<tr><td>3.</td><td>Arindam GhoshandGerald Ledwich, "Power Quality Enhancement Using Custom Power Devices", Springer-Verlag Publishers, New York Inc., Second Edition.2002.</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.class-central.com</td></tr>
<tr><td>3</td><td>www.mooc-list.com</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:	**Bloom's Taxonomy Mapped**

CO1	:	Recite the definitions and characterization of various power quality issues.	L1: Remembering
CO2	:	Discuss the sources of sag & long duration voltage variations and its control methods	L2: Understanding
CO3	:	Summarize the sources of transient overvoltage and principle of control methods	L2: Understanding
CO4	:	Understand about harmonics problem and apply filters to suppress harmonics in distribution system	L3: Applying
CO5	:	Demonstrate the operation and application of power quality measuring equipment.	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	1	1	1			1					1	2	1	1
CO2	3	2	1	1			1					1	3	2	1
CO3	3	1	1	1			1					1	3	2	1
CO4	3	1	2	1		2	2					1	3	2	1
CO5	3	1	2	1		2	2					1	3	2	1
Avg	**3**	**1.2**	**1.4**	**1**	**-**	**2**	**1.4**	**-**	**-**	**-**	**-**	**1**	**2.8**	**1.8**	**1**

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

22EEPE43	DISTRIBUTED GENERATION AND MICRO GRID		SEMESTER			VII
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution Systems,		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on distributed generation technologies.
2.	To familiarise on impact on grid integration.
3.	To understand the microgrid operation and control.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Conventional power generation: advantages and disadvantages, Energy crises, Non- conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.					
UNIT II	**DISTRIBUTED GENERATIONS**	**9**	**0**	**0**	**9**
Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.					
UNIT III	**IMPACT OF GRID INTEGRATION**	**9**	**0**	**0**	**9**
Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.					
UNIT IV	**BASICS OF A MICROGRID**	**9**	**0**	**0**	**9**
Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.					
UNIT V	**CONTROL AND OPERATION OF MICROGRID**	**9**	**0**	**0**	**9**
Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.					
Total (45 L + 0 T) = 45 Periods					

Text Books:

1.	Lee Willis, H., Walter G. Scott , “Distributed Power Generation – Planning and Evaluation”, Marcel Decker Press, 2000.
2.	Godoy Simoes, M., Felix A. Farret, “Renewable Energy Systems – Design and Analysis with Induction Generators”, CRC Press, 2004.
3.	Robert Lasseter, and Paolo Piagi, “Micro-grid: A Conceptual Solution”, PESC, June 2004.

Reference Books:

1.	John Twidell and Tony Weir, “Renewable Energy Resources” Tyalor and Francis Publications, 2005.
2.	DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
3.	AmirnaserYezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
4.	Katiraei, F., and Iravani, M.R., “Transients of a Micro-Grid System with Multiple Distributed Energy Resources”, International Conference on Power Systems Transients (IPST’05) in Montreal, Canada on June 19-23, 2005.
5.	Ye, Z., Walling, R., Miller, N., Du, P., and Nelson, K., “Facility Microgrids”, General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Identify various forms of energy sources.	L2: Understanding
CO2	Recognize various DG technologies.	L2: Understanding
CO3	Analyse the impact on grid while integrating DGs.	L4: Analysing
CO4	Demonstrate the concepts of microgrids.	L3: Applying
CO5	Categorize various microgrid control schemes.	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	3	3	3	2		3					1	2	3	1
CO2	1	3	3	3	2		3					1	2	2	1
CO3	1	2	2	2	2		3					1	1	3	1
CO4	1	2	3	2	2		3					1	2	2	1
CO5	1	2	2	2	2		2					1	2	2	1
Avg	**1**	**2.4**	**2.6**	**2.4**	**2**	**-**	**2.8**	**-**	**-**	**-**	**-**	**1**	**1.8**	**2.4**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE44	**RESTRUCTURED POWER SYSTEM**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution System; Power System Analysis and Stability		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on power system restructuring.
2.	To familiarise on electricity market models.
3.	To understand various network operations / analyses including transmission system operations, optimal power flow, and automatic generation control.

UNIT I	**POWER SYSTEM RESTRUCTURING**	**9**	**0**	**0**	**9**

Introduction –Deregulation - Need for deregulation – Power system restructure models - Electricity Market Participants – GENCOS- DISCOS- TO- ISO- PX- SC - trading arrangements - Operational Planning Activities (OPA) of Electricity Market Participants - Causes of restructuring- types and effects of restructuring – restructure models

UNIT II	**ELECTRICAL UTILITY**	**9**	**0**	**0**	**9**

Electrical utility restructuring Power System Operation in competitive environment –Electricity Market Models (PoolCo- bilateral- hybrid)- Components of restructured system - Power Sector restructuring and influence on environment - Functions and responsibilities of PX- ISO- RTO and ITP - Electric Utility Market – Market Models - wholesale electricity market characteristic – Electricity Market types (energy- ancillary services- transmission- forward- real time) – Market power evaluation and mitigation

UNIT III	**EVALUATION OF TRANSMISSION SYSTEM**	**9**	**0**	**0**	**9**

Electricity pricing and Transmission pricing in a restructured market - Congestion management in a deregulated market – Available Transfer Capabilities (ATC) of transmission system – Application of Monte Carlo Simulation in ATC calculation – ATC calculation with sensitivity analysis method - Tagging Electricity Transaction – Tagging process – Implementation- Curtailment and cancellation of transaction - Availability Based Tariff

UNIT IV	**OPTIMUM POWER FLOW (OPF) ANALYSIS IN MARKET ENVIRONMENT**	**9**	**0**	**0**	**9**

Introduction – Approaches to OPF – Application of OPF analysis in Electricity and Power Markets with Electricity Market Participants – Power Flow Tracing – current decomposition axioms- Mathematical model of loss allocation- usage sharing problem on transmission facilities - Methodology of graph theory - Economic issues- Mechanism and transmission issues in the new market environment.

UNIT V	**AGC IN RESTRUCTURED POWER SYSTEM**	**9**	**0**	**0**	**9**

Introduction – Traditional Vs Restructured Scenario –AGC in New market environment - Block diagram and State Space representation of a two-area interconnected power system in deregulated environment – Load-Frequency Control (LFC) dynamics and Bilateral Contacts – Modelling- DISCO Participation Matrix (DPM)- Generation Participation Matrix (GPM).

Total (45 L + 0 T) = 45 Periods

Text Books:

1.	Loi Lei Lai, "Power System Restructuring and deregulation"- John Wiley & Sons,2001.
2.	Md. Shahidehpour, and MuwaffagAlmoush, "Restructured Electric Power System – Operation- Trading and Volatility", Marcel Dekker Inc, New York, 2001.
3.	Arthur. R. Bergen, and Vijay Vittal, "Power System Analysis," Prentice Hall, New Jersey, 2000.

Reference Books:

1.	Xi Fan, Wang, Yonghua Song, and Malcolm Irving, "Modern Power System Analysis", Springer, 2008.
2.	Das, D., "Electrical Power Systems", New Age International (P) Ltd, New Delhi, 2008.
3.	Iiic, M., Galiana, F., and Fink, L., "Power Systems Restructuring" Norwell M A Kluwer, 1998.
4.	Philipson. L., and Willis H. Le, "Understanding Electric Utilities and de-regulation", Marcel Dekker Inc Publishers, New York, 2006.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recognize components in restructured power system.	L2: Understanding
CO2	:	Interpret various models in electricity market.	L3: Applying
CO3	:	Examine the congestion management and ATC in transmission system.	L4: Analysing
CO4	:	Formulate the power flow problem in restructured power system.	L4: Analysing
CO5	:	Develop automatic generation control in restructured power system.	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	3	3	1	1		1					1	1	3	1
CO2	1	2	3	2	2		2					1	1	3	1
CO3	1	2	3	2	2		2					1	1	2	1
CO4	1	2	2	1	1		1					1	1	2	1
CO5	1	2	3	2	2		2					1	1	1	1
Avg	**1**	**2.2**	**2.8**	**1.6**	**1.6**	**-**	**1.6**	**-**	**-**	**-**	**-**	**1**	**1**	**2.2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE45	**CONTROL AND INTEGRATION OF RENEWABLE ENERGY SOURCES**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand electric power Generation, Transmission and Distribution
2.	To study Power System Operation and Control

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Electric grid, Utility ideal features, Supply guarantee, power quality, Stability and cost; Importance & Effects of Renewable Energy penetration into the grid, Boundaries of the actual grid configuration, Consumption models and patterns.					
UNIT II	**CONVENTIONAL ENERGY CONVERSION TECHNOLOGIES**	**9**	**0**	**0**	**9**
Introduction, types of conventional and nonconventional dynamic generation technologies, principle of operation and analysis of reciprocating engines, gas and micro turbines, hydro and wind based generation technologies					
UNIT III	**NON CONVENTIONAL ENERGY CONVERSION TECHNOLOGIES**	**9**	**0**	**0**	**9**
Introduction, types of conventional and nonconventional static generation technologies; Principle of operation and analysis of fuel cell, photovoltaic systems and wind generation technologies; MPPT techniques and its classifications, principle of operation and partial shading effects; Storage Technologies - batteries, fly wheels, super capacitors and ultra-capacitors.					
UNIT IV	**CONTROL ISSUES AND CHALLENGES**	**9**	**0**	**0**	**9**
Linear and nonlinear controllers, predictive controllers and adaptive controllers, Load frequency and Voltage Control, PLL, Modulation Techniques, Control of Diesel, PV, wind and fuel cell based generators, Dimensioning of filters, Fault-ride through Capabilities.					
UNIT V	**INTEGRATION OF ENERGY CONVERSION TECHNOLOGIES**	**9**	**0**	**0**	**9**
Introduction & importance, sizing, Optimized integrated systems, Interfacing requirements, Distributed versus Centralized Control, Grid connected Photovoltaic systems –classifications, operation, merits & demerits; Islanding Operations, stability and protection issues, load sharing, operation & control of hybrid energy systems, Solar Photovoltaic applications. IEEE & IEC Codes and standards for renewable energy grid integrations					
Total (45L+0T) = 45 Periods					

Text Books:

1.	Renewable and Efficient Electric Power Systems, G. Masters, IEEE-John Wiley and Sons Ltd. Publishers, 2013,2nd Edition
2.	Microgrids and Active Distribution Networks, S.Chowdhury, S. P. Chowdhury, P.Crossley, IET Power Electronics Series, 2012.
3.	Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali, Min Dai, John Wiley publishing company, 2010, 2nd Edition.

Reference Books:

1.	Solar Photovoltaic: Fundamentals, technologies & Applications, Chetan Singh Solanki, PHI Publishers, 2019, 3rd Edition.
2.	Solar PV Power: Design, Manufacturing and Applications from Sand to Systems, Rabindra Kumar Satpathy, Venkateswarlu Parmuru, Academic Press, 2020.
3.	Control of Power Inverters in Renewable Energy and Smart Grid Integration, Quing-Chang Zhong, IEEE-John Wiley and Sons Ltd. Publishers, 2013,1st Edition.
4.	Power Conversion and Control of Wind Energy Systems, Bin Wu, Yongqiang Lang, NavidZargari, IEEE- John Wiley and Sons Ltd. Publishers,2011,1st Edition.
5.	Report on "Large Scale Grid Integration of Renewable Energy Sources - Way Forward" Central Electricity Authority, GoI, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the importance of renewable energy sources.	L2: Understanding
CO2	:	Familiarize the conventional energy system.	L5: Evaluating
CO3	:	Familiarize the nonconventional energy system.	L3: Applying
CO4	:	Analyze and simulate control strategies for grid connected and off-grid systems.	L4: Analyzing
CO5	:	Develop converters to comply with grid standards to obtain grid integration.	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**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	2	2	1	1	2					1	3	3	
CO2	3	2	3	3	1	1	2					1	3	3	
CO3	3	2	3	3	1	1	2					1	3	3	
CO4	3	2	3	3	1	1	2					1	3	3	
CO5	3	2	3	3	1	1	2					1	3	3	
Avg	**2.8**	**2**	**2.8**	**2.8**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE46	**DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS**		**SEMESTER**			**VII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To review the renewable energy systems and technology
2.	To learn the Single-phase grid-connected photovoltaic systems and three phase photovoltaic systems
3.	To illustrate the small wind energy systems
4.	To simulate the Doubly-fed induction generator based WECS

UNIT I	**RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES**	**9**	**0**	**0**	**9**
Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends					
UNIT II	**SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS**	**9**	**0**	**0**	**9**
Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single- Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters, Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems					
UNIT III	**THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES**	**9**	**0**	**0**	**9**
Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization, Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.					
UNIT IV	**SMALL WIND ENERGY SYSTEMS**	**9**	**0**	**0**	**9**
Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications- Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems-Magnus Turbine–Based Wind Energy System					
UNIT V	**DOUBLY-FED INDUCTION GENERATOR-BASED WECS**	**9**	**0**	**0**	**9**
Introduction – modelling of induction machine in machine variable form and arbitrary reference frame, modelling of Doubly-fed Induction Generator.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021
2.	Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021
3.	Nabil Derbel, Quanmin Zhu, “Modeling, Identification and Control Methods in Renewable Energy Systems" , Springer, First Edition, 2019
Reference Books:	
1.	Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
2.	Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.
3.	Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
4.	Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, FredeBlaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.
E-references	
1	https://www.mdpi.com/journal/applsci/topical_collections/Susta_Energy
2	https://www.mathworks.com/help/sps/ug/single-phase-grid-connected-in-pv-system.html
3.	https://www.sciencedirect.com/topics/engineering/three-phase-inverter
4	academia.edu/32704493/Wind_Power_Lecture_Notes

5	https://www.syscop.de/files/2018ss/WES/handouts/script.pdf
6	https://www.sciencedirect.com/topics/engineering/wound-rotor-induction-generator

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Overview of current trend in renewable energy systems.	L1: Remembering
CO2	:	Familiarize the integration of PV system with grid.	L3: Applying
CO3	:	Understand the different topologies of grid PV inverters.	L2: Understanding
CO4	:	Acquire knowledge on small wind energy system.	L2: Understanding
CO5	:	Understand the modelling of Doubly fed induction machine for RES.	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									3	2	1
CO2	3	2	3	3									3	2	1
CO3	3	2	3	3	2								3	2	1
CO4	3	2	3	3									3	2	1
CO5	3	2	3	3	2								3	2	1
Avg.	**3**	**2**	**3**	**2.8**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE51	**UTILIZATION OF ELECTRICAL ENERGY**		**SEMESTER**			**VIII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Electrical Machines, Power System, Power Electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the economics of 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 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)															

22EEPE52	**ELECTRICAL ENERGY CONSERVATION AND AUDITING**		**SEMESTER**			**VIII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution System		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To get knowledge about basics of energy and energy scenario of India.
2.	To familiarise the energy conservation methods.
3.	To acquire knowledge on energy auditing, energy efficiency and modern energy efficient devices.

UNIT I	**ENERGY SCENARIO**	**9**	**0**	**0**	**9**

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.

UNIT II	**BASICS OF ENERGY**	**9**	**0**	**0**	**9**

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.

UNIT III	**ENERGY MANAGEMENT AND AUDIT**	**9**	**0**	**0**	**9**

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.

UNIT IV	**ENERGY EFFICIENCY**	**9**	**0**	**0**	**9**

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.

UNIT V	**ENERGY EFFICIENT TECHNOLOGIES**	**9**	**0**	**0**	**9**

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.

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.
3.	Hossam A Gabbar, “Energy Conservation in Infrastructure Systems”, Wiley-IEEE Press, New Jersey, 2018

Reference Books:

1.	General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency, New Delhi, 2015.
2,	Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency, New Delhi, 2015.

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)

22EEPE53	**ELECTRICAL WIRING, ESTIMATION AND COSTING**		**SEMESTER**			**VIII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Basic Electrical Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
1.	To describe the fundamental electrical tools required for electrical wiring and estimate the costing of electrical wiring for residential, industrial, overhead, underground and substations.					
UNIT I	**ELECTRICAL WIRING & GENERAL PRINCIPLES OF ESTIMATION**		**9**	**0**	**0**	**9**
Guidelines for electrical wiring – Schematic diagram of electrical wiring system, sizes of wires, stranded wires, types of wires, wire splicing and termination, difference between neutral and earth wire, General idea about I.E rule - Indian Electricity Act. General principles of estimation - Electrical Schedule of rates, catalogues, Survey and source selection, Recording of estimates Quantity and cost of material required. Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills						
UNIT II	**RESIDENTIAL INSTALLATION**		**9**	**0**	**0**	**9**
Guidelines for electrical wiring installations of residential and positioning of equipment, Circuit design in lightning and power circuits , Method of drawing single line diagram, Selection of type of wiring and rating , Load calculations, Selection of rating of main switch, distribution board, cable selection, earthing, selection of switchgear, Sequence to be followed for preparing estimate, Preparation of detailed estimates and costing for residential installations.						
UNIT III	**COMMERCIAL INSTALLATION**		**9**	**0**	**0**	**9**
Fundamental considerations for planning of electrical wiring installation for commercial buildings, Design considerations , Load calculations and selection of size of service connection, Deciding the size of cables, busbar and busbar chambers, Selection of rating of main switch, distribution board, Earthing, cable selection, ,Selection of rating of main switch, distribution board, cable selection, earthing, selection of switchgear, Sequence to be followed for preparing estimate, Preparation of detailed estimates and costing for commercial installations.						
UNIT IV	**OVERHEAD AND UNDERGROUND DISTRIBUTIONSYSTEM**		**9**	**0**	**0**	**9**
Overhead distribution system and underground distribution system : materials and accessories required for the overhead distribution system, estimate for 440V/3-phase/ 4 wires or 3 wires overhead distribution system, types of service connections, method of installation of service connection(1-phase and 3-phase), I.E. rules pertaining to overhead lines and service connection.						
UNIT V	**SUBSTATION**		**9**	**0**	**0**	**9**
Classification of substation, selection and location of site for substation, main electrical connections, graphical symbols for various types of apparatus and circuit elements on substation, main connection diagram, key diagram of typical sub stations, equipment for substation and switchgear installations, substation auxiliaries supply, substation earthing.						
						Total (45L+0T) = 45 Periods

Text Books:	
1.	Raina K. B. and Bhattacharya S.K. “ Electrical Design, estimating & Costing”, New Age International (p) Limited, New Delhi,2007.
2.	Gupta J.B. , “Electrical Installation Estimating & Costing”, S. K. Kataria& Sons, New Delhi,2015.
3.	Uppal S.L. “Electrical Estimating & Costing”, New Age International (p) Limited, New Delhi ,2008
Reference Books:	
1.	SurjithSingh,“Electrical Estimating and Costing”, Danpat Rai &Co.
2.	CEA Regulations 2010
3.	I.E rules for wiring and supply act manuals.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the guidelines for electrical wiring installations.	L1: Remembering
CO2	:	Apply appropriate select criteria and sizing of the electrical wiring for different systems.	L3: Applying
CO3	:	Analyse the load calculations and provide appropriate earthing provision..	L4: Analysing
CO4	:	Prepare a detailed estimate and costing.	L5: Evaluating
CO5	:	Differentiate the various electrical installation.	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	3	1	1	1					1	2	1	1
CO2	3	2	2	2	1	1	1			1			2	1	1
CO3	3	1	1	1	2	2	1	1				1	2	2	1
CO4	3	3	2	2	2	3	1	1	1	1	1		3	2	1
CO5	3	3	2	2	2	1	1						3	1	
Avg	**2.8**	**2**	**1.6**	**2**	**1.6**	**1.6**	**1**	**1**	**1**	**1**	**1**	**1**	**2.4**	**1.4**	**1**

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

22EEPE54	**TRACTION ENGINEERING**		**SEMESTER**			**VIII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Electronics, Electrical Machines		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To learn the fundamentals of electric traction, power substation, distribution system and overhead contact system design, construction and operation
2.	To learn the traction mechanics, power supply systems and role of battery banks and maintenance
3.	To learn the traction motor drives and control
4.	To learn about traction power supply and protection
5.	To learn about railway signalling

UNIT I	**INTRODUCTION TO ELECTRIC TRACTION**	**9**	**0**	**0**	**9**

Requirements of Ideal Traction Systems, the Indian Scenario of Electric traction, Present day State of art Electric traction as a Viable Transport Strategy, Advantages of Electric Traction over other systems of traction, Ideal choice of traction system, Power supply systems for Electric Traction, DC systems, Single phase ac system and three phase ac systems, Kando systems, Latest Developments in 3phase with special reference to locomotives, EMUs and Metro stock, Role of Battery banks in Traction, types and maintenance.

UNIT II	**TRACTION MECHANICS**	**9**	**0**	**0**	**9**

Requirements of Ideal Traction Systems, the Indian Scenario of Electric traction, Present day State of art Electric traction as a Viable Transport Strategy, Advantages of Electric Traction over other systems of traction, Ideal choice of traction system, Power supply systems for Electric Traction, DC systems, Single phase ac system and three phase ac systems, Kando systems, Latest Developments in 3phase with special reference to locomotives, EMUs and Metro stock, Role of Battery banks in Traction, types and maintenance.

UNIT III	**TRACTION MOTOR AND DRIVES**	**9**	**0**	**0**	**9**

Type of traction motor best suited for traction duties, Available motor characteristics and their suitability for traction duties, speed control methods, Braking methods, special Emphasis and techniques of regenerative braking, Optimization of design and construction features for improved power to weight ratio, Power Factor and Harmonics, Tractive Effort and Drive Ratings, Important Features of Traction Drives, conventional DC and AC Traction drives, Semiconductor/IGBT based Converter Controlled Drives, DC Traction using Chopper Controlled Drives, AC Traction employing Poly-phase motors, Traction control of DC locomotives and EMU's, Traction control system of AC locomotives, Control gear, PWM control of induction motors, Power & amp; Auxiliary circuit equipment (Other than traction motors), Linear Induction motors, introduction to Maglev Technology.

UNIT IV	**POWER SUPPLY AND PROTECTION**	**9**	**0**	**0**	**9**

Traction substation, spacing and location of Traction substations, Major equipment at traction substation, selection and sizing of major equipment like transformer and Switchgear, Types of protection provided for Transformer and overhead lines, surge protection, maximum demand and load sharing between substations, sectionalizing paralleling post and feeder posts, Booster transformers, Return Conductor, 2X25KV AC system, controlling/monitoring, Railway SCADA systems, Train lighting and Air-conditioning.

Design requirement of catenary wire, contact wire, Dropper, Height, span length, Automatic weight tensioning, section insulator, overlap, Different techniques of current collection (overhead and underground systems), neutral section, overhead crossing of power lines, Protection

UNIT V	**RAILWAY SIGNALING**	**9**	**0**	**0**	**9**

Block Section Concept, AC/DC Track Circuits, Interlocking Principle, Train speed and signaling, Solid state Interlocking, Automatic Warning Systems, CAB signaling, Signaling level crossing. Permissible limit of EMI and EMC, Permissible capacitively-coupled current, Coupling between circuits, conductive coupling, Electrostatic induction.

Total (45L+0T) = 45 Periods

Reference Books:

1.	E. A. Binney, "Electric Traction Engineering: An Introduction", Cleaver-Hume Press, 1955, 1 Oct 2007
2.	Douglas W. Hinde, M. Hinde, "Electric Traction Systems and Equipment", Elsevier Science & Technology, 1968
3.	Samuel Sheldon, Erich Hausmann, "Electric Traction and Transmission Engineering", Van Nostrand, 1911
4.	Frederick William Carter, "Railway Electric Traction", E. Arnold & Company, 1922
5.	Edward Parris Burch, "Electric traction for railway trains; a book for students, electrical and mechanical engineers,

	superintendents of motive power and others", New York, McGraw-Hill Book Company
6.	Edward Trevert, "Electric Railway Engineering", Lynn, Mass. :Bubier Pub. Co.
7.	Burch Edward Parris, "Electric Traction for Railway Trains; a Book for Students, Electrical and Mechanical Engineers, Superintendents of Motive Power and Others", Arkose Press, ISBN: 9781345582376, 9781345582376

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the basics of traction and supply systems.	L2: Understanding
CO2	:	Understand the traction mechanics and ideal choice of supply systems.	L4: Analyzing
CO3	:	Describe the concepts of traction motors and applying the solid state drive control.	L3: Applying
CO4	:	Design the protection system for the traction power supply system	L5: Evaluating
CO5	:	Understand the concepts of railway signaling	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	2	3	2		1	1	1				1	3	2	1
CO2	3	2	3	2		1	1	1				1	3	2	1
CO3	3	2	3	2		1	1	1				1	3	2	1
CO4	3	2	3	2		1	1	1				1	3	2	1
CO5	3	2	3	2		1	1	1				1	3	3	1
Avg	**3**	**2**	**3**	**2**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**3**	**2.2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE55	**ENERGY STORAGE SYSTEMS AND APPLICATIONS**		**SEMESTER**			**VIII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Electrical Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand the various types of energy storage technologies.
2.	To analyze thermal storage system.
3.	To analyze different battery storage technologies.
4.	To model the Lithium-ion batteries.
5.	To study the various applications of energy storage systems.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Necessity of energy storage – Types of energy storage – Comparison of energy storage technologies – Demand functions of energy storage technology in power system, application outlook and challenges of energy storage technology in power system.					
UNIT II	**THERMAL STORAGE SYSTEM**	**9**	**0**	**0**	**9**
Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – Pressurized water storage system – Modeling of phase change storage system – Simple units, packed bed storage units – Modeling using porous medium approach – Use of TRNSYS.					
UNIT III	**ELECTRICAL ENERGY STORAGE**	**9**	**0**	**0**	**9**
Fundamental concept of batteries – Measuring battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries – Mathematical modeling of Lead Acid batteries – Flow batteries.					
UNIT IV	**LITHIUM-ION BATTERY MODELING**	**9**	**0**	**0**	**9**
Analysis on charge and discharge temperature characteristics of Lithium-ion batteries – Electrothermal coupling Modeling - Modeling and Optimization of Air Cooling Heat Dissipation of Lithium-ion Battery Packs.					
UNIT V	**ALTERNATE ENERGY STORAGE TECHNOLOGIES**	**9**	**0**	**0**	**9**
Flywheel, Supercapacitors, Principles and methods – Applications, Compressed air energy storage, Concept of Hybrid storage – Applications, Pumped hydro storage – Applications.					
					Total (45L+0T)= 45 Periods

Text Books:

1.	Ibrahim Dincer and Mark A. Rosen, ‘Thermal Energy Storage Systems and Applications’, John Wiley & Sons, 3rd Edition, 2021.
2.	Ru-shi Liu, Lei Zhang and Xueliang sun, ‘Electrochemical technologies for energy storage and conversion’, Wiley publications, 2nd Volume set, 2012.
3.	Junqiu Li, “Modeling and simulation of Lithium-ion power battery thermal management”, Springer, 2020.

Reference Books:

1.	Lunardini.V.J, ‘Heat Transfer in Cold Climates’, John Wiley and Sons 1981, 1st Edition
2.	Schmidt. F.W. and Willmott. A.J., ‘Thermal Energy Storage and Regeneration’, Hemisphere Publishing Corporation, 1981, 1st Edition

E-References:

1.	Prof. SubhasishBasu Majumder, “Electrochemical Energy Storage”, NPTEL Course, https://nptel.ac.in/courses/113105102
2.	Prof. PK Das, “Energy conservation and waste heat recovery”, NPTEL Course, https://nptel.ac.in/courses/112105221.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand different types of storage technologies.	L2: Understanding
CO2	:	Model a thermal battery energy storage system	L1: Remembering
CO3	:	Analyze the modeling of Lithium-ion batteries.	L4: Analyzing
CO4	:	Analyze the appropriate storage technologies for different applications.	L3: Applying
CO5	:	Explore the alternate energy storage technologies.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1					1						2	2	
CO2	3		2				1						2	2	
CO3	3		2				1						2	2	
CO4	3		2				1						2	2	
CO5		3				2	1	1					2	2	
Avg	**3**	**2**	**2**	**-**	**-**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE56	SMPS AND UPS		SEMESTER			VIII
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)															

22EEPE61	SPECIAL ELECTRICAL MACHINES			SEMESTER			VIII
PREREQUISITES			**CATEGORY**	**PE**	**Credit**		**3**
Electrical Machines, Power Electronics.			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To learn the fundamental concepts of special electrical machines.
2.	To select proper special machines based on applications.

UNIT I	**SYNCHRONOUS RELUCTANCE MOTORS**	**9**	**0**	**0**	**9**
Constructional features – Types – Axial and radial air gap motors – Operating principle – Reluctance – Phasor diagram - Characteristics – Vernier motor.					
UNIT II	**PERMANENT MAGNET BRUSHLESS D.C. MOTORS**	**9**	**0**	**0**	**9**
Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control.					
UNIT III	**PERMANENT MAGNET SYNCHRONOUS MOTORS**	**9**	**0**	**0**	**9**
Principle of operation – EMF and torque equations – Reactance – Phasor diagram – Power controllers - Converter - Volt-ampere requirements – Torque speed characteristics - Microprocessor based control.					
UNIT IV	**SWITCHED RELUCTANCE MOTORS**	**9**	**0**	**0**	**9**
Constructional features – Principle of operation – Torque prediction – Power controllers – Non-linear analysis – Microprocessor based control - Characteristics – Computer control.					
UNIT V	**STEPPING MOTORS**	**9**	**0**	**0**	**9**
Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Theory of torque predictions – Linear and non-linear analysis – Characteristics – Drive circuits					
	Total (45L+0T)= 45 Periods				

Text Books:

1.	T.J.E. Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
2.	P.P. Acarnley, "Stepping Motors – A Guide to Motor Theory and Practice", Peter Perengrinus, London, 1982.

Reference Books:

1.	R. Krishnan, "Switched reluctance motor drives", CRC Press, 2001.
2.	R. Krishnan , "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press, 2010

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	:	Explain the principles behind the different special machines.	L2: Understanding
CO2	:	Apply the electromagnetic concepts for development of EMF and Torque in machines.	L3: Applying
CO3	:	Select the control structure in terms of hardware to control the special machines.	L4: Analyzing
CO4	:	Analyze appropriate control techniques for efficient control of special machines.	L4: Analyzing
CO5	:	Develop strategy and methods to implement suitable application-based projects.	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						3	2	2	2	2
CO2	1	1	3	2	2						2	2	3	3	2
CO3	2	2	2	3	1						3	1	2	2	2
CO4	2	1	1	2	3						2	2	2	3	2
CO5	1	1	2	1	2						2	1	2	2	3
Avg	**1.6**	**1.2**	**2**	**2**	**1.8**	**-**	**-**	**-**	**-**	**-**	**2.4**	**1.6**	**2.2**	**2.4**	**2.2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE62	**INDUSTRIAL ELECTRICAL SYSTEMS**	**SEMESTER**			**VIII**
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Distribution System, Measurements and Instrumentation.	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**
Course Objectives:					
1.	To emphasize the electrical components, safety equipments, residential and commercial installations, illumination systems and automation in Electrical Systems				
UNIT I	**ELECTRICAL SYSTEM COMPONENTS**	**9**	**0**	**0**	**9**
LT system wiring components - Selection of cables, wires, switches, distribution box, metering system, Protection components- Fuse, MCB, MCCB, ELCB, RCCB – Construction and working of Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices, Single Line Diagram (SLD) of wiring system.					
UNIT II	**COMMERCIAL ELECTRICAL SYSTEMS**	**9**	**0**	**0**	**9**
Types of commercial wiring systems, general rules and guidelines for installation, load calculations, selection and sizing of components , rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, earthing of commercial installation.					
UNIT III	**ILLUMINATION SYSTEMS**	**9**	**0**	**0**	**9**
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.					
UNIT IV	**PROTECTION AND COMPERNSATION MEASURES**	**9**	**0**	**0**	**9**
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.					
UNIT V	**ELECTRICAL SYSTEM AUTOMATION**	**9**	**0**	**0**	**9**
Study of basic PLC, Role of PLC in automation, advantages of process automation, PLC based control system design, Panel Metering, Introduction to SCADA system for distribution automation.					
					Total (45L+0T) = 45 Periods

Text Books:	
1.	S.L. Uppal and G.C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2.	K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3.	S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
4.	H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.
Reference Books:	
1.	Partab , Art and Science of Utilization of Electrical Energy.
2.	Open Shaw Taylor, "Utilization of Electrical Energy", Oriented Longmans Limited, (Revised in SI Units), 1971.
3.	C. L Wadhwa , “Generation, Distribution and Utilization of Electrical Energy”, New Age International Publishers, 2012.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Associate the various components of industrial electrical system	L2: Understanding
CO2	:	Apply appropriate criteria for selection and sizing of the different electrical systems.	L3: Applying
CO3	:	Recall the various terms and factors for illuminations systems	L1:Remebering
CO4	:	Analyse the essential safety, protection and compensation measures.	L4:Analysing
CO5	:	Select the appropriate electrical system for automation.	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	1	1			1	1	1			1	1	1	1	1
CO2	2	2	1			1	1	1			1	1	2	1	1
CO3	2	2	1			1	1	1			1	1	2	1	1
CO4	2	2	1			1	1	1			1	1	2	1	1
CO5	2	1	1			1	1	1			1	1	1	1	1
Avg	**2**	**1.6**	**1**	**-**	**-**	**1**	**1**	**1**	**-**	**-**	**1**	**1**	**1.4**	**1**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE63	**ELECTRIC VEHICLES AND CONTROL**		**SEMESTER**			**VIII**
PREREQUISITES		**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)

22EEPE64	**EMBEDDED CONTROL FOR ELECTRICAL DRIVES**		**SEMESTER**			**VIII**
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To provide the control concept for electrical drives
2.	To emphasize the need of embedded systems for controlling the electrical drives
3.	To provide knowledge about various embedded system-based control strategies for electrical drives
4.	To Impart the knowledge of optimization and machine learning techniques used for electrical drives
5.	To familiarize the high-performance computing for electrical drives.

UNIT I	**INTRODUCTION TO ELECTRIC DRIVES**	**9**	**0**	**0**	**9**
Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives- Control techniques for electrical drives.					
UNIT II	**EMBEDDED SYSTEM FOR MOTOR CONTROL**	**9**	**0**	**0**	**9**
Embedded Processors choice for motor control- Sensors and interface modules for Electric drives- Electrical drives applications.					
UNIT III	**INDUCTION MOTOR CONTROL**	**9**	**0**	**0**	**9**
Speed control methods-PWM techniques- VSI fed three-phase induction motor- Embedded processor based three phase induction motor speed control.					
UNIT IV	**BLDC MOTOR CONTROL**	**9**	**0**	**0**	**9**
Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control.					
UNIT V	**SRM MOTOR CONTROL**	**9**	**0**	**0**	**9**
Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”,Prentice-Hall of India Pvt. Ltd., New Delhi,2010, 1st Edition.
2.	Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1st Edition
Reference Books:	
1.	VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2nd Edition.
2.	K. Venkataratnam ,Special Electrical Machines, Universities Press, 2014, 1st Edition.
3.	Steve Furber, ‘ARM system on chip architecture’, Addision Wesley, 2nd Edition 2015
4.	Ron Sass and AnderewG.Schmidt, “Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010, 1st Edition.
5.	Tim Wescott , Applied Control Theory for Embedded Systems , Elsevier, 2006, 1st Edition.
E-References:	
1	https://archive.nptel.ac.in/courses/108/104/108104140/
2	https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/
3	https://www.e3sconferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf
4	https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
5	http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Interpret the significance of embedded control for electrical drives	L2: Understanding
CO2	:	Deliver insight into various control strategies for electrical drives	L2: Understanding
CO3	:	Developing knowledge of control techniques for motor control.	L6: Creating
CO4	:	Develop embedded system solutions for drives used in Electric vehicles	L3: Applying
CO5	:	Knowledge up gradation on recent trends in embedded system skills required for motor control strategy	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**	**PS O1**	**PS O2**	**PS O3**
CO1	1	1	2	2	1							1	2	2	
CO2	2	1	3	2	1							1	2	2	
CO3	3	2	3	3	3							1	2	3	
CO4	3	2	3	3	3							1	3	3	
CO5	3	2	1	2	1							1	2	3	
Avg.	**2.4**	**1.6**	**2.4**	**2.4**	**1.8**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2.2**	**2.6**	**-**

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

22EEPE65	**GRID INTEGRATION OF ELECTRIC VEHICLES**	**SEMESTER**	**VIII**

PREREQUISITES	**CATEGORY**	**PE**	**Credit**	**3**

	Hours/Week	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:	
1.	To know the basic details of V2G
2.	To study the benefits & challenges of V2G
3.	To learn EV & V2G on the smart grids renewable energy systems
4.	To know the grid integration

UNIT I	**DEFINITION, AND STATUS OF V2G**	**9**	**0**	**0**	**9**

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications. Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid: Other Concepts Related to V2G.

UNIT II	**BENEFITS AND CHALLENGES OF V2G**	**9**	**0**	**0**	**9**

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

UNIT III	**CHALLENGES TO V2G**	**9**	**0**	**0**	**9**

Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues, EV Costs and Benefits, Adding V2G Costs and Benefits, Additional V2G Costs, The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G, V2G and Regulatory Frameworks, Market Design Challenges. Other V2G Regulatory and Legal Challenges

UNIT IV	**IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS**	**9**	**0**	**0**	**9**

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

UNIT V	**GRID INTEGRATION AND MANAGEMENT OF EVS**	**9**	**0**	**0**	**9**

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

Total (45L+0T)= 45 Periods

Reference Books:	
1.	Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2.	Plug In Electric Vehicles in Smart Grids, Charging Strategies, SumedhaRajakaruna ,FarhadShahnia and Arindam Ghosh,Springer, 2015, 1st Edition.
3.	ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
4.	Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
5.	Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicleto-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the concepts related with V2G	L2: Understanding
CO2	:	Study the grid connection of 3 phase Q inverter	L3: Applying
CO3	:	Explain the technical, economics. business, regulatory & political challenges related with V2G	L2: Understanding

CO4	:	Demonstrate the impact of EV and V2G on smart grid and renewable energy system	L4: Analyzing
CO5	:	Explain the concept of grid integration and management of EVs.	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	2	2									2	3	3	1
CO2	3	3	1		3							1	3		
CO3	3	1	1		3							2	3		
CO4	3	1	1									1	3		2
CO5	3	1	2									2	3		3
Avg.	**3**	**1.6**	**1.4**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**1.6**	**3**	**3**	**1.2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEPE66	**EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS**		**SEMESTER**		**VIII**
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Embedded System Design	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1. To expose the students to the fundamentals and building of Electronic Engine Control systems.
2. To teach on sensor functional components for vehicles.
3. To discuss on programmable controllers for vehicles management systems.
4. To teach logics of automation & communication techniques for vehicle communication.
5. To introduce the infotainment system development.

UNIT I	**INTRODUCTION TO AUTOMOTIVE SYSTEMS**	**9**	**0**	**0**	**9**
Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit– open-source ECU.					
UNIT II	**SENSORS AND ACTUATORS FOR AUTOMOTIVES**	**9**	**0**	**0**	**9**
Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications					
UNIT III	**VEHICLE MANAGEMENT SYSTEMS**	**9**	**0**	**0**	**9**
Energy Management system -Adaptive cruise control - anti-locking braking system - Safety and Collision Avoidance.					
UNIT IV	**ONBOARD DIAGONSTICS AND COMMUNICATION**	**9**	**0**	**0**	**9**
OBD, Vehicle communication protocols - Bluetooth, CAN, LIN, FLEXRAY and MOST.					
UNIT V	**RECENT TRENDS**	**9**	**0**	**0**	**9**
Navigation- Autonomous car- Role of IoT in Automotive systems.					
					Total (45L+0T)= 45 Periods

Text Books:

1. William B. Ribbens, “Understanding Automotive Electronics”, Elseiver, 8th Edition, 2017.
2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2nd Edition, 1999.
3. L.Vlacic,M.Parent,F.Harahima, “Intelligent Vehicle Technologies”, SAE International, 2001, 1st Edition, 2017.

Reference Books:

1. Ali Emedi, Mehrdedehsani, John M Miller , “Vehicular Electric power system- land, Sea, Air and Space Vehicles” Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec,JeffArias,”Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles”,Cengage ,2012, 2nd Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton’s guide to Fuel Injection – Ford 2nd Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.
5. Uwe Kiencke, Lars Nielsen, “Automotive Control Systems: For Engine, Driveline, and Vehicle”, Springer; 1st Edition, 2005.
6. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5th Edition, 2014.
7. Automotive Hand Book, Robert Bosch, Bently Publishers, 10th Edition, 2018.

E-references:

1 https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2 https://microcontrollerslab.com/can-communication-protocol/
3. https://ackodrive.com/car-guide/different-types-of-car-sensors/
4 https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/

5.	https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/
6.	https://www.synopsys.com/automotive/what-is-autonomous-car.html

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Insight into the significance of the role of embedded system for automotive applications.	L2:Understanding
CO2	:	Illustrate the need, selection of sensors and actuators and interfacing with ECU.	L2: Understanding
CO3	:	Develop the Embedded concepts for vehicle management and control systems.	L6: Creating
CO4	:	Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs.	L3: Applying
CO5	:	Improve employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.	L6: Creating

COURSE ARTICULATION MATRIX

COs /POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	3	2	2	1								2	2	
CO2	2	3	3	2	2								2	2	
CO3	3	3	3	3	3								2	2	
CO4	3	3	3	3	3								3	2	
CO5	3	3	1	2	1				1				2	2	
Avg.	**2.4**	**3**	**2.4**	**2.4**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2.2**	**2**	**-**
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 12th 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", 5th 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'", 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	:	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)

22CEOE01	**ENVIRONMENTAL MANAGEMENT**		**Semester**			**VI**
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To study the variable natures of our environmental resources and to understand their importance associated with our societic life.
2	To study the variable categories of pollutants and their controlling measures
3	To impart an understanding of systems approach to Environmental Management as per ISO 14000 and to evaluate the management plan using gis tools
4	To impart skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.
5	To impart skills for managing the usage of our natural resources without disrupting balance and stability of the natural system.

Unit I	**ENVIRONMENTAL RESOURCES**	**9**	**0**	**0**	**9**

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

Unit II	**ENVIRONMENTAL POLLUTION**	**9**	**0**	**0**	**9**

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

Unit III	**ENVIRONMENTAL MANAGEMENT SYSTEM**	**9**	**0**	**0**	**9**

Environmental Management Systems; ISO14000 series; Environmental auditing: Environmental Impact Assessment; Life cycle assessment; Human health risk assessment. Management plans using GIS and RS tools

Unit IV	**ENVIRONMENTAL LAW AND POLICY**	**9**	**0**	**0**	**9**

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.

Unit V	**ENERGY-ENVIRONMENT AND SUSTAINABLE DEVELOPMENT**	**9**	**0**	**0**	**9**

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**
			3	**0**	**0**

		TH			
		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.

<table>
<tr><td colspan="2">COURSE OUTCOMES:
Upon completion of the course, the students will be able to:</td><td>Bloom’s Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>Interpret the components and functionalities of the operating system</td><td>Understand</td></tr>
<tr><td>CO2</td><td>Apply various services and concepts of operating system to real time applications</td><td>Apply</td></tr>
<tr><td>CO3</td><td>Analyze the issues related to operating system and provide suitable solutions.</td><td>Analyze</td></tr>
</table>

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

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

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

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

<table>
<tr><td>22CSOE06</td><td colspan="2">COMPUTER ORGANIZATION</td><td colspan="4">SEMESTER VI</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Digital Principles and System Design</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>
</table>

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

<table>
<tr><td>UNIT I</td><td>INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">Functional units ,Basic Operational Concepts, Bus Structure ,Memory Locations and Addresses, MemoryOperations, Instruction and Instruction Sequencing, Addressing modes.</td></tr>
<tr><td>UNIT II</td><td>ARITHMETIC UNIT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, BoothAlgorithm, Fast Multiplication, Integer Division, Floating point number operations.</td></tr>
<tr><td>UNIT III</td><td>PROCESSOR UNIT AND PIPELINING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT IV</td><td>MEMORY SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">Basic Concepts, Semiconductor RAM, ROM, Cache memory, Improving Cache Performance, Virtual memory, Memory Management requirements, Secondary Storage Device.</td></tr>
<tr><td>UNIT V</td><td>INPUT AND OUTPUT ORGANIZATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">Accessing I/O devices, Programmed I/O, Interrupts, Direct Memory Access, Interface circuits, Standard I/OInterfaces (PCI, SCSI, USB).</td></tr>
<tr><td colspan="6">Total (45 L)= 45 Periods</td></tr>
</table>

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**	**THH**
			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 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 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 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 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 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)															

<table>
<tr><th>22ECOE05</th><th colspan="3">BASICS OF EMBEDDED SYSTEMS</th><th colspan="4">OPEN ELECTIVE</th></tr>
<tr><td colspan="3" rowspan="3">PREREQUISITES</td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><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 impart knowledge on embedded system architecture and embedded development Strategies</td></tr>
<tr><td>2.</td><td colspan="7">To understand the bus Communication in processors and peripheral interfacing</td></tr>
<tr><td>3.</td><td colspan="7">To understand basics of Real Time Operating System</td></tr>
<tr><td>Unit I</td><td colspan="3">BASICS OF EMBEDDED SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit II</td><td colspan="3">MEMORY MANAGEMENT AND INTERRUPTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit III</td><td colspan="3">COMMUNICATION INTERFACES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth</td></tr>
<tr><td>Unit IV</td><td colspan="3">REAL TIME OPERATING SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit V</td><td colspan="3">VALIDATION AND DEBUGGING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8" align="right">Total (45L)= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Sriram VIyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.</td></tr>
<tr><td>2.</td><td>Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003</td></tr>
<tr><td>2.</td><td>Heath, “Embedded Systems Design‖”, Newnes an Imprint of Elsevier, Massachusetts, 2003.</td></tr>
<tr><td>3.</td><td>Tammy Noergaard, “Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.</td></tr>
<tr><td>4.</td><td>Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, McGraw Hill, 2013</td></tr>
<tr><td colspan="2">E-References:</td></tr>
<tr><td>1.</td><td>https://lecturenotes.in/subject/225/embedded-system-es</td></tr>
<tr><td>2.</td><td>https://nptel.ac.in/courses/108102045/19</td></tr>
<tr><td>3.</td><td>https://www.coursera.org/learn/introduction-embedded-systems.</td></tr>
</table>

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”, 1^{st} 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 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)															

<table>
<tr><td>22MEOE01</td><td colspan="2">DESIGN OF MACHINE ELEMENTS AND MACHINING</td><td colspan="4">SEMESTER VI/VIII</td></tr>
<tr><td colspan="2" rowspan="3"></td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><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>
</table>

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.

<table>
<tr><td>UNIT I</td><td>STRESSES IN MACHINE ELEMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT II</td><td>DESIGN OF SHAFTS AND WELDED JOINTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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</td></tr>
<tr><td>UNIT III</td><td>DESIGN OF MACHINE ELEMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT IV</td><td>METAL CUTTING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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)</td></tr>
<tr><td>UNIT V</td><td>MACHINE TOOLS AND SURFACE FINISHING PROCESSES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6" align="right">Total(45L) = 45Periods</td></tr>
</table>

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)														

<table>
<tr><td>22MEOE02</td><td colspan="2">INDUSTRIAL ENGINEERING</td><td colspan="4">SEMESTER
VI / VIII</td></tr>
<tr><td colspan="2" rowspan="3"></td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><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>
</table>

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”, 8^{th}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)

<table>
<tr><td>22MEOE04</td><td colspan="2">POWER PLANT ENGINEERING</td><td colspan="4">SEMESTER VI/VII</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2">1. Having sufficient knowledge on basics of power plant</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td colspan="2">2. Basic unit calculation for consumption of power</td><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">Understanding of thermal power plant operations and its components.</td></tr>
<tr><td>2.</td><td colspan="6">Location of hydro power plant and its components to generate power.</td></tr>
<tr><td>3.</td><td colspan="6">Complete knowledge about diesel and gas power plant.</td></tr>
<tr><td>4.</td><td colspan="6">Basic knowledge of nuclear reaction and types of nuclear power plant.</td></tr>
<tr><td>5.</td><td colspan="6">Basic knowledge of power plant economics and various tariff methods.</td></tr>
<tr><td>UNIT I</td><td colspan="2">STEAM POWER PLANT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT II</td><td colspan="2">HYDRO ELECTRIC POWER PLANT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Layout of hydel power plant- classification –working – components – layout of pumped storage power plant - Plant equipment for Pumped Store Schemes.</td></tr>
<tr><td>UNIT III</td><td colspan="2">DIESEL AND GAS POWER PLANT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">NUCLEAR, MHD POWER GENERATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT V</td><td colspan="2">ECONOMICS AND SAFETY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7">Total(45L) = 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">TEXT BOOKS:</td></tr>
<tr><td>1.</td><td>S. Domkundwar, A.V. Domkundwar, S.C. Arora.A Course in Power Plant Engineering, Dhanpat Rai Publications. 2013</td></tr>
<tr><td>2.</td><td>P.K. Nag, Power Plant Engineering, Tata McGraw Hill, Laxmi Publications Pvt.Ltd New Delhi, 5th Edition, 2014.</td></tr>
<tr><td colspan="2">REFERENCES:</td></tr>
<tr><td>1</td><td>R.K. Rajput. A Text of Power Plant Engineering, Laxmi publications, New Delhi 5th Edition, 2016.</td></tr>
<tr><td>2</td><td>G.R. Nagpal, Power Plant Engineering, Khanna Publications 1998.</td></tr>
<tr><td>3</td><td>Bernhardt G. Askrotzki and William A. Vopat, “Power Station Engineering and Economy”, Tata McGraw Hill Publishing Co. Ltd., 1972.</td></tr>
<tr><td>4</td><td>Frederick T. Mores, “Power Plant Engineering”, Affiliated East-West Press Private Ltd., 1953.</td></tr>
<tr><td>5</td><td>Joel Weisman and Roy Eckart, “Modern Power Plant Engineering”, Prentice Hall International Inc., 1985.</td></tr>
</table>

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.

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.

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.

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.

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.

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)

<table>
<tr><td>22MEOE07</td><td colspan="2">RENEWABLE SOURCES OF ENERGY</td><td colspan="4">SEMESTER VI/VIII</td></tr>
<tr><td colspan="2" rowspan="3">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</td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td rowspan="2">Horus/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>4</td></tr>
</table>

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

<table>
<tr><td>UNIT I</td><td>SOLAR RADIATION AND ITS MEASUREMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">Alternative energy sources, Global and Indian energy scenario. Solar Energy: Introduction – Solar Radiation Measurement and Instruments – Data and estimation.</td></tr>
<tr><td>UNIT II</td><td>SOLAR ENERGY COLLECTORS, SOLAR ENERGY STORAGE AND APPLICATIONS OF SOLAR ENERGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT III</td><td>BIOMASS AND ITS CONVERSION TECHNOLOGIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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;</td></tr>
<tr><td>UNIT IV</td><td>WIND, GEOTHERMAL AND TIDAL ENERGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT V</td><td>CHEMICAL ENERGY, HYDROGEN ENERGY AND MAGNETO HYDRO DYNAMIC</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6">Total (45L) = 45Periods</td></tr>
</table>

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)

<table>
<tr><td colspan="2">2MEOE08</td><td colspan="2">ROBOTIC PROCESS AUTOMATION</td><td colspan="4">SEMESTER VI/VIII</td></tr>
<tr><td colspan="3">Pre-requisite:</td><td>CATEGORY</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Basics in kinematics and dynamics</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">COURSEOBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="7">To study the various parts of robots and fields of robotics.</td></tr>
<tr><td>2.</td><td colspan="7">To study the various kinematics and inverse kinematics of robots.</td></tr>
<tr><td>3.</td><td colspan="7">To study the Euler, Lagrangian formulation of Robot dynamics.</td></tr>
<tr><td>4.</td><td colspan="7">To study the trajectory planning for robot.</td></tr>
<tr><td>5.</td><td colspan="7">To study the control of robots for some specific applications</td></tr>
<tr><td colspan="2">UNIT I</td><td colspan="2">BASIC CONCEPTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="2">UNIT II</td><td colspan="2">POWER SOURCES AND SENSORS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="2">UNIT III</td><td colspan="2">MANIPULATORS, ACTUATORS AND GRIPPERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.</td></tr>
<tr><td colspan="2">UNIT IV</td><td colspan="2">KINEMATICS AND PATH PLANNING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Solution of inverse kinematics problem – multiple solution jacobian work envelop – Hill Climbing Techniques – robot programming languages</td></tr>
<tr><td colspan="2">UNIT V</td><td colspan="2">CASE STUDIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Multiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.</td></tr>
<tr><td colspan="8">Total (45L) = 45 Periods</td></tr>
</table>

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.

UNIT I	**MOULDING MATERIALS AND PATTERNS**	**9**	**0**	**0**	**9**

Introduction to foundry operations, patterns - functions, types, allowances, selection of pattern materials, colour codes, core boxes, moulding practice, ingredients of moulding sand and core sand, Testing of Moulding sands. Sand preparation, Sand reclamation in foundries.

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.

UNIT III	**MELTING PRACTICE**	**9**	**0**	**0**	**9**

Melting practice and special precautions for steels, alloy steels, cast irons, aluminium alloys, copper alloys and magnesium alloys, Cleaning and repair of castings. Casting defects and remedies

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

UNIT V	**SPECIAL WELDING PROCESSES**	**9**	**0**	**0**	**9**

Principle, equipment, process variables, merits, limitations and applications of Electron beam, plasma arc and laser 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, electroless plating, 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, Flame spray 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 and applications.

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.

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, computeraided 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 Plastic Deformation, 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

PROGRAMME ELECTIVE COURSEVERTICALS FOR HONOURS / MINOR DEGREE

VERTICAL I : POWER ENGINEERING

22EEH101	**SUBSTATION ENGINEERING AND AUTOMATION**	**SEMESTER**			
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Electrical Measurements; Power Generation, Transmission and Distribution system	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the importance of the substation design
2.	To outline the different factor for effecting substation design
3.	To classify the bus configurations
4.	To know the design criteria for substation grounding
5.	To understand the importance of substation automation

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Background, Need Determination, Budgeting, Financing, Traditional and innovative Substation Design, Site Selection and Acquisition, Design, Construction and Commissioning Process					
UNIT II	**HIGH VOLTAGE SWITCHING EQUIPMENT**	**9**	**0**	**0**	**9**
Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers.					
UNIT III	**TYPES OF SUBSTATIONS & BUS/SWITCHING CONFIGURATIONS**	**9**	**0**	**0**	**9**
Transmission substation, distribution substation, collector substation, switching substations, gas insulated substations, air insulated substations, bus configurations: single bus, double bus, double break, main and transfer bus, double bus, single breaker, ring bus, break-and-a-half, Comparison of configurations.					
UNIT IV	**DESIGN OF SUBSTATION GROUNDING AND PROTECTION**	**9**	**0**	**0**	**9**
Reasons for substation grounding system, accidental ground circuit, Design criteria-Actual Touch and step voltage, soil resistivity, grid resistance, grid current, use of the design equations, selection of conductors, grounding fence, other design considerations. Lightning stroke protection-lightning parameters, empirical design methods. Substation fire protection-Fire hazards, fire protection measures, fire protection selection criterion.					
UNIT V	**SUBSTATION AUTOMATION AND COMMUNICATIONS**	**9**	**0**	**0**	**9**
Introduction , components of substation automation system, automation applications, protocol fundamentals, supervisory control and data acquisition (SCADA) historical perspective, SCADA functional requirements, SCADA communication requirements, components of SCADA system, SCADA communication protocols, the structure of a SCADA communication protocol, security for substation communications, security methods, security assessment.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	John D. McDonald , Electrical Power Substation Engineering , CRC Press, 3 rd Edition, 2017
Reference Books:	
1.	R. S. Dahiya, VinayAttri," Sub-Station Engineering Design & Computer Applications " S K Kataria and son Publications, 1 st Edition, 2013.
2.	P. S. Satnam, P. V. Gupta, " Substation Design and Equipment " Dhanapat Rai Publications, 1 st Edition, 2013.
3.	TuranGonen, " Electric Power Distribution Engineering " CRC press, third edition, 2014.
E-Reference	
1	https://www.transgrid.com.au/what-we-do/our-network/connections
2	https://new.abb.com/substations
3	https://ieeexplore.ieee.org/document/178016
4	https://www.sciencedirect.com/topics/engineering/substations

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the commissioning of substation	L2: Understanding
CO2	:	Know working principles of substation switching equipment	L2: Understanding
CO3	:	Identify the different types of bus configurations	L1: Remembering
CO4	:	Design substation grounding and protection	L6: Creating
CO5	:	Analyse the substation communication (SCADA)	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	3	1	1		1				1	1	2	2	1
CO2	1	2	1	1	1							1	1	1	1
CO3	1	3	2	2	2		1					1	1	2	1
CO4	2	2	3	2	3							1	2	2	1
CO5	1	2	1	1	3		1				1	1	2	2	1
Avg	**1.4**	**2.2**	**2**	**1.4**	**2**	**-**	**1**	**-**	**-**	**-**	**1**	**1**	**1.6**	**1.8**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEH102	**ENERGY MANAGEMENT SYSTEMS AND SCADA**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power System		**Hours/Week**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on energy management systems.
2.	To understand network analysis function of EMS.
3.	To study the function and control of SCADA.
4.	To analyze the concept of SCADA hardware and software.
5.	To study the concept of power system automation using SCADA.

UNIT I	**ENERGY MANAGEMENT SYSTEM**	**9**	**0**	**0**	**9**

Introduction to EMS, Objectives, Evolution of EMS, Evolution of SCADA, Function and Benefits of EMS, EMS Architecture, Practical EMS, Working of EMS, Power System Security: Introduction, Static Security Assessment, Operating states of Power System. Real Time or Online Application : Control Function, Protection Function, Operating States of Power System

UNIT II	**NETWORK ANALYSIS FUNCTION OF EMS**	**9**	**0**	**0**	**9**

Real Time Function, Extended Real Time Function, State Estimation: Introduction, Conventional State Estimation, Linear state estimation. Economic Dispatch and Optimal Power Flow: Introduction, Economic Dispatch, Generation Model, Economic Dispatch Problem, Optimal Power Flow problem Formulation.

UNIT III	**SCADA**	**9**	**0**	**0**	**9**

Introduction to SCADA, Evolution of SCADA, Benefits of SCADA, Function of SCADA, SCADA in Process control, SCADA Application, Usage of SCADA, Real-Time Monitoring and Control using SCADA, Data Acquisition, Data Communication, Data Presentation, and Control.

UNIT IV	**SCADA HARDWARE AND SOFTWARE**	**9**	**0**	**0**	**9**

Introduction, SCADA hardware Functions, Remote Terminal Units, SCADA RTU, Basic Functions, RTU Standards, Difference Between RTU and PLC, Features of SCADA. SCADA Software and Protocols: Introduction to ISO Model, DNP3 Model, Important Features of DNP3, IEC60870 PROTOCOL, HDLC, Modbus Protocol.

UNIT V	**POWER SYSTEM AUTOMATION**	**9**	**0**	**0**	**9**

Power System Automation – Benefits - Architecture for Power System Automation, Classification of Power system Automation, Implementation of Power System Automation and Protection using SCADA, SCADA based Model for Automation and Digital Protection.

Total (45L+0T)= 45 Periods

Text Books:

1.	Wayne C. Turner, Steve Doty, Energy Management Hand book, The Fairmont Press, 6th Edition, 2007.
2.	Handschin, E. “Energy Management Systems”, Springer Verlag, 1990.
3.	Mini S. Thomas, John D McDonald, “Power System SCADA and Smart Grids”, CRC Press, 2015.

Reference Books:

1.	John D Mc Donald, “Electric Power Substation Engineering”, , CRC press, 2001
2.	Handschin, E, “Real Time Control of Electric Power Systems”, Elsevier, 1972.

E-References:

1.	NPTEL Online Courses, Energy Management Systems and SCADA, IIT Madras. Link : “https://nptel.ac.in/courses/108106022/12“

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Explore the objectives of EMS.	L2: Understanding
CO2	:	Understand the real time function of EMS.	L1: Remembering
CO3	:	Explain the real time monitoring and control of SCADA.	L4: Analyzing
CO4	:	Analyze the hardware and software functions of SCADA.	L4: Analyzing
CO5	:	Outline the power system automation and protection using SCADA.	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					2		2
CO2	3		2			2							2		2
CO3	3	1	2										2	1	2
CO4	3		2										2		2
CO5	3		2			2							2	1	2
Avg	**3**	**1**	**2**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**1**	**2**

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

22EEH103	**POWER SYSTEM AUTOMATION**			**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**	
Power Generation, Transmission and Distribution System; Power System Analysis and Stability		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Objectives:

1.	To acquire fundamental knowledge on power system instrumentation.
2.	To familiarise on automations in electric power distribution systems.
3.	To get conceptual aspects in modern tools for power system automation.

UNIT I	**MEASUREMENTS AND SIGNAL TRANSMISSION TECHNIQUES**	**9**	**0**	**0**	**9**
Object and philosophy of power system instrumentation to measure large currents, high voltages, Torque and Speed - Standard specifications - Data acquisition systems for Power System applications - Data Transmission and Telemetry - PLC equipment, RTU, IED - computer control of power system - Man Machine Interface.					
UNIT II	**COMMUNICATION TECHNOLOGIES**	**9**	**0**	**0**	**9**
Communication requirements; Two way capability – outages and faults; Public switched telephone network, Power line carrier communication – ripple control, cyclocontrol, carrier frequency (PLC, DLC, BPL), Radio communication (UHF point to point, UHF multi address system radio, VHF, PSN, Cellular radio), Fibre optics, Satellite communication. Standards: IEE802, IEC61850					
UNIT III	**DISTRIBUTION SYSTEM INSTRUMENTATION**	**9**	**0**	**0**	**9**
Definitions – automation switching control – management information systems (MIS) – remote terminal units – communication method for data transfer – consumer information service (CIS) – graphical information systems (GIS) - automatic meter reading (AMR) – Remote control load management.					
UNIT IV	**DISTRIBUTION AUTOMATION**	**9**	**0**	**0**	**9**
Introduction to distribution automation: Customer automation- Feeder automation – Substation automation, Subsystems in distribution control centre – Distribution management systems-Outage management systems, Distribution management system framework-Advanced real time DMS applications- Advanced analytical DMS applications – DMS coordination with other systems.					
UNIT V	**CONCEPTS FOR SMART SYSTEMS**	**9**	**0**	**0**	**9**
Smart system solutions – Asset optimization, Demand optimization, distribution optimization, smart meter and communications, transmission optimization; Demand side management and demand response – DSM Planning-DSM techniques; Advanced metering infrastructure integration with distribution automation, distribution management system, and outage management system; Smart homes with home energy management systems.					
Total (45 L + 0 T)= 45 Periods					

Text Books:

1.	Pabla. A.S, “Electric Power Distribution”, Tata McGraw Hill, New Delhi, 2019.
2.	Mini S Thomas, and John D McDonald, “Power System SCADA and Smart Grids”, Taylor and Francis, 2015.
3.	Mahalanabis, Kothari and Ahson, “Computer Aided Power System Analysis and Control”, Tata McGraw Hill Publishers, 1991.

Reference Books:

1.	Momoh A. Momoh, and James A. Momoh., “Electric Power Distribution, Automation, Protection, and Control”, CRC Press, 2007.
2.	Gonen., “Electric Power Distribution System Engineering”, BSP Books, Pvt. Ltd, 2007.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the conceptual aspects in power system measurements and signal transmission techniques.	L2: Understanding
CO2	:	Demonstrate various communication technologies for data transmission.	L3: Applying
CO3	:	Acquire proficiency to distribution system instrumentation.	L3: Applying
CO4	:	Demonstrate the automation in power distribution system.	L3: Applying
CO5	:	Conceptualize the smart tools for automation.	L3: Applying

COURSE ARTICULATION MATRIX

CO\/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	3	3	1	1		1				1	2	1	3	1
CO 2	1	2	3	2	2		2				1	2	1	3	1
CO 3	1	2	3	2	2		2				1	2	1	2	1
CO 4	1	2	2	1	1		1				1	2	1	2	1
CO 5	1	2	3	2	2		2				1	2	1	1	1
Avg	**1**	**2.2**	**2.8**	**1.6**	**1.6**	**-**	**1.6**	**-**	**-**	**-**	**1**	**2**	**1**	**2.2**	**1**

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

22EEH104	POWER PLANT ENGINEERING		SEMESTER			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Generation, Transmission and Distribution System.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
To familiarize with operation of various power plants						
UNIT I	**THERMAL POWER PLANT**		**9**	**0**	**0**	**9**
Thermal Stations- layout- main components- boiler- economizer- air preheater- super heater- reheater- condenser- feed heater- cooling powers- FD and ID fans- Coal handling plant-water treatment plant- Ash handling plant- Types of boilers and theirs characteristics- Steam turbines- and their characteristics- governing system for thermal stations						
UNIT II	**HYDRO POWER PLANT**		**9**	**0**	**0**	**9**
Hydro Electric Stations- Selection of site- layout- classification of hydro plants- general arrangement and operation of a hydro-plant- governing system for hydel plant- types of turbines-pumped storage plants.						
UNIT III	**NUCLEAR POWER PLANT**		**9**	**0**	**0**	**9**
Nuclear power plants - Principles of nuclear energy -Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors - location - advantages and disadvantages of nuclear power plants - Reactor control						
UNIT IV	**POWER FROM RENEWABLE ENERGY**		**9**	**0**	**0**	**9**
Principle, Construction and working of Solar Thermal, Solar Photo Voltaic (SPV), Wind, Tidal, Geo Thermal, Biogas and Fuel Cell power systems.						
UNIT V	**POWER PLANT ECONOMICS AND ENVIRONMENTAL HAZARDS**		**9**	**0**	**0**	**9**
Economics of power generation -Capital & Operating Cost of different power plants. Environmental aspect of power generation- Comparison of site selection criteria, relative merits & demerits of different plants -Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants- safety measures for Nuclear Power plants.						
						Total (45L) = 45 Periods

Text Books:	
1.	Nag. P.K., Power Plant Engineering, 4th ed., Tata McGraw-Hill, 2017.
2.	Domkundwar, S., Power Plant Engineering, Dhanpat Rai & Sons, 2016.
3.	El-Wakil, M.M., “Power plant Technology”, McGraw-Hill Book Co, 2002.
Reference Books:	
1.	Deshpande.M.V, “Elements of Electrical Power station Design”, Pitman, New Delhi,Tata McGraw Hill, 2008.
2.	Soni Gupta, Bhatnagar and Chakrabarti, “A text book on Power Systems Engineering”, Dhanpat Rai and Sons, New Delhi, 1997.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Recall the construction and principle of working for different power plants.	L1: Remembering
CO2	:	Identify the site requirements and component requirements.	L2: Understanding
CO3	:	Analyze the concept governors and their control of power plant.	L4: Analysing
CO4	:	Assess the power plant and its suitability for the environment.	L3: Applying
CO5	:	Interpret the economics involved in design of power plant.	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		2		1	1	1	1				1	3	1	1
CO2	1		2		1	1	1					1	2	1	1
CO3	1		2	1	1	1	1					1	2	1	1
CO4	1	1	3	1	1	1	1					1	2	2	1
CO5	1	1	3	1	1	1	1	1				1	2	2	1
Avg	**1.4**	**1**	**2.4**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**2**	**1.4**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEH105	**COMPUTER RELAYING AND WIDE AREA MEASUREMENT SYSTEMS**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power System Protection		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
To understand different techniques of digital relaying - their constructions, working principles, applications and limitations along with introduction to Wide Area Measurement System and network protection.						
UNIT I	**INTRODUCTION TO COMPUTER RELAYING**		**9**	**0**	**0**	**9**
Computer relay architecture - analog-to-digital converters - anti-aliasing filters - expected benefits of computer relaying						
UNIT II	**RELAYING PRACTICES**		**9**	**0**	**0**	**9**
Introduction to protection systems, function of protection system, protection of transmission lines, overcurrent relays, directional relays, distance relays, pilot relaying, transformer protection, reactor protection, generator protection and bus protection						
UNIT III	**MATHEMATICAL BASIS FOR PROTECTIVE RELAYING ALGORITHMS**		**9**	**0**	**0**	**9**
Fourier series, Walsh functions, Fourier transforms, probability and random process, Kalman filtering						
UNIT IV	**SYSTEM RELAYING AND CONTROL**		**9**	**0**	**0**	**9**
Phasor Measurement Unit - Measurement of frequency and phase – sampling clock synchronization – Application of phasor measurement to state estimation – Monitoring- Control applications						
UNIT V	**WIDE AREA MEASUREMENT SYSTEMS**		**9**	**0**	**0**	**9**
Wide Area Measurement Systems (WAMS) architecture – WAMS based protection concepts : Adaptive dependability and security – Monitoring approach of apparaent impedances towards relay characteristics – WAMS based out-of step relaying – Supervision of backup zones – Intelligent load shedding – Intelligent islanding – System wide integration of SIPS – Load shedding and restoration						
Total (45L) = 45 Periods						

Text Books:	
1.	Arun G. Phadke, James S. Thorp, “Computer Relaying for Power Systems”, Wiley, Second Edition,2009.
2.	Allan Thomas Johns, S.K. Salman, “Digital Protection for Power Systems”, The Institution of Engineering and Technology, Second Edition, 1995.
Reference Books:	
1.	A.G. Phadke, J.S. Thorp, “Synchronized Phasor Measurements and Their Applications”, Springer, 2008.
2.	Walter A. Elmore, “Protective Relaying: Theory and Applications”, CRC Press, 2004.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand on protection system schemes, its co-ordination and settings for any general power network.	L2: Understanding
CO2	:	Identify the digital relaying, its fundamentals, attributes and implementation.	L2: Understanding
CO3	:	Analyze the concept synchro-phasor based power system relaying	L4: Analysing
CO4	:	Assess the algorithms and its importance	L3: Applying
CO5	:	Recall the power system monitoring using wide area measurement system	L1: 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**	**PS O1**	**PS O2**	**PS O3**
CO1	1	1	2	2	1	1	1					1	3	1	1
CO2	1	1	2	2	1	1	1					1	2	1	1
CO3	1	1	3	3	1	1	1					1	3	2	1
CO4	1	1	3	3	1	2	1					1	3	2	1
CO5	1	1	3	2	1	2	1					1	2	2	1
Avg	**1**	**1**	**2.6**	**2.4**	**1**	**1.4**	**1**	**-**	**-**	**-**	**-**	**1**	**2.4**	**1.6**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEH106</td><td colspan="2">POWER SYSTEM PLANNING AND RELIABILITY</td><td colspan="4">SEMESTER</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">Power Generation, Transmission and Distribution system ;
Power system analysis and stability</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 understand the concepts of power system planning</td></tr>
<tr><td>2.</td><td colspan="6">To analyze power system reliability</td></tr>
<tr><td>3.</td><td colspan="6">To understand generation, transmission and distribution planning and reliability</td></tr>
<tr><td>UNIT I</td><td colspan="2">INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction, Objectives and Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning.</td></tr>
<tr><td>UNIT II</td><td colspan="2">RELIABILITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost.</td></tr>
<tr><td>UNIT III</td><td colspan="2">GENERATION PLANNING AND RELIABILITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches),Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods, Interconnected System, Factors Affecting Interconnection under Emergency Assistance.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">TRANSMISSION PLANNING AND RELIABILITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.</td></tr>
<tr><td>UNIT V</td><td colspan="2">DISTRIBUTION PLANNING AND RELIABILITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Radial Networks, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices, Parallel & Meshed Networks, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Breaker Failure.</td></tr>
<tr><td colspan="7">Total (45L+0T)= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>R.L. Sullivan “Power System Planning”, Tata McGraw Hill Publishing Company Ltd, 1977.</td></tr>
<tr><td>2.</td><td>Roy Billinton and Ronald N. Allan “Reliability Evaluation of Power System”, Springer Publication, 1996</td></tr>
<tr><td>3.</td><td>T. W. Berrie “Electricity Economics & Planning”, Peter Peregrinus Ltd., London, 1992.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>Ali Chowdhury, Don Koval, “Power Distribution System Reliability: Practical Methods and Applications”, Wiley-IEEE Press, 2009.</td></tr>
<tr><td>2.</td><td>Roy Billinton, R.N. Allan, “Reliability Evaluation of Power Systems”, Springer, 1996.</td></tr>
<tr><td colspan="2">E-Reference</td></tr>
<tr><td>1</td><td>https://archive.nptel.ac.in/courses/117/103/117103149/</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 Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>:</td><td>Understand the power system planning</td><td>L2: Understanding</td></tr>
<tr><td>CO2</td><td>:</td><td>Determine the reliability of power system</td><td>L1: Applying</td></tr>
<tr><td>CO3</td><td>:</td><td>Understand the generation planning and reliability of power system</td><td>L1: Remembering</td></tr>
<tr><td>CO4</td><td>:</td><td>Understand the transmission planning and reliability of power system</td><td>L2: Understanding</td></tr>
<tr><td>CO5</td><td>:</td><td>Understand the distribution planning and reliability of power system</td><td>L1: Remembering</td></tr>
</table>

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	1	1	1	1	1		1				1		1	1	1
CO2	1	3	3	3	2		1				1		1	1	1
CO3	1	2	2	3	2		1				1		1	1	1
CO4	1	3	2	3	2		1				1		1	1	1
CO5	1	2	3	3	2		1				1		1	1	1
Avg	**1**	**2.2**	**2.2**	**2.6**	**1.8**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEH107	**ADVANCED POWER SYSTEM PROTECTION**		**SEMESTER**		
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Power systems protection	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:	
1.	To understand the concepts of advances in power system protection.
2.	To analyze digital protection of power system equipments.
3.	To design of protective relays.

UNIT I	**NUMERICAL PROTECTION**	**9**	**0**	**0**	**9**
Introduction - Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave - Least Error Squared (LES) technique - Digital filtering and numerical over- Current protection.					
UNIT II	**DIGITAL PROTECTION OF TRANSMISSION LINE**	**9**	**0**	**0**	**9**
Introduction - Protection scheme of transmission line – Distance relays - Traveling wave relays - Digital protection scheme based upon fundamental signal - Hardware design - Software design - Digital protection of EHV/UHV transmission line based upon traveling wave phenomenon - New relaying scheme using amplitude comparison.					
UNIT III	**DIGITAL PROTECTION OF SYNCHRONOUS GENERATOR & TRANSFORMER**	**9**	**0**	**0**	**9**
Introduction - Faults in synchronous generator - Protection schemes for Synchronous Generator - Digital protection of Synchronous Generator - Faults in a Transformer - Schemes used for Transformer Protection - Digital Protection of Transformer.					
UNIT IV	**DISTANCE AND OVERCURRENT RELAY SETTING AND CO-ORDINATION**	**9**	**0**	**0**	**9**
Directional instantaneous IDMT over current relay - Directional multi-Zone distance relay - Distance relay setting - Co-ordination of distance relays - Co-ordination of over current relays - Computer graphics display - Man-machine interface subsystem - Integrated operation of national power system - Application of computer graphics.					
UNIT V	**PC APPLICATIONS FOR DESIGNING PROTECTIVE RELAYING SCHEME**	**9**	**0**	**0**	**9**
Types of faults – Assumptions - Development of algorithm for SC studies - PC based integrated software for SC studies - Transformation to component quantities - SC studies of multiphase systems - Ultra high speed protective relays for high voltage long transmission line.					
Total (45L+0T)= 45 Periods					

Text Books:	
1.	L. P. Singh, "Digital Protection - Protective Relaying from Electromechanical to Microprocessor", New Age International Ltd., New Delhi, Second Edition, 2006.
2.	S. R. Bhide, “Digital Power System Protection”, Prentice Hall of India Pvt. Ltd., New Delhi, 2014.
3.	Paithankar and Bhide, “Fundamentals of Power System Protection”, Prentice Hall of India Pvt. Ltd., New Delhi, Second Edition, 2010.
Reference Books:	
1.	Paithankar, “Transmission Network Protection”, Marcel & Dekker, New York, 1998
2.	Stanley Horowitz, “Protective Relaying for Power System II”, John Wiley & Sons, 2008.
E-Reference	
1	https://nptel.ac.in/courses/108101039

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	To understand the numeric protection	L2: Understanding
CO2	:	To design the digital protection of transmission line	L1: Applying
CO3	:	To design the digital protection of synchronous generator	L4: Analysing
CO4	:	To design the digital protection relays	L5: Evaluating
CO5	:	To study the pc based digital protection relays	L2: 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**	**PSO 3**
CO1	1	1	1	1	1								1	1	1
CO2	1	3	3	2	2								1	1	1
CO3	1	2	2	2	2								1	1	1
CO4	1	3	2	2	2								1	1	1
CO5	1	2	3	2	2								1	1	1
Avg.	**1**	**2.2**	**2.2**	**1.8**	**1.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**

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

22EEH108	**HIGH VOLTAGE INSULATION SYSTEMS**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
High voltage Engineering, Measurements and Instrumentation		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To expose the various types of insulating materials used for power system equipment.
2.	To introduce the concept of insulation design.
3.	To provide an overview of insulation defects in power system equipment.
4.	To understand insulation condition monitoring techniques.

UNIT I	**INSULATING MATERIALS**	**9**	**0**	**0**	**9**
Review of electrical insulating materials, characterization of insulation condition, models of deterioration and failure of practical insulating materials, electrical breakdown and operating stresses, development of insulation applications.					
UNIT II	**ELECTRICAL INSULATION DESIGN CONCEPTS**	**9**	**0**	**0**	**9**
Overview of insulation design requirements – electrical stress distribution in simple insulation system – Electric stress control: Principles of stress control, Stress distribution in multiple dielectrics, Stress calculation.					
UNIT III	**INSULATION DEFECTS IN HV POWER SYSTEM EQUIPMENT**	**9**	**0**	**0**	**9**
HV Insulators - HV bushings - HV power capacitors - HV surge arresters – HV circuit breakers, HV Cables - Gas Insulated system – HV Transformers - HV instrument transformers.					
UNIT IV	**BASIC METHODS FOR INSULATION ASSESSMENT**	**9**	**0**	**0**	**9**
Generation and measurement of test high voltages - Non-destructive electrical measurements: Insulation Resistance, dielectric dissipation factor, partial discharges, dielectric response – Physical and chemical diagnostic methods.					
UNIT V	**ONLINE INSULATION CONDITION MONITORING TECHNIQUES**	**9**	**0**	**0**	**9**
Main problem with Offline condition monitoring - Noise-mitigation techniques - Non-electrical online condition monitoring - Online acoustic/electric PD location methods for transformers - Electrical online condition monitoring.					
					Total (45L+0T)= 45 Periods

Text Books:

1.	R. E. James and Q. Su, "Condition Assessment of High Voltage Insulation in Power System Equipment", IET power and Energy Series Publisher, London, United Kingdom, 2008.

Reference Books:

1.	Dieter Kind and Hermann Kärner, "High-Voltage Insulation Technology", Springer,1985.
2.	Ravindra Arora & Wolfgang Mosch, "High Voltage and Electrical Insulation Engineering", John Wiley& Sons Publishers, 2011.
3.	E. Kuffel W.S. Zaengl, and J.Kuffel, 'High Voltage Engineering Fundamentals', Newness Publishers, Second Edition, Elsevier, New Delhi, 2005.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Know the various insulating materials.	L2: Understanding
CO2	:	Understand the concepts of insulation design for power system equipment.	L2: Understanding
CO3	:	Analyze insulation defects in high voltage power system equipment	L4: Analyzing
CO4	:	Recite the basic methods for insulation assessment	L1: Remembering
CO5	:	Apply online insulation condition monitoring techniques	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	2			1			1						1	1	
CO2	2	1	3	1	1		1						3	2	
CO3	2			3	2	1	1						1	3	
CO4	2	1	1	3		1						1	2	3	1
CO5	2	1	1	3	2		1					1	2	3	1
Avg	**2**	**1**	**1.6**	**2.2**	**1.6**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**1.8**	**2.4**	**1**

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

PROGRAMME ELECTIVE COURSE VERTICALS FOR HONOURS / MINOR DEGREE

VERTICAL II : POWER CONVERTERS AND DRIVES

<table>
<tr><td>22EEH201</td><td colspan="2">ANALYSIS OF ELECTRICAL MACHINES</td><td colspan="4">SEMESTER</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">DC Machines , Synchronous and Induction Machines</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>2</td><td>3</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="6">To model & simulate all types of DC machines</td></tr>
<tr><td>2.</td><td colspan="6">To develop reference frame equations for various elements like R, L and C</td></tr>
<tr><td>3.</td><td colspan="6">To model an induction (three phase and ‘n’ phase) and synchronous machine</td></tr>
<tr><td>4.</td><td colspan="6">To drive reference frame equations for induction and synchronous machine</td></tr>
<tr><td>5.</td><td colspan="6">To study the need and working of multiphase induction and synchronous machine</td></tr>
<tr><td>UNIT I</td><td colspan="2">MODELING OF BRUSHED-DC ELECTRIC MACHINERY</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor – Shunt, Series and Compound – State model derivation – Construction of Model of a DC Machine using state equations- Shunt, Series and Compound.</td></tr>
<tr><td>UNIT II</td><td colspan="2">REFERENCE FRAME THEORY</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame .</td></tr>
<tr><td>UNIT III</td><td colspan="2">INDUCTION MACHINES</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">Three phase induction machine - equivalent circuit– free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no load and load conditions- Machine variable form, arbitrary reference variable form.</td></tr>
<tr><td>UNIT IV</td><td colspan="2">SYNCHRONOUS MACHINES</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park’s equations).</td></tr>
<tr><td>UNIT V</td><td colspan="2">MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines- Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine -Modeling of ‘n’ phase machine. Applications of Multiphase Machines</td></tr>
<tr><td colspan="7">LAB COMPONENT</td></tr>
<tr><td>1</td><td colspan="6">Modeling of DC machines.</td></tr>
<tr><td>2</td><td colspan="6">Simulation under no-load and loaded conditions for a PMDC motor</td></tr>
<tr><td>3</td><td colspan="6">Simulation of smooth starting for DC motor.</td></tr>
<tr><td>4</td><td colspan="6">Simulation under no-load and load conditions of a three phase induction machine in machine variable form and arbitrary reference variable form</td></tr>
<tr><td>5</td><td colspan="6">Simulation under no-load and load conditions of a three phase synchronous machine in machine variable form and arbitrary reference variable form.</td></tr>
<tr><td colspan="7" align="right">Total (30L+0T+30P)= 60 Periods</td></tr>
</table>

Test Books:

1.	Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.
2.	Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.
3.	Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013..
4.	Chee Mun Ong, Dynamic Simulation of Electric Machinery using MATLAB, Prentice Hall, 1997, 1st Edition
5.	Atif Iqbal,ShaikhMoinoddin, BhimireddyPrathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley,2021,1st Edition

Reference Books

1.	R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015, 1st Edition.
2.	R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k.International Publishing House Pvt.Ltd,2018.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separately excised motor) and to simulate DC motors using state models	L1: Remembering
CO2	:	Apply reference frame theory for, resistive and reactive elements (three phase)	L2: Understanding
CO3	:	Compute the equivalent circuit and torque of three phase induction motor and synchronous motor in machine variable arbitrary reference frame variable	L5: Evaluating
CO4	:	Demonstrate the working of multiphase induction and synchronous machine.	L3: Applying
CO5	:	Compute the model of three phase and multiphase induction and synchronous machine.	L6: Creating

COURSE ATTRICULATION 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**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3		2	1		3		3	3	3
CO2	3	3	3	3	3		2	1		3		3	3	3
CO3	3	3	3	3	3		2	1		3		3	3	3
CO4	3				3		2	1		3		3	3	3
CO5	3				3		2	1		3		3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**-**	**2**	**1**	**-**	**3**	**-**	**3**	**3**	**3**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)														

22EEH202	**MULTILEVEL POWER CONVERTERS**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1. To introduce the fundamentals of multilevel voltage source inverters and multilevel current source inverters with its modulation control

UNIT I	**DIODE-CLAMPED MULTILEVEL INVERTERS**	**9**	**0**	**0**	**9**
Three-Level Inverter - Converter Configuration and Switching State, Space Vector Modulation - Stationary Space Vectors, Dwell Time Calculation and Switching Sequence Design, Neutral-Point Voltage Control 164 Discontinuous Space Vector Modulation, SVM Based on Two-Level Algorithm, High-Level Diode-Clamped Inverters - Four-and Five-Level Diode-Clamped Inverters					
UNIT II	**MULTILEVEL VOLTAGE SOURCE INVERTERS**	**9**	**0**	**0**	**9**
Introduction, NPC/H-Bridge Inverter, Inverter Topology and Modulation Scheme, Waveforms and Harmonic Content, Multilevel Flying-Capacitor Inverters, Inverter Configuration, Modulation Schemes					
UNIT III	**CASCADED MULTILEVEL INVERTERS**	**9**	**0**	**0**	**9**
H-Bridge Inverter, Bipolar Pulse-Width Modulation and Unipolar Pulse-Width Modulation, CHB Inverter with Equal DC Voltages, H-Bridges with Unequal DC Voltages, Carrier Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes					
UNIT IV	**MODULAR MULTILEVEL INVERTER**	**9**	**0**	**0**	**9**
Five level Modular Multilevel Inverter- Power circuit , operation and applications, DC Voltage balance control, Carrier Based PWM for Modular Multilevel Inverter					
UNIT V	**PWM TECHNIQUES**	**9**	**0**	**0**	**9**
Trapezoidal Modulation, Selective Harmonic Elimination, Space Vector Modulation-Switching States, Space Vectors, Dwell Time Calculation, Switching Sequence, Harmonic Content					
					Total (45L+0T)= 45 Periods

Text Books:

1.	Bin Wu, Mehdi Narimani, ‘High-Power Converters and AC Drives, 2nd Edition, Wiley-IEEE Press, 2017

Reference Books:

1.	N. Mohan, T. M. Undeland, et al., Power Electronics—Converters, Applications and Design, 3rd edition, John Wiley & Sons, New York, 2003

E-Reference

1	https://archive.nptel.ac.in/courses/108/102/108102157/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the configurations for multilevel voltage source inverters.	L1: Remembering
CO2	:	Describe the working principle of multilevel current source inverters	L2: Understanding
CO3	:	Draw the topology structure of different types of multilevel inverters	L3: Applying
CO4	:	Understand the principle of space vector modulation for multilevel inverters	L1: Remembering
CO5	:	Select an appropriate modulation scheme for multilevel inverters	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	2	2	2	2				1	2	2		2	2	2	2
CO2	1	3			2				2	2		1	1	3	
CO3	1	1		1	1	1	2						1	1	
CO4	1	1		1	1		2	2	1		2	2	1	1	
CO5	2	2	3	1	2	2	1			1	3		2	2	3
Avg	**1.4**	**1.8**	**2.5**	**1.25**	**1.5**	**1.5**	**1.67**	**1.5**	**1.67**	**1.67**	**2.5**	**1.67**	**1.4**	**1.8**	**2.5**

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

22EEH203	MODELING AND CONTROL OF POWER CONVERTERS		SEMESTER			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Electronics and Control Systems		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	To learn the basics of control system simulation.
2.	To do symbolic calculation and study the principles of sliding mode control and the way of apply smc for buck converter.
3.	To learn the concept of power factor correction.
4.	To design simulate smc for buck converter and power factor correction circuit with controller.

UNIT I	**SIMULATION BASICS IN CONTROL SYSTEMS**	**9**	**0**	**0**	**9**
Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space model.					
UNIT II	**SYMBOLIC CALCULATIONS**	**9**	**0**	**0**	**9**
Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions - Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations.					
UNIT III	**SLIDING MODE CONTROL BASICS**	**9**	**0**	**0**	**9**
Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory- Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.					
UNIT IV	**POWER FACTOR CORRECTION CIRCUITS**	**9**	**0**	**0**	**9**
Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.					
UNIT V	**CONTROLLER DESIGN FOR PFC CIRCUITS**	**9**	**0**	**0**	**9**
Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter - PFC circuits employing bridgeless topologies.					
Total (45L+0T) = 45 Periods					

Text Books:	
1.	Feedback Control problems using MATLAB and the Control system tool box By Dean Frederick and Joe Chow, 2000, 1st Edition, Cengage Learning.
2.	Ned Mohan,"Power Electronics: A First Course", Johnwiley, 2013, 1st Edition.
3.	Marian K. Kazimierczuk and AgasthyaAyachit,"Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters", Wiley 2016, 1st Edition.
4.	Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002, 1st Edition.
Reference Books:	
1.	Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1st Edition, CRC Press.
2.	Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3.	MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	To calculate transfer function for constant, differential, integral, First order and Second order factors.	L2: Understanding
CO2	:	To illustrate the effect of poles and zero's in the 's' plane.	L1: Remembering
CO3	:	To select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.	L5: Evaluating

CO4	:	To compute the control expression for DC – DC buck converter using sliding mode control theory	L3: Applying
CO5	:	To determine the controller expression for power factor correction circuits and to simulate sliding mode control of buck converter and power factor correction circuit.	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	3	3	3			1		2		3	3	3	3
CO2	3	3	3	3	3			1		2		3	3	3	3
CO3	3	3	3	3	3			1		2		3	3	3	3
CO4	3	3	3	3	3			1		2		3	3	3	3
CO5	3	3	3	3	3			1		2		3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**2**	**-**	**3**	**3**	**3**	**3**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEH204	DIGITAL CONTROLLER IN POWER ELECTRONICS APPLICATION				SEMESTER	
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Control systems, Power Electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand the concepts of discrete time systems.
2.	To analyze systems in z domain.
3.	To design the digital controllers

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction-Comparison between analog and digital control-Importance of digital control-Structure of digital control-Examples of digital control system-Difference equations-Z-transform-MATLAB examples. Frequency response of discrete time systems-Properties of frequency response of discrete time systems-Sampling theorem.					
UNIT II	**Z-PLANE ANALYSIS OF DISCRETE-TIME CONTROL SYSTEMS**	**9**	**0**	**0**	**9**
Impulse sampling and data hold -Pulse transfer function - Realization of digital controllers- Mapping between s-plane and zplane - Stability analysis of closed loop systems in z-plane–Transient and steady state analyses.					
UNIT III	**STATE SPACE APPROACH TO DISCRETE-TIME CONTROL SYSTEMS**	**9**	**0**	**0**	**9**
State space representation of continuous and digital control systems - Solution of continuous and discrete time state space equations -Pulse transfer function matrix - Discretization of continuous time state space equations.					
UNIT IV	**DIGITAL CONTROLLER DESIGN METHODS**	**9**	**0**	**0**	**9**
Cascade compensators using Root Locus- Design of PID controllers by using bilinear transformation- Digital controller design using bilinear transformation- Dead-beat response design- Deadbeat controller without and with prescribed manipulated variable-Choice of sample time for deadbeat controller-Realization of Digital controllers- Computer based simulation.					
UNIT V	**DIGITAL CONTROLLERS IN POWER ELECTRONICS APPLICATIONS**	**9**	**0**	**0**	**9**
Micro Controllers and Digital Signal Controllers for Converter Control Application, Interface Modules for Converter Control – A/D, Capture, Compare and PWM, Analog Comparators for instantaneous over current detection, interrupts, Discrete PI and PID equations, Algorithm for PI and PID implementation, Example Code for PWM generation.					
					Total (45L+0T)= 45 Periods

Text Books:

1.	M. Gopal, "Digital Control and State Variable Methods", McGraw Hill Education, 4th Edition, 2014.
2.	K.Ogata "Discrete- Time control systems", Pearson Education, India, 2nd Edition, 2015.
3.	B.C.Kuo, "Digital Control System", Oxford University Press; 2ndEdition, 2012.
4.	Karl J. Astrom& Tore Hagglun. "PID Controllers: Theory, Design and Tuning" International Society for Measurement and Control, 1995.

Reference Books:

1.	G.F.Franklin, J.David Powell and M.Workman, Digital Control of Dynamic Systems, 3rd ed., Addison Wesley, 2000.
2.	Constantine H. Houpis and Gary B. Lamont, Digital control systems: Theory, hardware, software, Mcgraw-Hill Book Company, 1985.
3.	M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.

E-Reference

1	https://nptel.ac.in/courses/108103008

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	To understand the digital control system	L2: Understanding
CO2	:	Capable of determining the stability in z domain	L1: Applying
CO3	:	To understand the state space analysis	L1: Remembering
CO4	:	To design the various types of digital controllers	L3: Analysing
CO5	:	To check the digital controllers in power electronics design	L5: Evaluating

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	1	1	1	1	1	1	1	1			1		1	1	1
CO2	1	3	3	3	2	1	2	1	1		1		1	1	1
CO3	1	2	2	3	2	1	2	1	1		1		1	1	1
CO4	1	3	2	3	2	1	2	1	1		1		1	1	1
CO5	1	2	3	3	2	1	2	1	1		1		1	1	1
Avg	**1**	**2.2**	**2.2**	**2.6**	**1.8**	**1**	**1.8**	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**1**

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

22EEH205	**PWM CONVERTERS AND APPLICATIONS**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Electronics.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To provide a strong foundation of fundamental concepts in basic operation of PWM converters like solid state drives and power quality.
2.	To enable the student to apply these techniques in applications including basic circuit operation and design
3.	To enable understand the steady-state and dynamic analysis of PWM converters applications

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Power conversion Overview of applications of voltage source converters and current source converters. DC to AC Converters: Classification of inverters, operation of each type, design of commutating circuits, Analysis of voltage and current waveforms, voltage and frequency control, current source inverter and pulse width modulated inverter .

UNIT II	**PWM TECHNIQUES**	**9**	**0**	**0**	**9**

Pulse width modulation techniques for bridge converters Bus clamping PWM. Space vector based PWM. Advanced PWM techniques. DC to DC Converters: Classification of choppers, operating principle and control circuits for each type. Analysis of voltage and current waveforms.

UNIT III	**PERFORMANCE ANALYSIS OF LINE CURRENT RIPPLE**	**9**	**0**	**0**	**9**

Analysis of line current ripple: Synchronously revolving reference frame; error between reference voltage and applied voltage; integral of voltage error; evaluation of line current ripple; hybrid PWM for reduced line current ripple. **Analysis of dc link current**: Relation between line-side currents and dc link current; dc link current and inverter state; rms dc current ripple over a carrier cycle; rms current rating of dc capacitors.

UNIT IV	**PERFORMANCE ANALYSIS OF TORQUE RIPPLE AND LOSS**	**9**	**0**	**0**	**9**

Analysis of torque ripple: Evaluation of harmonic torques and rms torque ripple, hybrid PWM for reduced torque ripple **Analysis for inverter's loss**: Simplifying assumptions in evaluation of inverter loss, dependence of inverter loss on line power factor, influence of PWM techniques on switching loss, design of PWM for low inverter loss.

UNIT V	**PWM FOR MULTILEVEL INVERTER AND APPLICATIONS**	**9**	**0**	**0**	**9**

PWM for multilevel inverter -Extensions of sine-triangle PWM to multilevel inverters, voltage space vectors, space vector based PWM, analysis of line current ripple and torque ripple . Applications Active power filtering, Reactive power compensation, Constant Volt Per hertz drives, PWM Rectifier etc.

Total (45L+0T)= 45 Periods

Test Books:

1.	D. G. Holmes, T. A. Lipo, 'Pulse Width Modulation For Power Converters: Principles and Practice', John Wiley and Sons., 2003.
2.	Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
3.	Ned Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John's Wiley and Sons.

Reference Books

1.	Euzeli Cipriano dos Santos Jr. and Edison Roberto Cabral Da Silva "Advanced Power Electronics Converters - PWM Converters Processing AC Voltages", Willey – IEEE Press, 2014.
2.	M.H.Rashid, "Power Electronics", Prentice Hall of India

E -References

1.	NPTEL Lecture series by Prof. G. Narayanan, Department of Electrical Engineering, IISC Bangalore on the web-course . http://www.digimat.in/nptel/courses/video/108108035/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the need of PWM	L1: Remembering
CO2	:	Compare the PWM techniques on different aspects	L2: Understanding
CO3	:	Analyze parameter current ripple for different PWM approaches.	L5: Analyzing
CO4	:	Analyze parameters like losses, torque ripple for different PWM approaches.	L4: Analyzing
CO5	:	Develop suitable Pulse Width Modulation method for power converter used for different applications	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	1	1			1	1	2	1		2	1	2
CO2	3	1	1	2	2			1	2	2	1		1	1	1
CO3	1	1	1	2	1			2	2	2	2		2	1	2
CO4	1	2	2	3	3			2	1	1	1		1	1	1
CO5	1	1	1	1	1			1	2	1	1		2	1	2
Avg	**1.6**	**1.4**	**1.4**	**1.8**	**1.6**	**-**	**-**	**1.4**	**1.6**	**1.6**	**1.2**	**-**	**1.6**	**1**	**1.6**

22EEH206	**GRID CONVERTERS FOR RENEWABLE ENERGY APPLICATIONS**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the inverter structures and grid integration methods for solar and wind energy systems.

UNIT I	**PHOTOVOLTAIC INVERTER STRUCTURES**	**9**	**0**	**0**	**9**
Power circuit, operation modes and Solar PV integration with H5 Inverter, HERIC Inverter, REFU Inverter, Neutral Point Clamped (NPC) Half-Bridge Inverter, Conergy NPC Inverter, Three-Phase PV Inverter, Control Structures					
UNIT II	**GRID SYNCHRONIZATION IN SINGLE-PHASE POWER CONVERTERS**	**9**	**0**	**0**	**9**
Grid Synchronization Techniques for Single-Phase Systems, Grid Synchronization Using the Fourier Analysis, Grid Synchronization Using a Phase-Locked Loop, PLLs Based on In-Quadrature Signal Generation, PLL Based on the Hilbert Transform , PLL Based on the Inverse Park Transform, PLLs Based on Adaptive Filtering					
UNIT III	**GRID CONVERTER STRUCTURES FOR WIND TURBINE SYSTEMS**	**9**	**0**	**0**	**9**
Wind Turbine System Power Configurations, Grid Power Converter Topologies: Single-Cell (Voltage Source Converter or Current Source Converter), Multicell (Interleaved or Cascaded), Wind Turbine System Control: Generator-Side Control, Wind Turbine System Control Grid Control					
UNIT IV	**GRID SYNCHRONIZATION IN THREE-PHASE POWER CONVERTERS**	**9**	**0**	**0**	**9**
Synchronous Reference Frame PLL under Unbalanced and Distorted Grid Conditions, Decoupled Double Synchronous Reference Frame PLL (DDSRF-PLL): Double Synchronous Reference Frame, Decoupling Network and Analysis of the DDSRF, Double Second-Order Generalized Integrator FLL (DSOGI-FLL), Structure of the DSOGI, Relationship between the DSOGI and the DDSRF					
UNIT V	**GRID CONVERTER CONTROL FOR WIND TURBINE SYSTEMS**	**9**	**0**	**0**	**9**
Voltage Oriented Control and Direct Power Control: Synchronous Frame VOC: PQ Open-Loop Control, Synchronous Frame VOC: PQ Closed-Loop Control, Stationary Frame VOC: PQ Open-Loop Control, Stationary Frame VOC: PQ Closed-Loop Control, Virtual-Flux-Based Control, Direct Power Control, Stand-alone, Micro-grid, Droop Control and Grid Supporting: Grid-Connected/Stand-Alone Operation without Load Sharing, Micro-Grid Operation with Controlled Storage, Droop Control					
					Total (45L+0T)= 45 Periods

Text Books:

1.	Remus Teodorescu, Marco Liserre, Pedro Rodríguez, ‘Grid Converters for Photovoltaic and Wind Power Systems, Wiley-IEEE Press, 2017

Reference Books:

1.	Chetan Singh Solanki, " Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011.

E-Reference

1	https://onlinecourses.nptel.ac.in/noc22_ee71

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the configurations for inverter structures for solar photovoltaic system	L1: Remembering
CO2	:	Use grid synchronization technique for single phase converters	L3: Applying
CO3	:	Draw the topology structure of three phase converter for wind energy conversion system	L3: Applying
CO4	:	Understand the principle of grid converter control for wind energy conversion system	L1: Remembering
CO5	:	Select an grid synchronization scheme for three phase converters	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	2	2	3	2	2			1		2		2	2	1	3
CO2	1	3		2	2					2		1	1	2	
CO3	1	1	2			1	2		1				1	1	2
CO4	1	1	1				2	2	1		2	2	1	1	1
CO5	1	2	1	1	1	2	1			1	3		2	2	1
Avg	**1.2**	**1.8**	**1.75**	**1.67**	**1.67**	**1.5**	**1.67**	**1.5**	**1**	**1.67**	**2.5**	**1.67**	**1.4**	**1.4**	**1.75**

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

22EEH207	**MODERN ELECTRICAL DRIVES**			**SEMESTER**			
PREREQUISITES			**CATEGORY**	**PE**	**Credit**		**3**
Electrical Drives and control.			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**
Course Objectives:							
1.	To know about the overview of Electrical drives.						
2.	To know about the Vector control strategies for DC motor drives.						
3.	To understand the concepts of various DSP based control.						
UNIT I	**DC MOTOR DRIVES:**			**9**	**0**	**0**	**9**
Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives Closed loop control of separately excited dc motor drive. Supply harmonics and ripple in motor current chopper controlled DC motor drives.							
UNIT II	**INDUCTION MOTOR DRIVES**			**9**	**0**	**0**	**9**
Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC)							
UNIT III	**SYNCHRONOUS MOTOR DRIVES**			**9**	**0**	**0**	**9**
Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.							
UNIT IV	**PERMANENT MAGNET MOTOR AND SWITCHED RELUCTANCE MOTOR DRIVES**			**9**	**0**	**0**	**9**
Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives. Various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.							
UNIT V	**DSP BASED MOTION CONTROL**			**9**	**0**	**0**	**9**
Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.							
							Total (45L+0T)= 45 Periods

Text Books:	
1.	B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, Asia, 2003.
2.	P. C. Krause, O. Wasynczuk and S. D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley & Sons, 2013.
Reference Books:	
1.	H. A. Taliyat and S. G. Campbell, “ DSP based Electromechanical Motion Control” , CRC press, 2003
2.	R. Krishnan, “Permanent Magnet Synchronous and Brushless DC motor Drives”, CRC Press, 2009.
3.	https://nptel.ac.in/courses/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Apply Power converters for DC drives.	L1: Remembering
CO2	:	Understand the basics of Permanent magnet motor and Switched reluctance motor drives.	L2: Understanding
CO3	:	Learn the concepts of Synchronous motor drives.	L5: Evaluating
CO4	:	Gain knowledge of Induction motor drives.	L4: Analyzing
CO5	:	Explain DSP based motion control.	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	2	2	1	1	1			1	1	1	1	1
CO2	3	3	3	3	3	1	1	1			1	1	3	3	3
CO3	1	3	3	3	3	1	1	1					1	3	1
CO4	1	3	3	3	3	1	1	1				1	1	3	1
CO5	3	3	3	3	3	1	1	1			1	1	3	3	3
Avg	**1.8**	**2.6**	**3**	**2.8**	**2.8**	**1**	**1**	**1**	**-**	**-**	**1**	**1**	**1.8**	**2.6**	**1.8**

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

PROGRAMME ELECTIVE COURSE VERTICALS FOR HONOURS DEGREE

VERTICAL III :ELECTRIC VEHICLE TECHNOLOGY

22EEH301	**ELECTRIC VEHICLE ARCHITECTURE**	**SEMESTER**			
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Electric Drives, Energy management, Electric Vehicles	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:	
1.	To provide knowledge about electric vehicle architecture and power train components.
2.	To know the concepts of dynamics of electrical vehicles
3.	To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)
4.	To understand the concept of energy storage systems
5.	To provide knowledge about different energy sources and energy management in HEVs.

UNIT I	**HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS**	**9**	**0**	**0**	**9**
History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.					
UNIT II	**MECHANICS OF HYBRID ELECTRIC VEHICLES**	**9**	**0**	**0**	**9**
Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity.					
UNIT III	**CONTROL OF DC AND AC MOTOR DRIVES**	**9**	**0**	**0**	**9**
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives					
UNIT IV	**ENERGY STORAGE SYSTEMS**	**9**	**0**	**0**	**9**
Battery: Principle of operation, types, models, estimation of parameters, battery modeling, SOC of battery, Traction Batteries and their capacity for standard drive cycles, Vehicle to Grid operation of EV's. Alternate sources: Fuel cells, Ultra capacitors, Fly wheels.					
UNIT V	**HEV CONTROL STRATEGY AND ENERGY MANAGEMENT**	**9**	**0**	**0**	**9**
HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - serie parallel mode - energy management of HEV's.					
					Total (45L+0T)= 45 Periods

Text Books:	
1.	Iqbal Husain, ‘Electric and Hybrid Electric Vehicles’, CRC Press, 2011.
2.	Wei Liu, ‘Hybrid Electric Vehicle System Modeling and Control’, Second Edition, WILEY, 2017.
Reference Books:	
1.	James Larminie and John Lowry, ‘Electric Vehicle Technology Explained’, Second Edition, 2012.
2.	Goodarzi, Gordon A., Hayes, John G, Electric power train: energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles, Wiley 2018
3.	De Doncker, Rik, Pulle, Duco W.J., Veltman, Andre, Advanced Electrical Drives, First Edition, CRC Press, Taylor and Francis Group, 2011.
4.	MehradadEshani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory and Design, Second Edition, CRC Press, Taylor and Francis Group, 2010.
	RiK De Doncker, Advanced Electric Drives – Analysis , Modeling ,Control, Springer publications
E-Reference	
1	https://nptel.ac.in/courses/108/106/108106170/

2	https://nptel.ac.in/courses/108/102/108102121/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Learn the electric vehicle architecture and power train components.	L1: Remembering
CO2	:	Acquired the concepts of dynamics of electrical vehicles	L2: Understanding
CO3	:	Apply the vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs).	L3: Applying
CO4	:	Ability to design and select energy storage systems.	L6: Creating
CO5	:	Evaluate different energy sources and energy management in HEVs.	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	2	2	2	2	2	2	2	1	1	1	1	2	1	1
CO2	2	2	2	2	2	2	2	2	1	1	1	1	2	1	1
CO3	2	2	2	2	2	2	2	2	1	1	1	1	2	1	1
CO4	2	2	2	2	2	2	2	2	1	1	1	1	2	1	1
CO5	2	2	2	2	2	2	2	2	1	1	1	1	2	1	1
Avg	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**

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

22EEH302	**DESIGN OF MOTORS AND POWER CONVERTERS FOR ELECTRIC VEHICLE**	**SEMESTER**			
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Power Electronics, Special Electrical Machines	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1.	To study the characteristics of motors used Electric Vehicle
2.	To understand the design of dc drives used in Electric Vehicle
3.	To analyse the ac drives used in Electric Vehicle
4.	To understand the role of converters used in Electric Vehicle

UNIT I	**EV MOTORS CHARACTERISTICS**	**9**	**0**	**0**	**9**
Requirement of EV motors, Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Comparison of EV motors, Basics of DC Motor, Torque speed characteristics, DC Motor dynamics, Field Weakening Control, Four quadrant operation					
UNIT II	**DESIGN OF DC DRIVES**	**9**	**0**	**0**	**9**
Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits.					
UNIT III	**INVERTER FED AC DRIVES**	**9**	**0**	**0**	**9**
Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations., Problems and strategies.					
UNIT IV	**PERMANENT MAGNET AC MOTORS AND CONTROL**	**9**	**0**	**0**	**9**
BLDC dynamic modelling, torque equations, BLDC control methods, machine sizing, current, voltage and speed limits, extending constant power speed range, current control methods- Application of hall current sensor in PM AC motors.					
UNIT V	**PWM AND INVERTER**	**9**	**0**	**0**	**9**
Sinusoidal PWM, Injection of third order harmonics, Space Vector Modulation, Dead time & compensation Encoders, Resolvers, R/D Converters.					
					Total (45L+0T)= 45 Periods

Text Books:

1.	B.K. Bose, "Power Electronics and Motor Drives", Elsevier 2015.

Reference Books:

1.	H. Buyse and I.J. Robert, "Electrical machines and converters: Modeling and simulation", North Holland, digitized 2007.
2.	R. Krishnan, " Electric Motor Drives Modeling Analysis and Control", Prentice -Hall of India2001.
3.	P.S. Bhimra," Generalized Theory of Electrical Machines", Khanna Publisher.

E-Reference

1	https://nptel.ac.in/courses/108104140

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Describe the characteristics of the motors use in EV.	L1: Remembering
CO2	:	Analyze dynamics of DC motor and different controllers used in their control	L4: Analysing
CO3	:	Explain the speed control and PWM techniques used in the control of ac motor	L2: Understanding
CO4	:	Analyze the operation and control of permanent magnet ac motors.	L4: Analyzing
CO5	:	Analyze sensors used for control of 3-phase ac motors.	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	3	1	1		1	1			1		2	2	1
CO2	2	2	1	1	1								1	1	2
CO3	1	2	3	2	2		1	1				1	1	2	1
CO4	2	2	3	2	3	2						1	3	2	1
CO5	1	3	2	1	3	1	1	1			1	1	3	2	1
Avg	**1.6**	**2.2**	**2.4**	**1.4**	**2**	**1.5**	**1**	**1**	**-**	**-**	**1**	**1**	**2**	**1.8**	**1.2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEH303	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL		SEMESTER			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Electronics and Electrical Machines		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To learn the basics of EV and vehicle mechanics
2.	To know the EV architecture and to study the energy storage system concepts
3.	To derive model for batteries and to know the different types of batteries and its charging methods
4.	To learn the control preliminaries for DC-DC converters.

UNIT I	**INTERNAL COMBUSTION ENGINES**	**9**	**0**	**0**	**9**
IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions, Comparison of Internal Combustion Engine and Electric Vehicle, Review of light-, medium-, and heavy-duty all-electric vehicles.					
UNIT II	**ELECTRIC VEHICLES AND VEHICLE MECHANICS**	**9**	**0**	**0**	**9**
Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.					
UNIT III	**BATTERY MODELING, TYPES AND CHARGING**	**9**	**0**	**0**	**9**
Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.					
UNIT IV	**CONTROL PRELIMINARIES**	**9**	**0**	**0**	**9**
Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.					
UNIT V	**CONTROL OF AC MACHINES**	**9**	**0**	**0**	**9**
Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.					
					Total (45L+0T) = 45 Periods

Reference Books:

1.	Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2.	Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, TeuvoSuntio, TuomasMesso, Joonas Puukko, 1st Edition, Wiley - VCH.
3.	Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
4.	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
5.	Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley & Sons, 2017, 2nd Edition.
6.	Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall,1997, 1st Edition.
7.	Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, Atif Iqbal, Shaikh Moinoddin, BhimireddyPrathap Reddy, Wiley, 2021, 1st Edition

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	To describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles	L2: Understanding
CO2	:	To find gain margin & phase margin for various types of transfer functions of boost converter	L5: Evaluating
CO3	:	To demonstrate the Control of A.C Machines	L3: Applying
CO4	:	To explain the concepts related with batteries and parameters of battery	L4: Analyzing
CO5	:	To module the battery and to study the research and development for batteries	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**	**PS O1**	**PS O2**	**PS O3**
CO1	3								1	2		2	3		3
CO2	3								1	2		2	3		3
CO3	3						3		1	2		2	3		3
CO4	3						3		1	2		2	3		3
CO5	3						3		1	2		2	3	2	3
Avg	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**1**	**2**	**-**	**2**	**3**	**2**	**3**

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

22EEH304	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM				SEMESTER			
PREREQUISITES			**CATEGORY**		**PE**	**Credit**		**3**
Electric vehicle			**Hours/Week**		**L**	**T**	**P**	**TH**
					3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the fundamentals of charging architectures, converter topologies and control schemes for electric vehicle charging system

UNIT I	**CHARGING ARCHITECTURES FOR ELECTRIC VEHICLES**	**9**	**0**	**0**	**9**
Classification of EV charging architectures, Onboard Chargers, Level 1: Dedicated Converter (Slow Charging), Level 2: Integrated Converter (Semi-fast Charging), Off-Board Chargers, Level 3: Dedicated Off-Board DC Chargers (Fast Charging), Common AC Bus Architecture, Common DC Bus Architecture					
UNIT II	**CONVERTER TOPOLOGIES FOR CHARGING STATION**	**9**	**0**	**0**	**9**
Vienna Rectifier, Multipulse Rectifier with DC Active Power Filter, Non-isolated Multichannel Interleaved Buck Converter, Phase-Shifted ZVS Full-Bridge Converter, Grid-connected cascaded H-bridge converter, Grid-connected Modular Multilevel Converter based integrated charger for split integrated battery pack, Neutral-Point Clamped Converter					
UNIT III	**CONTROL SCHEMES AND CHARGING STANDARDS**	**9**	**0**	**0**	**9**
Control Schemes for Charging Converters, Single-Phase AC–DC Converter Control, Three-Phase AC–DC Converter Control, voltage-oriented control (VOC) and direct power control (DPC), Electric Vehicle / Plug in Hybrid Electric Vehicle charging Standards					
UNIT IV	**BATTERY TECHNOLOGIES FOR TRANSPORTATION APPLICATIONS**	**9**	**0**	**0**	**9**
Nickel-Cadmium (Ni-Cd) Battery, Nickel-Metal Hydride (Ni-MH), Lithium-Ion (Li-Ion), Flow Batteries, Battery Charging Methods, Battery management system					
UNIT V	**LATEST DEVELOPMENTS IN EV CHARGING**	**9**	**0**	**0**	**9**
Inductive Charging, Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H), EV charging safety configuration and considerations, Grid-Tied Residential charging Systems, Grid-Tied Public charging Systems, EV cable communication protocols, Charging cable standards					
					Total (45L+0T)= 45 Periods

Text Books:

1.	SulabhSachan, P. Sanjeevikumar, Sanchari Deb, Smart Charging Solutions for Hybrid and Electric Vehicles, Wiley-Scrivener Publishing LLC, 2022

Reference Books:

1.	Mary Murphy " Electric and Hybrid Vehicles: Principles, Design and Technology ", Larsen and Keller Education, 2019

E-Reference

1	https://archive.nptel.ac.in/courses/108/103/108103009/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the configurations for chargers for electric vehicle	L1: Remembering
CO2	:	Select a converter topology for electric vehicle charging station	L3: Applying
CO3	:	Use an appropriate control scheme for charging converter	L3: Applying
CO4	:	Understand the principle of batteries used for EV charging station	L1: Remembering
CO5	:	Explain the latest developments in Electric vehicle charging technologies	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	1	1	2	2		2		1		2		2	2	2	2
CO2	2	1			1					2		1	1	3	
CO3	2	1	1	2	1	1	2		1				1	1	1
CO4	1	1		1		2	2	2	1		2	2	1	1	
CO5	2	2	3	1		3	1			1	3		2	2	3
Avg	**1.6**	**1.2**	**2**	**1.5**	**1**	**2**	**1.67**	**1.5**	**1**	**1.67**	**2.5**	**1.67**	**1.4**	**1.8**	**2**

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

22EEH305	**TESTING OF ELECTRIC VEHICLES**	**SEMESTER**			
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Electrical Machines and Power Electronics	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1. To know various standardization procedures
2. To learn the testing procedures for EV & HEV components
3. To know the functional safety and EMC
4. To realize the effect of EMC in EVs
5. To study the effect of EMI in motor drives and in DC-DC converter system

UNIT I	**EV STANDARDIZATION**	**9**	**0**	**0**	**9**
Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.					
UNIT II	**TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES**	**9**	**0**	**0**	**9**
Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.					
UNIT III	**FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC**	**9**	**0**	**0**	**9**
Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management - Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.					
UNIT IV	**EMC IN ELECTRIC VEHICLES**	**9**	**0**	**0**	**9**
Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements.					
UNIT V	**EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM**	**9**	**0**	**0**	**9**
Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path					
Total (45L+0T) = 45 Periods					

Reference Books:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.
3. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.
4. EMI/EMC Computational Modeling Handbook, DruceArchambeault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.
5. Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.
6. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	To describe the status and other details of standardization of EVs	L1: Remembering
CO2	:	To illustrate the testing protocols for EVs and HEV components	L2: Understanding
CO3	:	To analyze the safety cycle and need for functions safety for EV	L4: Analyzing
CO4	:	To analyze the problems related with EMC for EV components.	L4: Analyzing
CO5	:	To evaluate the EMI in motor drive and DC-DC converter 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**	**PSO 3**
CO1	3	1	1				2						3		2
CO2	3	1	1				1						3		2
CO3	3	1	1				2						3		2
CO4	3	1	1				1						3		2
CO5	3	1	1				2						3		3
Avg	**3**	**1**	**1**	**-**	**-**	**-**	**1.6**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**2.2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEH306</td><td colspan="2">INTELLIGENT CONTROL OF ELECTRIC VEHICLES</td><td colspan="4">SEMESTER</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">Power Electronics and Electric Vehicle</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 design and drive the mathematical model of a BLDC motor and its characteristics</td></tr>
<tr><td>2.</td><td colspan="6">To learn the different control schemes for BLDC motor</td></tr>
<tr><td>3.</td><td colspan="6">To study the basics of fuzzy logic</td></tr>
<tr><td>4.</td><td colspan="6">To study the FPGA & VHDL basics</td></tr>
<tr><td>5.</td><td colspan="6">To implement fuzzy logic control of BLDC motor in real time</td></tr>
<tr><td>UNIT I</td><td colspan="2">MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients</td></tr>
<tr><td>UNIT II</td><td colspan="2">SPEED CONTROL FOR ELECTRIC DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor</td></tr>
<tr><td>UNIT III</td><td colspan="2">FUZZY LOGIC</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Membership functions: features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making</td></tr>
<tr><td>UNIT IV</td><td colspan="2">FPGA AND VHDL BASICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection</td></tr>
<tr><td>UNIT V</td><td colspan="2">REAL TIME IMPLEMENTATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T) = 45 Periods</td></tr>
</table>

Reference Books:	
1.	Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.
2.	VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.
3.	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1st Edition.
4.	Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.
5.	M.N. Cirstea, A.Dinu, J.G.Khor,M.McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
6.	Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition
7.	Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi • Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1st Edition. 2018.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	To design the mathematical model of a BLDC motor and to discuss about its characteristics	L2: Understanding
CO2	:	To demonstrate the PID control, anti-windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.	L5: Evaluating
CO3	:	To illustrate the basics of fuzzy logic system	L1: Remembering
CO4	:	To describe the basics of VHDL & FPGA applied to control of EVs.	L2: Understanding
CO5	:	To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time	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**	**PS O1**	**PS O2**	**PS O3**
CO1	3								1	2		2	3		3
CO2	3								1	2		2	3		3
CO3	3						3		1	2		2	3		3
CO4	3						3		1	2		2	3		3
CO5	3						3		1	2		2	3	2	3
Avg	**3**	**-_**	**-**	**-**	**-**	**-**	**3**	**-**	**1**	**2**	**-**	**2**	**3**	**2**	**3**

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

<table>
<tr><td>22EEH307</td><td colspan="6">HYBRID ELECTRIC VEHICLES</td><td colspan="4">SEMESTER</td></tr>
<tr><td colspan="6">PREREQUISITES</td><td>CATEGORY</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="6" rowspan="2">Electric Drives, Electric Vehicles</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="11">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="10">This course introduces the fundamental concepts, principles and analysis of hybrid and electric vehicles.</td></tr>
<tr><td>UNIT I</td><td colspan="6">HISTORY OF HYBRID ELECTRIC VEHICLES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance, Capabilities, Automation system computer facilities.</td></tr>
<tr><td>UNIT II</td><td colspan="6">HYBRID ELECTRIC VEHICLES - INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">Micro hybrid vehicles, mild hybrid vehicles, full hybrid vehicles, Parallel Hybrid vehicles, series Hybrid Vehicles, Series-Parallel Hybrid vehicles, plug-in hybrid vehicles, power flow diagrams for various operating modes. Plug-in Hybrid Vehicles: Operating principle, architectures: series-parallel-series-parallel, challenges related to grid connection. Range-extended Electric Vehicles: Classification and configurations, Fuel Cell Electric Vehicles, Solar electric Vehicles, Electric Bi-cycles and their propulsion systems, Vehicle-to- grid, vehicle- to-home concepts, Concept of Hybrid Electric Vehicles.</td></tr>
<tr><td>UNIT III</td><td colspan="6">ELECTRIC PROPULSION UNIT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">Electric components used in electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, Drive system efficiency.</td></tr>
<tr><td>UNIT IV</td><td colspan="6">ELECTRIC DRIVE-TRAINS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis</td></tr>
<tr><td>UNIT V</td><td colspan="6">EV MODELLING AND SIMULATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">Modelling of BEV-Forward looking Model-Driver Perspective, Backward Looking Model-Drive Cycle Perspective, Modelling of Driver, Modelling of Brake Control Unit, Modelling of Vehicle Control Strategy, Modelling of Vehicle Chassis
Sizing of Components- Steady State Energy Balance Equation, Powertrain Dimensioning-Peak vs Continuous performance, Type of Drive cycles, Types of Control Strategy, Analysis-Performance, Range, Consumption Prediction</td></tr>
<tr><td colspan="11">Total (45L+0T)= 45 Periods</td></tr>
</table>

Text Books:	
1.	Goodarzi, Gordon A., Hayes, John G, Electric powertrain: energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles, Wiley 2018
2.	Wei Liu, Introduction of Hybrid Vehicle system Modelling and Control, Wiley student edition 2013.
3.	MehradadEshani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory and Design, Second Edition, CRC Press, Taylor and Francis Group, 2010.
4.	James Larminie John Lowry, Electric Vehicle Technology Explained, Second Edition, Wiley, 2012.
5.	Ali Emadi, Mehrdad Ehsani, John M. Miller, ‘Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles’, CRC Press, 2003.
6.	Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press, 2003, 2ndEdition.
Reference Books:	
1.	RiK De Doncker, Advanced Electric Drives – Analysis ,Modeling ,Control, Springer publications
2.	De Doncker, Rik, Pulle, Duco W.J., Veltman, Andre, Advanced Electrical Drives, First Edition, CRC Press, Taylor and Francis Group, 2011.
3.	Ned Mohan, Power Electronics Convertor, Applications, and Design, Third Edition, Wiley, 2002.
4.	Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, Second Edition, CRC Press, Taylor and Francis Group, 2011.
5.	Sandeep Dhameja, ’Electric Vehicle Battery Systems’, Newnes, 2002.
6.	Chris Mi, M. Abul Masrur, David Wenzhong Gao, ’Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives’, Wiley, 2011.
E-Reference	

1	https://nptel.ac.in/courses/108/106/108106170/
2	https://nptel.ac.in/courses/108/102/108102121/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Plan the selection of electrical machines for hybrid and electric vehicles.	L3: Applying
CO2	:	Analyze the drive-train topologies and advanced propulsion techniques	L4: Analyzing
CO3	:	Understand the concepts of electric vehicles, hybrid electric vehicles and their impact on environment	L2: Understanding
CO4	:	Evaluate modelling and simulation of EV	L5: Evaluating
CO5	:	Demonstrate the power system of various vehicular system.	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**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
CO2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
CO3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
CO4	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
CO5	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
Avg	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

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

22EEH308	**BATTERY MANAGEMENT SYSTEMS**		**SEMESTER**			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Basics of Electrical Engineering, Electric Circuit theory, Chemistry and Physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Objectives:						
To understand different techniques of digital relaying - their constructions, working principles, applications and limitations along with introduction to Wide Area Measurement System and network protection.						
UNIT I	**INTRODUCTION**		**9**	**0**	**0**	**9**
Introduction to Battery Management System(BMS), Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging						
UNIT II	**BATTERY-MANAGEMENT-SYSTEM REQUIREMENTS.**		**9**	**0**	**0**	**9**
Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation.						
UNIT III	**BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION**		**9**	**0**	**0**	**9**
Preliminary definitions. - Battery state of charge estimation (SOC)- voltage-based methods to estimate SOC , Model-based state estimation - Battery State of Health Estimation (SOH) - Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode						
UNIT IV	**MODELLING AND SIMULATION.**		**9**	**0**	**0**	**9**
Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs.						
UNIT V	**DESIGN OF BMS**		**9**	**0**	**0**	**9**
Design of battery BMS: Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system						
Total (45L) = 45 Periods						

Text Books:	
1.	Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2.	Plett, G., Battery Management Systems: Volume II, Equivalent-Circuit Methods, Artech House, 2015
3	Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
Reference Books:	
1.	Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
2.	Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the role of battery management system	L1: Remembering
CO2	:	Identify the requirements of Battery Management System w.r.t application	L2: Understanding
CO3	:	Analyze the concept associated with battery charging / discharging process	L4: Analysing
CO4	:	Assess the various parameters of battery and battery pack	L3: Applying
CO5	:	Design the battery pack model.	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	2	2	2	1					1	2	2	1
CO2	1	2	2	2	2	2	1					1	2	2	1
CO3	2	3	3	3	3	2	1					1	3	2	1
CO4	3	3	3	3	3	2	1					1	3	2	1
CO5	2	2	3	3	3	3	1					1	3	2	1
Avg	**2**	**2.4**	**2.6**	**2.6**	**2.6**	**2.2**	**1**	**-**	**-**	**-**	**-**	**1**	**2.4**	**1.9**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

<table>
<tr><td>22EEH309</td><td colspan="2">ADVANCED ELECTRIC DRIVES FOR ELECTRIC VEHICLE</td><td colspan="4">SEMESTER</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">Solid state drives</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 introduce the electrical machines with control module for electric vehicle propulsion.</td></tr>
<tr><td>UNIT I</td><td colspan="2">PERMANENT MAGNET BRUSHLESS MOTOR DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">PM Brushless Machines : Structure and Principle of PM Brushless Machines, Inverters for PM Brushless, Switching Schemes for Brushless AC Operation, PM Brushless Motor Control, Application of PM Brushless Motor Drives in Electric vehicle</td></tr>
<tr><td>UNIT II</td><td colspan="2">SWITCHED RELUCTANCE MOTOR DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">System Configurations, Switched Reluctance Machine: Structure and Principle of operation, Switched Reluctance Motor Converter Topologies, Soft-Switching Switched Reluctance Motor Converter Topologies, Switched Reluctance Motor Control, Torque-Ripple Minimization Control, Switched Reluctance Motor Drives for Electric Vehicle, Application Examples of Switched Reluctance Motor Drives in Electric Vehicles</td></tr>
<tr><td>UNIT III</td><td colspan="2">MAGNETLESS MOTOR DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Synchronous Reluctance Motor Drives, Doubly-Salient DC Motor Drives, Flux-Switching DC Motor Drive, Axial-Flux Magnetless Motor Drives, Design Criteria of Advanced Magnetless Motor Drives for EVs, Design Examples of Advanced Magnetless Motor Drives for EVs, Potential Applications of Advanced Magnetless Motor Drives in EVs</td></tr>
<tr><td>UNIT IV</td><td colspan="2">VERNIER PERMANENT MAGNET MOTOR DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">System Configurations and Vernier Permanent Magnet Machines, Structure and Principle of Vernier Permanent Magnet Machines, Inverters for Vernier Permanent Magnet Motors, Vernier Permanent Magnet Motor Control, Design Examples of Vernier PM Motor Drives for EVs, Outer-Rotor Vernier PM Motor Drive, Outer-Rotor Flux-Controllable Vernier PM Motor Drive, Potential Applications of Vernier PM Motor Drives in EVs</td></tr>
<tr><td>UNIT V</td><td colspan="2">DOUBLE-ROTOR ELECTRIC VARIABLE TRANSMISSION SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Double-Rotor Machines, Double-Rotor Electric Variable Transmission System (DR EVT) Structure and operation, Advance Double-Rotor EVT Systems, PM DR EVT System, SR DR EVT System, Axial-Flux DR EVT System, Potential Applications o DR EVT Systems in HEVs</td></tr>
<tr><td colspan="7">Total (45L+0T)= 45 Periods</td></tr>
</table>

Text Books:	
1.	K. T. Chau, ‘Electric Vehicle Machines and Drives: Design, Analysis and Application, Wiley-IEEE Press, 2015
Reference Books:	
1.	Mary Murphy " Electric and Hybrid Vehicles: Principles, Design and Technology ", Larsen and Keller Education, 2019
E-Reference	
1	https://archive.nptel.ac.in/courses/108/103/108103009/

<table>
<tr><td colspan="3">Course Outcomes:
Upon completion of this course, the students will be able to:</td><td>Bloom’s Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>:</td><td>Explain the use for Permanent magnet Brushless motor drive for electric vehicle</td><td>L1: Remembering</td></tr>
<tr><td>CO2</td><td>:</td><td>Select converter topology for Switched Reluctance Motor used for electric vehicle</td><td>L3: Applying</td></tr>
<tr><td>CO3</td><td>:</td><td>Describe the operation of Magnetless Motor Drives in Electric Vehicles</td><td>L2: Understanding</td></tr>
<tr><td>CO4</td><td>:</td><td>Understand the principle of Vernier Permanent Magnet Machines</td><td>L1: Remembering</td></tr>
<tr><td>CO5</td><td>:</td><td>Select a suitable electric drive for electric vehicle</td><td>L4: Analyzing</td></tr>
</table>

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	2	2	3		3		1		2		2	2	1	2
CO2		3			1					2		1	1	2	
CO3	2	1		2	1		1		1				1	1	1
CO4	1	1		1		2	1	2	1		2	2	1	1	1
CO5	1	2	3	1		3				1	3	1	2	2	1
Avg	**1.75**	**1.8**	**2.5**	**1.75**	**1**	**2.67**	**1**	**1.5**	**1**	**1.67**	**2.5**	**1.5**	**1.4**	**1.4**	**1.25**

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)**															

<table>
<tr><td>22CEM02</td><td colspan="2">BUILDING CONSTRUCTION & EQUIPMENT</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>OE</td><td colspan="2">Credit</td><td>3</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>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">Able to gain basic knowledge in construction methods.</td></tr>
<tr><td>2</td><td colspan="6">Able to gain basic knowledge in equipment.</td></tr>
<tr><td>3</td><td colspan="6">Able to gain basic knowledge in machineries.</td></tr>
<tr><td>4</td><td colspan="6">Able to gain basic knowledge in fire safety principles.</td></tr>
<tr><td>5</td><td colspan="6">Able to gain basic knowledge in green technology.</td></tr>
<tr><td>Unit I</td><td colspan="2">CLASSIFICATION OF BUILDINGS, FOUNDATIONS AND TYPES OF MASONRY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>Unit II</td><td colspan="2">DOORS, WINDOWS, LINTELS, SCAFFOLDING AND STAIRCASES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>Unit III</td><td colspan="2">ROOFS, FLOORINGS, PROTECTIVE AND DECORATIVE FINISHES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit IV</td><td colspan="2">CONSTRUCTION EQUIPMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Selection of equipment for earthwork excavation, drilling, blasting, tunnelling, erection and dewatering and pumping, concreting, material handling and erection of structures</td></tr>
<tr><td>Unit V</td><td colspan="2">GREEN BUILDING TECHNOLOGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction to green technology – types and importance; zero waste and r concept, green materials – green concrete (purpose and limitations), green buildings, green engineering.</td></tr>
<tr><td colspan="7">Total= 45 Periods</td></tr>
</table>

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)**															

<table>
<tr><td>22CEM03</td><td colspan="6">CONCRETE TECHNOLOGY</td><td colspan="2">Semester</td><td></td></tr>
<tr><td colspan="5">PREREQUISITES</td><td>Category</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="5" 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="10">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="9">To understand the properties of ingredients of concrete.</td></tr>
<tr><td>2</td><td colspan="9">To study the behavior of concrete at its fresh and hardened state.</td></tr>
<tr><td>3</td><td colspan="9">To study about the concrete design mix.</td></tr>
<tr><td>4</td><td colspan="9">To know about the procedures in concrete at different stage.</td></tr>
<tr><td>5</td><td colspan="9">To understand special concrete and their uses.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="4">INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">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.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="4">ADMIXTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Accelerating admixtures, Retarding admixtures, water reducing admixtures, Air entraining admixtures, coloring agent, Plasticizers. Batching, Mixing, Transportation, placing of concrete, curing of Concrete</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="4">MIX DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Factors influencing mix proportion, Mix design by ACI method and I.S. code method, Design of high strength concrete.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="4">BEHAVIOUR OF CONCRETE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">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.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="4">SPECIAL CONCRETE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">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.</td></tr>
<tr><td colspan="10" align="right">Total= 45 Periods</td></tr>
</table>

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

<table>
<tr><td>22CSM05</td><td colspan="4">DATA COMMUNICATION AND COMPUTER NETWORKS</td><td colspan="2">Semester</td><td></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"></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 concepts of data communications and functions of different ISO/OSI reference architecture</td></tr>
<tr><td>2</td><td colspan="7">To understand the error detection and correction methods and also the types of LAN</td></tr>
<tr><td>3</td><td colspan="7">To study the concepts of subnetting and routing mechanisms</td></tr>
<tr><td>4</td><td colspan="7">To understand the different types of protocols and congestion control</td></tr>
<tr><td>5</td><td colspan="7">To study the application protocols and network security</td></tr>
<tr><td>UNIT I</td><td colspan="3">DATA COMMUNICATIONS AND PHYSICAL LAYER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>UNIT II</td><td colspan="3">DATA LINK LAYER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>UNIT III</td><td colspan="3">NETWORK LAYER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Network Layer services-Packet Switching-Network Layer Performance-IPv4 addresses-IPv6 addressing- Subnetting-Bridges-Gateways- Routers-Routing Algorithm-Distance Vector Routing, Link State Routing.</td></tr>
<tr><td>UNIT IV</td><td colspan="3">TRANSPORT LAYER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>UNIT V</td><td colspan="3">PRESENTATION LAYER AND APPLICATION LAYER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Domain Name System - Domain Name Space, DNS in the Internet; Electronic Mail-FTP- HTTP- World Wide Web.</td></tr>
<tr><td colspan="8">Total (45 L) =45 Periods</td></tr>
</table>

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="2">PREREQUISITES</td><td colspan="2">Category</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" 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="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To introduce the broad perceptive of Parallel Computing, Distributed Computing and Cloud Computing.</td></tr>
<tr><td>2</td><td colspan="7">To understand the concept of Virtualization</td></tr>
<tr><td>3</td><td colspan="7">To identify the approaches of SLA and programming model in Cloud</td></tr>
<tr><td>4</td><td colspan="7">To understand the Cloud Platforms in Industry and Software Environments.</td></tr>
<tr><td>5</td><td colspan="7">To learn to design the trusted Cloud Computing system</td></tr>
<tr><td>UNIT I</td><td colspan="3">INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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="3">VIRTUALIZATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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="3">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="8">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="3">CLOUD INDUSTRIAL PLATFORMS AND SOFTWARE ENVIRONMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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="3">CLOUD SECURITY AND APPLICATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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="8">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 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 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 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 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 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	PSO1	PSO2	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

<table>
<tr><td>22ECM06</td><td colspan="4">ANALOG AND DIGITAL COMMUNICATION</td><td colspan="4"></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"></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">Understand analog and digital communication techniques.</td></tr>
<tr><td>2.</td><td colspan="7">Learn data and pulse communication techniques.</td></tr>
<tr><td>3.</td><td colspan="7">Be familiarized with source and Error control coding.</td></tr>
<tr><td>Unit I</td><td colspan="3">INFORMATION THEORY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Uncertainty, information and entropy – Source coding theorem – Shannon Fano coding – Huffman coding – Discrete memoryless channels – Mutual information – Channel capacity – Channel coding theorem.</td></tr>
<tr><td>Unit II</td><td colspan="3">ANALOG COMMUNICATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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).</td></tr>
<tr><td>Unit III</td><td colspan="3">DIGITAL COMMUNICATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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).</td></tr>
<tr><td>Unit IV</td><td colspan="3">PULSE COMMUNICATION AND MULTIPLE ACCESS TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit V</td><td colspan="3">ERROR CONTROL CODING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Linear block codes - Cyclic codes - Convolution codes – Maximum likelihood decoding of convolutional codes – Sequential decoding of convolutional codes – Trellis codes – Applications.</td></tr>
<tr><td colspan="8">Total (45L)= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2014.</td></tr>
<tr><td>2.</td><td>J.G.Proakis, M.Salehi, ―Fundamentals of Communication Systems‖, Pearson Education 2014.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>B.P.Lathi, ―Modern Digital and Analog Communication Systems‖, 4th Edition, Oxford University Press,</td></tr>
<tr><td>2.</td><td>D.Roody, J.Coolen, ―Electronic Communications, 4th edition PHI 2015.</td></tr>
<tr><td>3.</td><td>B.Sklar, ―Digital Communications Fundamentals and Applications‖, 5th Edition Pearson Education 2017</td></tr>
<tr><td>4.</td><td>H P Hsu, Schaum Outline Series - ―Analog and Digital Communications‖ TMH, 5th edition 2006</td></tr>
<tr><td colspan="2">E-References:</td></tr>
<tr><td>1.</td><td>https://onlinecourses.nptel.ac.in/noc21_ee74/preview</td></tr>
<tr><td>2.</td><td>https://nptel.ac.in/courses/117101051</td></tr>
<tr><td>3.</td><td>https://www.digimat.in/nptel/courses/video/117105143/L51.html</td></tr>
</table>

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	PO10	PO11	PO12	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)

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)															

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)

<table>
<tr><td>22EEM06</td><td colspan="2">ELECTRICAL DRIVES AND CONTROL</td><td colspan="3">SEMESTER</td><td></td></tr>
<tr><td colspan="2">PREREQUISTIES</td><td>CATEGORY</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">DC Machines and Transformers, Synchronous and Induction Machines, and Power Electronics</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 know about the operation analyse of chopper fed DC drive, both qualitatively and quantitatively.</td></tr>
<tr><td>2.</td><td colspan="6">To understand the operation and performance of AC motor drives.</td></tr>
<tr><td>UNIT I</td><td colspan="2">DC MOTOR CHARACTERISTICS & CHOPPER FED DC DRIVES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT II</td><td colspan="2">MULTI-QUADRANT & CLOSED-LOOP CONTROL OF DC DRIVE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT III</td><td colspan="2">INDUCTION MOTOR CHARACTERISTICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT IV</td><td colspan="2">CONTROL OF SLIP RING INDUCTION MOTOR</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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. .</td></tr>
<tr><td>UNIT V</td><td colspan="2">CONTROL OF SRM AND BLDC MOTOR DRIVES.</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T)= 45 Periods</td></tr>
</table>

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="2">ELECTRICAL ENERGY CONSERVATION AND AUDITING</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">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="7">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="6">To get knowledge about basics of energy and energy scenario of India.</td></tr>
<tr><td>2.</td><td colspan="6">To familiarise the energy conservation methods.</td></tr>
<tr><td>3.</td><td colspan="6">To acquire knowledge on energy auditing, energy efficiency and modern energy efficient devices.</td></tr>
<tr><td>UNIT I</td><td colspan="2">ENERGY SCENARIO</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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>UNIT II</td><td colspan="2">BASICS OF ENERGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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>UNIT III</td><td colspan="2">ENERGY MANAGEMENT AND AUDIT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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>UNIT IV</td><td colspan="2">ENERGY EFFICIENCY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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>UNIT V</td><td colspan="2">ENERGY EFFICIENT TECHNOLOGIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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="7" align="right">Total (45 L+ 0 T) = 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1.</td><td>Sonal Desai, “Handbook of Energy Audit”, McGraw Hill, 2015.</td></tr>
<tr><td>2,</td><td>Tripathy, S. C, “Utilization of Electrical Energy and Conservation”, McGraw Hill, 1991.</td></tr>
<tr><td>3.</td><td>Hossam A Gabbar, “Energy Conservation in Infrastructure Systems”, Wiley-IEEE Press, New Jersey, 2018</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1.</td><td>General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency, New Delhi, 2015.</td></tr>
<tr><td>2,</td><td>Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency, New Delhi, 2015.</td></tr>
</table>

<table>
<tr><td colspan="2">Course Outcomes:
Upon completion of this course, the students will be able to:</td><td>Bloom’s Taxonomy Mapped</td></tr>
<tr><td>CO1</td><td>Identify the present energy scenario and future energy strategy.</td><td>L1: Understanding</td></tr>
<tr><td>CO2</td><td>Recognize the various forms of energy.</td><td>L1: Understanding</td></tr>
<tr><td>CO3</td><td>Interpret energy management methods and energy auditing.</td><td>L3: Applying</td></tr>
<tr><td>CO4</td><td>Familiar in energy efficiency of electrical systems.</td><td>L4: Analysing</td></tr>
<tr><td>CO5</td><td>Familiar with the advanced energy efficient technologies.</td><td>L4: Analysing</td></tr>
</table>

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.

		L	T	P	TH
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.

		L	T	P	TH
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.

		L	T	P	TH
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.

		L	T	P	TH
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.

		L	T	P	TH
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)															

<table>
<tr><td>22MEM01</td><td colspan="6">ENGINEERING THERMODYNAMICS
<i>(Use of standard thermodynamic tables, Mollier diagram are permitted)</i></td><td colspan="4"></td></tr>
<tr><td colspan="6">PRE-REQUISITE:</td><td>CATEGORY</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="6" 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="11">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="10">To impart the knowledge on concepts of zeroth and first law of thermodynamics.</td></tr>
<tr><td>2.</td><td colspan="10">To make the learners to understand the third law of thermodynamics and analyze the various work and heat interactions in closed and open systems.</td></tr>
<tr><td>3.</td><td colspan="10">To teach properties of pure substance.</td></tr>
<tr><td>4.</td><td colspan="10">To impart knowledge on the concepts of steam power cycle.</td></tr>
<tr><td>5.</td><td colspan="10">To derive thermodynamic relations for ideal and real gases.</td></tr>
<tr><td>UNIT I</td><td colspan="6">BASIC CONCEPT AND FIRST LAW</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">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.</td></tr>
<tr><td>UNIT II</td><td colspan="6">SECOND LAW AND ENTROPY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">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.</td></tr>
<tr><td>UNIT III</td><td colspan="6">PROPERTIES OF PURE SUBSTANCES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">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.</td></tr>
<tr><td>UNIT IV</td><td colspan="6">STEAM POWER CYCLE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">Basic Rankine cycle, T-s & h-s diagrams - Performance Improvement - Reheat cycle, regenerative cycle and their combination cycles.</td></tr>
<tr><td>UNIT V</td><td colspan="6">IDEAL AND REAL GASES AND THERMO DYNAMIC RELATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="11">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.</td></tr>
<tr><td colspan="11" align="right">Total (45L)= 45 Periods</td></tr>
</table>

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)

22MEM02	**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)

22MEM03	**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)

22MEM04	**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)															

22MEM05	**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)

22MEM06	**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)

22MEM07	**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)

22MEM08	**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)															

22MEM09	**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)															

22MEM10	**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)

22MTM01	**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$_3$C phase diagram and discuss various properties of steel and cast iron.	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			
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)

22MTM02	**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)

<table>
<tr><td>22MTM03</td><td colspan="2">MECHANICAL BEHAVIOUR OF MATERIALS</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 know the fundamental concepts of deformation behaviour for structural engineering applications.</td></tr>
<tr><td>Unit I</td><td colspan="2">DISLOCATIONS AND PLASTIC DEFORMATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit II</td><td colspan="2">STRENGTHENING MECHANISMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit III</td><td colspan="2">FRACTURE AND FRACTURE MECHANICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit IV</td><td colspan="2">FATIGUE BEHAVIOUR AND TESTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit V</td><td colspan="2">CREEP BEHAVIOUR AND TESTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td colspan="7" align="right">Total (45+0) = 45 Hours</td></tr>
</table>

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)																

<table>
<tr><td colspan="2">22MTM04</td><td colspan="2">RATE PROCESSES IN METALLURGY</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td></td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" 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="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">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.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="2">INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">KINETICS OF SOLID-FLUID REACTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">LIQUID-SOLID PHASE TRANSFORMATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Principles of Solidification in metals and alloys: thermodynamics involved, eutectic and peritectic Solidification, Homogeneous and heterogeneous nucleation, Mechanisms of growth. Rapid Solidification Processing.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">SOLID STATE PHASE TRANSFORMATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Nucleation and growth Kinetics, homogeneous and heterogeneous transformation, Precipitation: Coherency, age hardening, particle Coarsening. Ostwald ripening, Order-disorder transformation, spinodal decomposition, massive transformations</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="2">SOLID STATE PHASE TRANSFORMATIONS IN STEEL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8" align="right">Total (45+0) = 45 Hours</td></tr>
</table>

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)																

<table>
<tr><td>22MTM05</td><td colspan="2">CORROSION AND SURFACE ENGINEERING</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 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>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 understand the corrosion and surface engineering, with its application in engineering field.</td></tr>
<tr><td>Unit I</td><td colspan="2">MECHANISMS AND TYPES OF CORROSION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>Unit II</td><td colspan="2">TESTING AND PREVENTION OF CORROSION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit III</td><td colspan="2">CORROSION OF INDUSTRIAL COMPONENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit IV</td><td colspan="2">SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit V</td><td colspan="2">THIN LAYER ENGINEERING PROCESSES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7" align="right">Total (45+0) = 45 Hours</td></tr>
</table>

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)																

22MTM06	**MATERIALS CHARACTERIZATION**		**Semester**			
PREREQUISITES			**OE**	**Credit**		**3**
Engineering physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
Course Learning Objectives						
1	To acquire knowledge on various characterizations, chemical and thermal analysis of metallurgical components using its analysis tools.					
Unit I	**OPTICAL MICROSCOPY**		**9**	**0**	**0**	**9**
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.						
Unit II	**X-RAY DIFFRACTION**		**9**	**0**	**0**	**9**
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.						
Unit III	**ELECTRON MICROSCOPY**		**9**	**0**	**0**	**9**
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.						
Unit IV	**SPECTROSCOPIC TECHNIQUES**		**9**	**0**	**0**	**9**
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.						
Unit V	**THERMAL ANALYSIS AND ADVANCED CHARACTERIZATION TECHNIQUES**		**9**	**0**	**0**	**9**
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.						
Total (45+0) = 45 Hours						

Text Books:	
1.	Cullity, B.D., Elements of X Ray Diffraction, Addison-Wesley Publishing Company Inc, Philippines, 1978
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)																

22MTM07	**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)