CURRICULUM

GOVERNMENT COLLEGE OF ENGINEERING, SALEM – 636 011.

B.E – CIVIL ENGINEERING (FULL TIME)

SEMESTER I

S. No.	Course Code	Course Title	Cat.	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	FE	Total
1	22MC101	Induction Program	MC	-	-	-	0	-	-	-
THEORY										
2	22MA101	Matrices, Calculus and Ordinary Differential Equations	BS	3	1	0	4	40	60	100
3	22PH101	Engineering Physics	BS	3	1	0	4	40	60	100
4	22CY101	Engineering Chemistry	BS	3	1	0	4	40	60	100
5	22EE101	Basic Electrical and Electronics Engineering	ES	3	1	0	4	40	60	100
6	22ME101	Engineering Graphics and Design	ES	1	0	4	3	40	60	100
7	22MC102	Heritage of Tamils /தமிழர் மரபு	HS MC	1	0	0	1	100	-	100
PRACTICAL										
8	22EN102	Professional Skills Laboratory	HS	0	0	2	1	60	40	100
9	22PH103	Physics Laboratory	BS	0	0	3	1.5	60	40	100
10	22CY102	Chemistry Laboratory	BS	0	0	3	1.5	60	40	100
11	22EE102	Basic Electrical and Electronics Engineering Laboratory	ES	0	0	3	1.5	60	40	100
TOTAL							**25.5**			**1000**

SEMESTER II

S. No.	Course Code	Course Title	Cat.	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22EN101	Communicative English (Theory Cum Practical)	HS	2	0	2	3	50	50	100
2	22MA201	Partial Differential Equations, Vector Calculus and Complex Variables	BS	3	1	0	4	40	60	100
3	22CY201	Environmental Science and Engineering	BS	3	0	0	3	40	60	100
4	22CS101	Problem Solving and C Programming	ES	3	0	0	3	40	60	100
5	22CE101	Engineering Mechanics	ES	2	1	0	3	40	60	100
6	22HS201	Universal Human Values	HS	2	1	0	3	40	60	100
7	22MCIN01	Engineering Sprints	EE	0	0	2	1	100	-	100
8	22MC201	Tamils and Technology/ தமிழரும் தொழில்நுட்பமும்	HS MC	1	0	0	1	100	-	100
9	22NC201	NCC COURSE – I (only for NCC Students)	NC	3	0	0	3*	40	60	100
PRACTICAL										
10	22CS102	Computer Practice and C Programming Laboratory	ES	0	0	3	1.5	60	40	100
11	22ME102	Workshop Manufacturing Practices	ES	0	0	4	2	60	40	100
TOTAL							**24.5**			**1100**

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

SEMESTER III										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22MA301	Transforms and Numerical Methods	BS	3	1	0	4	40	60	100
2	22CE301	Mechanics of Fluids	PC	3	0	0	3	40	60	100
3	22CE302	Surveying	PC	3	0	0	3	40	60	100
4	22CE303	Construction Materials and Technology	PC	3	0	0	3	40	60	100
5	22ES301	Mechanics of Solids	ES	3	0	0	3	40	60	100
6	22EN301	Technical English	HS	2	0	2	3	50	50	100
7	22MCIN02	Innovation Sprints	EE	0	0	2	1	100	-	100
PRACTICAL										
8	22CE304	Advanced Surveying and Basic GIS Practical	PC	0	0	4	2	60	40	100
9	22CE305	Material Testing and Evaluation Laboratory	PC	0	0	4	2	60	40	100
10	22NC301	NCC Course – II (Only for NCC Students)	NC	3	0	0	3*	40	60	100
TOTAL							**24**			**1000**

SEMESTER IV										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22CE401	Strength of Materials	PC	3	1	0	4	40	60	100
2	22CE402	Steel Structural Elements	PC	3	1	0	4	40	60	100
3	22CE403	Mechanics of Soils	PC	3	0	0	3	40	60	100
4	22CE404	Water Supply Engineering	PC	3	0	0	3	40	60	100
5	22CE405	Applied Hydraulics and Fluid Machinery	PC	3	0	0	3	40	60	100
6	22CE406	Concrete Technology	PC	3	0	0	3	40	60	100
7	22MCIN03	Design Sprints	EE	0	0	2	1	100	-	100
8	22MC401	Disaster Preparedness and Planning	MC	2	-	-	0	100	-	100
PRACTICAL										
9	22CE407	Computer Aided Building Drawing	PC	0	0	3	1.5	60	40	100
10	22CE408	Applied Hydraulics and Machinery Laboratory	PC	0	0	3	1.5	60	40	100
TOTAL							**24**			**1000**

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

SEMESTER V										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22CE501	Basic Structural Analysis	PC	3	1	0	4	40	60	100
2	22CE502	Foundation Engineering	PC	3	0	0	3	40	60	100
3	22CE503	Water Resources Engineering	PC	3	0	0	3	40	60	100
4	22CE504	Design of Reinforced Concrete Elements	PC	3	1	0	4	40	60	100
5	22CE505	Waste Water Engineering	PC	3	0	0	3	40	60	100
6	22CE506	Transportation Engineering	PC	3	0	0	3	40	60	100
7	22MCIN04	Ideation Sprints	EE	0	0	2	1	100	-	100
8	22MC301	Indian Constitution	MC	2	0	0	0	100	-	100
PRACTICAL										
9	22CE507	Geotechnical Engineering Laboratory	PC	0	0	3	1.5	60	40	100
10	22CE508	Environmental Quality Measurement Laboratory	PC	0	0	3	1.5	60	40	100
TOTAL							**24**	460	440	**1000**

SEMESTER VI (Regular Stream)										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**FE**	**Total**
THEORY										
1	22CEPExx	Professional Elective - I	PE	3	0	0	3	40	60	100
2	22CEPExx	Professional Elective - II	PE	3	0	0	3	40	60	100
3	22CEPExx	Professional Elective - III	PE	3	0	0	3	40	60	100
4	22__OExx	Open Elective - I	OE	3	0	0	3	40	60	100
5	22__OExx	Open Elective - II	OE	3	0	0	3	40	60	100
6	22__OExx	Open Elective - III	OE	3	0	0	3	40	60	100
PRACTICAL										
7	22CE601	Mini Project	EE	0	0	6	3	60	40	100
TOTAL							**21**			**700**

SEMESTER VI (Protosem Stream)										
S. No.	Course Code	Course Title	Cat.	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22PSPE01	Computational Hardware	PE	3	0	0	3	100	-	100
2	22PSPE02	Coding for Innovators	PE	3	0	0	3	100	-	100
3	22PSPE03	Industrial Automation	PE	3	0	0	3	100	-	100
4	22PSOE01	Applied Design Thinking	OE	3	0	0	3	100	-	100
5	22PSOE02	Startup Fundamentals	OE	3	0	0	3	100	-	100
6	22PSOE03	Prototype Development	OE	3	0	0	3	100	-	100
PRACTICAL										
7	22PSEE01	Robotics	EE	0	0	6	3	100	-	100
TOTAL							**21**			**700**

SEMESTER VII										
S. No	Course Code	Course Title	Cat.	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22CE701	Advanced Structural Analysis	PC	3	0	0	3	40	60	100
2	22CE702	Human Values, Professional Practices, Ethics and Building by-laws	HS	3	0	0	3	40	60	100
3	22CE703	Estimation, Costing and Valuation	PC	3	0	0	3	40	60	100
4	22CEPExx	Professional Elective - IV	PE	3	0	0	3	40	60	100
5	22CEPExx	Professional Elective - V	PE	3	0	0	3	40	60	100
PRACTICAL										
6	22CE704	Concrete Technology Laboratory	PC	0	0	3	1.5	60	40	100
7	22CE705	Computer Aided Design and Drawing (Concrete & Steel)	PC	0	0	3	1.5	60	40	100
TOTAL							**18**			**700**

SEMESTER VIII										
S. No	Course Code	Course Title	Cat.	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	FE	Total
THEORY										
1	22CEPExx	Professional Elective -VI	PE	3	0	0	3	40	60	100
PRACTICAL										
2	22CE802	Project Work	EE	0	0	14	7	120	80	200
TOTAL							**10**			**300**

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Course Title	Cat	Hours/Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
COURSES OFFERED FOR THE VI SEMESTER										
1	22CEPE01	Building Information Modelling	PE	3	0	0	3	40	60	100
2	22CEPE02	Advanced Steel Structures	PE	3	0	0	3	40	60	100
3	22CEPE03	Dynamics and Earthquake Resistant Design of Structures	PE	3	0	0	3	40	60	100
4	22CEPE04	Air Pollution Control Engineering	PE	3	0	0	3	40	60	100
5	22CEPE05	Solid Waste Management	PE	3	0	0	3	40	60	100
6	22CEPE06	Subsurface Investigation and Instrumentation	PE	3	0	0	3	40	60	100
7	22CEPE07	Airports, Docks and Harbours Engineering	PE	3	0	0	3	40	60	100
8	22CEPE08	Highrise Buildings	PE	3	0	0	3	40	60	100
9	22CEPE09	Coastal Structures	PE	3	0	0	3	40	60	100
10	22CEPE10	Watershed Management	PE	3	0	0	3	40	60	100
11	22CEPE11	Rock Mechanics and Applications	PE	3	0	0	3	40	60	100
COURSES OFFERED FOR THE VII SEMESTER										
12	22CEPE12	Prestressed Concrete Structures	PE	3	0	0	3	40	60	100
13	22CEPE13	Advanced Concrete Design	PE	3	0	0	3	40	60	100
14	22CEPE14	Hazardous Waste Management	PE	3	0	0	3	40	60	100
15	22CEPE15	Irrigation Engineering	PE	3	0	0	3	40	60	100
16	22CEPE16	Hydrology	PE	3	0	0	3	40	60	100
17	22CEPE17	Advanced Surveying Techniques	PE	3	0	0	3	40	60	100
18	22CEPE18	Traffic Engineering and Management	PE	3	0	0	3	40	60	100
19	22CEPE19	Soil Structure Interaction	PE	3	0	0	3	40	60	100
20	22CEPE20	River Engineering	PE	3	0	0	3	40	60	100
21	22CEPE21	Design of Composite Structures	PE	3	0	0	3	40	60	100
COURSES OFFERED FOR THE VIII SEMESTER										
22	22CEPE22	Storage Structures	PE	3	0	0	3	40	60	100
23	22CEPE23	Sustainable and Green Building Technology	PE	3	0	0	3	40	60	100
24	22CEPE24	Formwork for Concrete Structures	PE	3	0	0	3	40	60	100
25	22CEPE25	Marine pollution Monitoring and Control	PE	3	0	0	3	40	60	100

26	22CEPE26	Open Channel Flow	PE	3	0	0	3	40	60	100
27	22CEPE27	Ground Improvement Techniques	PE	3	0	0	3	40	60	100
28	22CEPE28	Railway Engineering	PE	3	0	0	3	40	60	100
29	22CEPE29	Urban Planning & Development	PE	3	0	0	3	40	60	100
30	22CEPE30	Ferrocement Technology	PE	3	0	0	3	40	60	100
31	22CEPE31	Earth Retaining Structures	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVE COURSES

S.No.	Course Code	Course	Cat	Hours/Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
COURSES OFFERED BY THE DEPARTMENT OF MATHEMATICS										
1	22MAOE01	Sampling Theory and Numerical 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 THE DEPARTMENT OF CIVIL ENGINEERING										
4	22CEOE01	Environmental Management	OE	3	0	0	3	40	60	100
5	22CEOE02	Disaster Mitigation and Management	OE	3	0	0	3	40	60	100
6	22CEOE03	Repair and Rehabilitation of Building Elements	OE	3	0	0	3	40	60	100
7	22CEOE04	Mechanics of Deformable bodies	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
8	22CSOE01	Object Oriented Programming Concepts	OE	3	0	0	3	40	60	100
9	22CSOE02	Operating Systems Principles	OE	3	0	0	3	40	60	100
10	22CSOE03	Computer Communications and Networks	OE	3	0	0	3	40	60	100
11	22CSOE04	Python Programming	OE	3	0	0	3	40	60	100
12	22CSOE05	Introduction to Programming in Java	OE	3	0	0	3	40	60	100
13	22CSOE06	Computer Organization	OE	3	0	0	3	40	60	100
14	22CSOE07	Data Structures using C++	OE	3	0	0	3	40	60	100
15	22CSOE08	Cloud Computing Fundamentals	OE	3	0	0	3	40	60	100
16	22CSOE09	Artificial Intelligence and Machine Learning	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING										
17	22ECOE01	Fundamentals of Electron Devices	OE	3	0	0	3	40	60	100
18	22ECOE02	Principles of Modern Communication Systems	OE	3	0	0	3	40	60	100
19	22ECOE03	Microcontrollers and its applications	OE	3	0	0	3	40	60	100

20	22ECOE04	Computer Networks	OE	3	0	0	3	40	60	100
21	22ECOE05	Basics of Embedded Systems	OE	3	0	0	3	40	60	100
22	22ECOE06	Basics of Internet of Things	OE	3	0	0	3	40	60	100
23	22ECOE07	Basics of Artificial Intelligence	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
24	22EEOE01	Renewable Energy Sources	OE	3	0	0	3	40	60	100
25	22EEOE02	Industrial Drives	OE	3	0	0	3	40	60	100
26	22EEOE03	Energy Conservation and Management	OE	3	0	0	3	40	60	100
27	22EEOE04	Electric Vehicles	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF MECHANICAL ENGINEERING										
28	22MEOE01	Design of Machine Elements and Machining	OE	3	0	0	3	40	60	100
29	22MEOE02	Industrial Engineering	OE	3	0	0	3	40	60	100
30	22MEOE03	Industrial Robotics	OE	3	0	0	3	40	60	100
31	22MEOE04	Power plant Engineering	OE	3	0	0	3	40	60	100
32	22MEOE05	Principles of Management	OE	3	0	0	3	40	60	100
33	22MEOE06	Professional Ethics in Engineering	OE	3	0	0	3	40	60	100
34	22MEOE07	Renewable Sources of Energy	OE	3	0	0	3	40	60	100
35	22MEOE08	Robotic Process Automation	OE	3	0	0	3	40	60	100
36	22MEOE09	Total Quality Management	OE	3	0	0	3	40	60	100
COURSES OFFERED BY THE DEPARTMENT OF METALLURGICAL ENGINEERING										
37	22MTOE01	Foundry and Welding Technology	OE	3	0	0	3	40	60	100
38	22MTOE02	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

B.E – HONOURS

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 fthe same vertical or a combination of different verticals of the same programme of study only.

PROFESSIONAL ELECTIVE COURSES - VERTICALS FOR HONOURS

VERTICAL I		**VERTICAL II**		**VERTICAL III**	
Structural Engineering		**Environmental Engineering**		**Construction Engineering and Management**	
22CEH101	Bridge Engineering	22CEH201	Industrial Wastewater Treatment	22CEH301	Smart Materials and Smart Structures
22CEH102	Repair & Rehabilitation of Structures	22CEH202	Environmental Impact and Risk Assessment	22CEH302	Construction Techniques and Equipment
22CEH103	Industrial Structures	22CEH203	Environmental Management & Sustainable development	22CEH303	Project Safety Management
22CEH104	Prefabricated Structures	22CEH204	Environmental Legislations in India	22CEH304	Sustainable and Green Building Technology
22CEH105	Finite Elements Analysis	22CEH205	Environmental Microbiology	22CEH305	Functional Planning in Building Services
22CEH106	Experimental Techniques and Instrumentation	22CEH206	Waste Management Techniques	22CEH306	Building Valuation
22CEH107	Advanced Concrete Technology	22CEH207	Unit Operations and Processes in Water and Wastewater Treatment	22CEH307	Quality Control and Assurance in Construction

LIST OF PROFESSIONAL ELECTIVE COURSES- HONOURS

S. No.	Course Code	Course	Cat	Hours/Week			Credits	Maximum Marks		
				L	T	P		CA	FE	Total
VERTICAL –I (STRUCTURAL ENGINEERING)										
1	22CEH101	Bridge Engineering	PE	3	0	0	3	40	60	100
2	22CEH102	Repair & Rehabilitation of Structures	PE	3	0	0	3	40	60	100
3	22CEH103	Industrial Structures	PE	3	0	0	3	40	60	100
4	22CEH104	Prefabricated Structures	PE	3	0	0	3	40	60	100
5	22CEH105	Finite Elements Analysis	PE	3	0	0	3	40	60	100
6	22CEH106	Experimental Techniques and Instrumentation	PE	3	0	0	3	40	60	100
7	22CEH107	Advanced Concrete Technology	PE	3	0	0	3	40	60	100
VERTICALS – II (ENVRIONMENTAL ENGINEERING)										
1	22CEH201	Industrial Wastewater Treatment	PE	3	0	0	3	40	60	100
2	22CEH202	Environmental Impact and Risk Assessment	PE	3	0	0	3	40	60	100
3	22CEH203	Environmental Management & Sustainable development	PE	3	0	0	3	40	60	100
4	22CEH204	Environmental Legislations in India	PE	3	0	0	3	40	60	100
5	22CEH205	Environmental Microbiology	PE	3	0	0	3	40	60	100
6	22CEH206	Waste Management Techniques	PE	3	0	0	3	40	60	100
7	22CEH207	Unit Operations and Processes in Water and Wastewater Treatment	PE	3	0	0	3	40	60	100
VERTICAL – III (CONSTRUCTION ENGINEERING AND MANAGEMENT)										
1	22CEH301	Smart Materials and Smart Structures	PE	3	0	0	3	40	60	100
2	22CEH302	Construction Techniques and Equipment	PE	3	0	0	3	40	60	100
3	22CEH303	Project Safety Management	PE	3	0	0	3	40	60	100
4	22CEH304	Sustainable and Green Building Technology	PE	3	0	0	3	40	60	100
5	22CEH305	Functional Planning in Building Services	PE	3	0	0	3	40	60	100
6	22CEH306	Building Valuation	PE	3	0	0	3	40	60	100
7	22CEH307	Quality Control and Assurance in Construction	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 Thermodynamics and kinetics in Metallurgy
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 Processes in Metallurgy
22CEM05 Basics of Transportation Engineering	22CSM05 Data Communication and Computer Networks	22 ECM05 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 Materials Characteriztion
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 ELECTIVES - MINOR DEGREE

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	Microprocessor and Microcontroller	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	Electrical Drives and Control	OE	3	0	0	3	40	60	100
7	22EEM07	Electric Vehicles and Control	OE	3	0	0	3	40	60	100
8	22EEM08	Electrical Energy Conservation and Auditing	OE	3	0	0	3	40	60	100
9	22EEM09	SMPS and UPS	OE	3	0	0	3	40	60	100
10	22EEM10	Utilization of Electrical Energy	OE	3	0	0	3	40	60	100
MECHANICAL ENGINEERING										
1	22MEM01	Engineering Thermodynamics	OE	3	0	0	3	40	60	100
2	22MEM02	Fluid Mechanics and Machinery	OE	3	0	0	3	40	60	100
3	22MEM03	Manufacturing Processes	OE	3	0	0	3	40	60	100
4	22MEM04	Materials Engineering	OE	3	0	0	3	40	60	100
5	22MEM05	Kinematics of Machinery	OE	3	0	0	3	40	60	100
6	22MEM06	Hydraulics and Pneumatics	OE	3	0	0	3	40	60	100
7	22MEM07	Design of Machine Elements	OE	3	0	0	3	40	60	100
8	22MEM08	Heat and Mass Transfer	OE	3	0	0	3	40	60	100
9	22MEM09	Metrology and Quality Control	OE	3	0	0	3	40	60	100
10.	22MEM10	Dynamics of Machinery	OE	3	0	0	3	40	60	100
METALLURGICAL ENGINEEING										

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

SUMMARY

Course Component	Credits Per Semester								Total Credit
	I	II	III	IV	V	VI	VII	VIII	
Humanities and Social Sciences (HS / HSMC)	**2**	**7**	**3**				**3**		**15**
Engineering Sciences (ES)	**8.5**	**9.5**	**3**						**21**
Basic Sciences (BS)	**15**	**7**	**4**						**26**
Professional Core (PC)			**13**	**23**	**23**		**9**		**68**
Professional Elective (PE)						**9**	**6**	**3**	**18**
Open Electives (OE)						**9**			**09**
Empl. Enhancement Courses (EE)		**1**	**1**	**1**	**1**	**3**		**7**	**14**
Mandatory Course (ZeroCredit) (MC)	✓			✓	✓				**--**
Total	**25.5**	**24.5**	**24**	**24**	**24**	**21**	**18**	**10**	**171**

Course Component	TOTAL CREDITS as per		
	AICTE Model Curriculum	ANNA UNIVERSITY, Chennai	GCE-SALEM
Humanities and Social Sciences (HS / HSMC)	**06**	**12**	**15**
Engineering Sciences (ES)	**20**	**19**	**21**
Basic Sciences (BS)	**24**	**25**	**26**
Professional Core (PC)	**62**	**65**	**68**
Professional Elective (PE)	**26**	**18**	**18**
Open Electives (OE)	**12**	**12**	**09**
Empl. Enhancement Courses (EE)	**16**	**15**	**14**
Mandatory Course (ZeroCredit) (MC)	**02**	**--**	**--**
Total	**168**	**166**	**171**

SYLLABUS

PROFESSIONAL CORE COURSES

CIVIL ENGINEERING - FULL TIME

REGULATION 2022 – SYLLABUS

SEMESTER-I

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

INDUCTION PROGRAM (MANDATORY) - 3 WEEKS DURATION

LIST OF EXPERIMENTS

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

Total = 21 Days

22MA101	**MATRICES, CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS** **B.E. (Common to all Branches Except EEE)**			**Semester**				**I**
PREREQUISITES			**Category**	**BS**	**Credit**			**4**
Basic 12th level Matrices, Differential Calculus, Integral Calculus and ODE			**Hours/Week**	**L**	**T**		**P**	**TH**
				3	**1**		**0**	**4**

Course Learning Objectives

1	To know the use of matrix algebra needed by engineers for practical applications.
2	To understand effectively both the limit definition and rules of differentiation.
3	To familiarize in solving maxima and minima problems in two variables.
4	To obtain the knowledge of multiple integration and their related applications.
5	To obtain the knowledge to solve second order differential equations with constant and variable coefficients.

Unit I	**MATRICES**	**9**	**3**	**0**	**12**

System of linear equations – Characteristic equation of a Matrix – Eigenvalues and Eigenvectors – Properties – Cayley-Hamilton theorem (excluding proof) – Diagonalization of Matrices - Reduction of quadratic form to canonical form by orthogonal transformation.

Unit II	**DIFFERENTIAL CALCULUS**	**9**	**3**	**0**	**12**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules -Maxima and Minima of the function of a single variable.

Unit III	**FUNCTIONS OF SEVERAL VARIABLES**	**9**	**3**	**0**	**12**

Partial derivatives – Euler's theorem for homogeneous functions – Total Derivatives –Jacobians – Maxima, Minima and Saddle point – Method of Lagrangian multipliers – Taylor's series.

Unit IV	**MULTIPLE INTEGRALS**	**9**	**3**	**0**	**12**

Multiple integrals- Double integrals – Change of order of integration in double integrals – Change of variables (Cartesian to Polar) – Application to Areas – Evaluation of Triple integrals – Application to volumes.

Unit V	**ORDINARY DIFFERENTIAL EQUATIONS**	**9**	**3**	**0**	**12**

Second order linear differential equations with constant and variable coefficients –Cauchy-Euler equation and Cauchy-Legendre's linear equation - Method of variation of parameters –Simultaneous first order linear equations with constant coefficients.

Total (45+15) = 60 Periods

Text Books:

1	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2015.
2	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 3rd Edition, Narosa Publications, New Delhi, 2007.

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

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

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

<table>
<tr><td>22PH101</td><td colspan="2">ENGINEERING PHYSICS</td><td colspan="3">Semester</td><td>I</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>BS</td><td colspan="2">Credit</td><td>4</td></tr>
<tr><td colspan="2" rowspan="2">Basic knowledge in sound, light and heat</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To understand Principles of ultrasonic production, its applications and acoustics of buildings</td></tr>
<tr><td>2</td><td colspan="6">To understand Principle, working and industrial applications of LASER and optical fiber</td></tr>
<tr><td>3</td><td colspan="6">To gain knowledge in mode of transmission of heat by conduction mechanism with experimental illustrations</td></tr>
<tr><td>4</td><td colspan="6">To obtain knowledge in basic concepts of quantum physics and matter waves</td></tr>
<tr><td>5</td><td colspan="6">To acquire knowledge in basics of crystal structure, types of crystal, its defects and crystal growth techniques</td></tr>
<tr><td>Unit I</td><td colspan="2">ULTRASONICS AND ACOUSTICS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">ULTRASONICS: Introduction – Production - Magnetostriction effect –Magnetostriction generator – Piezoelectric effect – Piezoelectric generator –Detection of ultrasonic waves- Properties – Acoustical grating– Velocity measurement–Industrial applications- Drilling, welding, soldering and cleaning –SONAR – Medical applications (Qualitative).
ACOUSTICS OF BUILDINGS: Introduction –Reverberation and reverberation time - Factors affecting acoustics of buildings and their remedies – Absorption co–efficient – Basic requirements for the acoustically good auditorium.</td></tr>
<tr><td>Unit II</td><td colspan="2">LASER AND FIBER OPTICS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">LASER: Stimulated absorption, spontaneous emission and stimulated emission –Population inversion – Pumping methods – Types of laser- Nd–YAG, CO_2 laser – Industrial and medical applications (Qualitative)
FIBER OPTICS: Principle of optical fiber – Structure and classification of optical fiber – Critical angle - Numerical aperture – Acceptance angle – Fiber optic communication (Block diagram).</td></tr>
<tr><td>Unit III</td><td colspan="2">THERMAL PHYSICS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Modes of transmission of heat - Conduction – Convection – Radiation – Thermal conductivity – Coefficient of thermal conductivity and its unit –Thermal conduction through compound media in series – Determination of thermal conductivity - Searle’s method for good conductors, Lee’s disc method for Bad conductors – Thermal insulating materials – Thermal insulation in buildings.</td></tr>
<tr><td>Unit IV</td><td colspan="2">QUANTUM PHYSICS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Matter waves – experimental evidence - Davisson and Germer experiment – Schrodinger’s wave equation - Time independent and dependent equations – Physical significance of wave function – Particle in a one dimensional box – Electron Microscope (Qualitative).</td></tr>
<tr><td>Unit V</td><td colspan="2">CRYSTAL PHYSICS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Lattice – Unit cell – Bravais lattice – Number of atoms per unit cell, atomic radius, coordination number, packing factor– Crystal growth techniques: Bridgman, Czochralski techniques. Crystal imperfections - Point defects – Schottky defect, Frenkel defect – Line defects – Edge dislocation, Screw dislocation – Planar defects – Grain boundaries, Twin boundaries.</td></tr>
<tr><td colspan="7" align="right">Total (45+15) = 60 Periods</td></tr>
</table>

Text Books:	
1	Arumugam M, ‘Engineering Physics’, Anuradha publishers, 2019
2	Rajendran V. and Marikani A, ‘Engineering Physics’, PHI Learning Pvt., India, 2018.
3	Palanisamy P.K, ‘Engineering Physics’, SCITECH Publications, 2018.
4	Ragavan V, ‘Material science and engineering’, Prentice hall of India Pvt Ltd, New Delhi, 2004.
5	Introduction to crystal growth, Principles and Practice, H.L. Bhat, Taylor and Francis, 2015 edition
Reference Books:	
1	Gaur R.K. and Gupta S.L, ‘Engineering Physics’, Dhanpat Rai publishers, 2012.
2	Arthur Beiser, ‘Concepts of Modern Physics’, Tata McGraw Hill Publishing Co. Ltd, sixth Edition, 2019.
3	Gerd Keiser, ‘Optical Fiber Communications’, Tata McGraw Hill Publishing Co. Ltd, 5th Edition, 2017.
4	OrazioSvelto, David C. Hanna, ‘Principles of Lasers’, Springer Science & Business Media, LLC, 2010.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the principle to produce ultrasonic waves and acoustics of buildings.	Understand
CO2	Understand the principle and applications of laser & optical fiber.	Understand
CO3	Analyze various modes involved in heat transmission.	Analyze
CO4	Gain knowledge in the basic concept of quantum physics.	Remember
CO5	Recognize Crystal structure, crystal defects and crystal growth techniques.	Evaluate

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**	**1**						**2**	**2**	**1**	
CO2	**2**	**3**	**1**	**1**	**2**	**1**						**2**	**1**	**1**	
CO3	**3**	**2**	**1**	**1**								**1**	**2**		
CO4	**3**	**2**	**1**	**1**	**2**		**1**					**1**	**1**		
CO5	**2**	**2**	**1**	**1**	**2**							**1**		**1**	**1**
Avg	**2.6**	**2.2**	**1**	**1**	**1.75**	**1**	**1**					**1.4**	**1.5**	**1**	**1**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CY101	ENGINEERING CHEMISTRY				Semester		I
PREREQUISITES		**Category**	**BS**	**Credit**			**4**
Basic Chemistry		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**1**	**0**		**4**

Course Learning Objectives

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 techniques 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 NANOTECHNOLOGY**	**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 polymerizatio 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 (45+15) = 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- References :	
1	www.onlinecourses.nptel.ac.in/
2	www.ePathshala.nic.in

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

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**		**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**		**1.2**							**2.2**	**1.4**	**1.2**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22EE101</td><td colspan="2">BASIC ELECTRICAL AND ELECTRONICS ENGINEERING
(Common to Civil Engineering, Mechanical Engineering, and Computer Science and Engineering)</td><td colspan="3">Semester</td><td>I</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>ES</td><td colspan="2">Credit</td><td>4</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>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To understand and analyze basic electric circuits.</td></tr>
<tr><td>2</td><td colspan="6">To study working principle of electrical machines and transformer.</td></tr>
<tr><td>3</td><td colspan="6">To study basics of electronic devices and operational amplifier.</td></tr>
<tr><td>4</td><td colspan="6">To understand the concepts of electrical installations.</td></tr>
<tr><td>Unit I</td><td colspan="2">DC CIRCUITS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Electrical circuit elements (R, L and C) - Voltage and current sources - Ohm's law and Kirchhoff's laws- Series and parallel circuits - Analysis of simple electrical circuits with DC excitation using fundamental laws – Superposition theorem, Thevenin's and Norton's theorems.</td></tr>
<tr><td>Unit II</td><td colspan="2">AC CIRCUITS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Introduction to single phase AC circuits - Representation of sinusoidal waveforms, peak and RMS values, phasor representation-Analysis of single-phase AC circuits consisting of RL, RC, RLC combinations (series and parallel): real power, reactive power, apparent power and power factor. Three phase AC circuits, voltage and current relations in star and delta connections.</td></tr>
<tr><td>Unit III</td><td colspan="2">ELECTRICAL MACHINES AND TRANSFORMERS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">DC Motor: Construction, operation, types and applications, Speed control of DC shunt motor - Construction and working of three-phase induction motors - Working of single-phase induction motor and its applications – Transformers: Ideal and practical transformer, Construction and working, losses and efficiency in transformers, Introduction to three phase transformers.</td></tr>
<tr><td>Unit IV</td><td colspan="2">BASICS OF ELECTRONICS SYSTEM</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Introduction - Basic structure of semiconductors devices- PN junction diode, Zener diode and V-I characteristics- BJT – CE, CB, CC configuration and working principle. Operational Amplifier-principle of operation, Characteristics, Applications: Inverting Amplifier, non inverting amplifier, summing amplifier and differential amplifier.</td></tr>
<tr><td>Unit V</td><td colspan="2">ELECTRICAL INSTALLATIONS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="7">Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB - Types of wires and cables – Earthing - Basics of house wiring tools and components, types of house wiring – Batteries: Principle characteristics-Types and its applications - Introduction to UPS and SMPS.</td></tr>
<tr><td colspan="7" align="right">Total (45L+15T) = 60 Periods</td></tr>
</table>

Text Books:	
1	Muthu Subramaniyam, R., Salivaganan, R., and Muralidharan, K. A., "Basic Electrical and Electronics Engineering", Second Edition, Tata McGraw Hill, 2010.
2	Kothari, D. P., and Nagrath, I. J., "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3	Kulshreshtha, D.C., "Basic Electrical Engineering", Tata McGraw Hill, 2009.

Reference Books:	
1	Bobrow, L. S., "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2	Hughes, E., "Electrical and Electronics Technology", Pearson, 2010.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Analyze the DC circuits using fundamental laws and theorems.	Analyze
CO2	Analyze the single and three phase AC circuits.	Analyze
CO3	Recognize the working principle of electrical machines and transformers.	Understand
CO4	Recognize the fundamentals and characteristics of diode, BJT and operational amplifier.	Understand
CO5	Demonstrate the concept of electrical installations.	Apply

COURSE ARTICULATION MATRIX

COs\ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1									1	1		
CO 2	1	1									1	1		
CO 3	1										1	1		
CO 4	1										1	1		
CO 5	1										1	1		
Avg	**1**	**1**									**1**	**1**		

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

22ME101	ENGINEERING GRAPHICS AND DESIGN			Semester		I
PREREQUISITES		**Category**	**ES**	**Credit**		**3**
Students should know about the basics of drawings. Students should be able to construct geometric shapes		**Hours/Week**	**L**	**T**	**P**	**TH**
			1	**0**	**4**	**5**
Course Learning 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 an 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 above solids in a simple vertical position by cutting planes inclined to one reference plane and perpendicular to other – solids inclined position with cutting planes parallel to one reference plane- Obtaining true shape of the section. Development of lateral surfaces of simple and truncated solids – Prisms, pyramids cylinders and cones- Development of lateral surfaces of solids with square and cylindrical cutouts, perpendicular to the axis.						
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 objects. 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 (30+45) = 75 Periods

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

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

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	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)**															

22MC102	தமிழர் மரபு B.E (Common to all Branches)			Semester I			
முன்நிபந்தனைகள்:		Category		HSMC	Credit		1
இலக்கணம் மற்றும் இலக்கியத்தின் அடிப்படைகள்		Hours/Week		L	T	P	TH
				1	0	0	1
பாடநெறி நோக்கங்கள்: மாணவர்களால்							
1.	தமிழ் மொழி மற்றும் இலக்கியம் பற்றிய அறிவைப் பெற முடியும்.						
2.	பாரம்பரியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் மற்றும் சிற்பக் கலைகள் பற்றி தெரிந்து கொள்ள முடியும்						
3.	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் பற்றி அறிந்து கொள்ள முடியும்						
4.	தமிழர்களின் ஒழுக்க நெறிமுறைகளைப் பற்றி தெரிந்து கொண்டு அதன்படி நடந்து கொள்ள முடியும்.						
5.	பழங்கால இந்திய தேசிய இயக்கம் பற்றியும், இந்திய மக்களின் பன்பாட்டில் தமிழர்களின் பங்களிப்பு பற்றியும் நன்கு அறிந்து கொள்ள முடியும்.						
அலகு I	**மொழி மற்றும் இலக்கியம்**			3	0	0	3
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க்காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.							
அலகு II	**மரபு – பாறைஓவியங்கள்முதல்நவீன ஓவியங்கள் வரைசிற்பக்கலை**			3	0	0	3
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள்- குமரி முனையில் திருவள்ளுவர் சிலை- இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.							
அலகு III	**நாட்டுப்புறக்கலைகள்மற்றும்வீரவிளையாட்டுகள்**			3	0	0	3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான்கூத்து, ஒயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின்விளையாட்டுகள்.							
அலகு IV	**தமிழர்களின்திணைக்கோட்பாடுகள்**			3	0	0	3
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.							
அலகு V	**இந்தியதேசியஇயக்கம்மற்றும்இந்தியபண்பாட்டிற்குத்த மிழர்களின்பங்களிப்பு**			3	0	0	3
இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப்பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப்புத்தகங்களின் அச்சு வரலாறு.							
Total= 15 Periods							

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

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

COURSE ARTICULATION MATRIX

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

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

<table>
<tr><td>22MC102</td><td colspan="3">HERITAGE OF TAMILS</td><td colspan="3">Semester</td><td>I</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>HS MC</td><td colspan="2">Credit</td><td>1</td></tr>
<tr><td colspan="3" rowspan="2">Basics of Tamil Language and Literature</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>1.</td><td colspan="7">To Obtain the knowledge of Tamil Language and Literature</td></tr>
<tr><td>2.</td><td colspan="7">To familiarize with painting and Sculpture</td></tr>
<tr><td>3.</td><td colspan="7">To Know about the folks and martial arts</td></tr>
<tr><td>4.</td><td colspan="7">To understand the Thinai concept of Tamils</td></tr>
<tr><td>5.</td><td colspan="7">To know about the contribution of Tamils to Indian National Movement and Indian Culture.</td></tr>
<tr><td>Unit I</td><td colspan="3">LANGUAGE AND LITERATURE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.</td></tr>
<tr><td>Unit II</td><td colspan="3">HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.</td></tr>
<tr><td>Unit III</td><td colspan="3">FOLK AND MARTIAL ARTS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.</td></tr>
<tr><td>Unit IV</td><td colspan="3">THINAI CONCEPT OF TAMILS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.</td></tr>
<tr><td>Unit V</td><td colspan="3">CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.</td></tr>
<tr><td colspan="8" align="right">Total = 15 Periods</td></tr>
</table>

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

COURSE 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)															

22EN102	PROFESSIONAL SKILLS LABORATORY			Semester		I
PREREQUISITES		Category	HS	Credit		1
Basic language skills listening, speaking, reading and writing		Hours/Week	L	T	P	TH
			0	0	2	2

Course Learning 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 = 30 Periods

Text Books:

1	Norman Whitby. Business Benchmark – Pre-Intermediate to Intermediate, Students book, Cambridge University Pres 2014.

Reference Books:

1	Reading Fluency. Switzerland, MDPI AG, 2021.
2	McJacobs, Wade. Dare to Read: Improving Your Reading Speed and skills. Australia, 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 Level**
CO1	Read passages fluently with good pronunciation	Remember
CO2	Develop an expressive style of reading	Create
CO3	Make effective oral presentations in technical and general contexts	Create
CO4	Excel at professional oral communication	Evaluate

<u>COURSE ARTICULATION MATRIX</u>

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					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		I
PREREQUISITES		**Category**	**BS**	**Credit**		**1.5**
Basic theoretical knowledge in physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Learning 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 = 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 Level**
CO1	Handle different measuring instruments and to measure different parameters.	Apply
CO2	Calculate the important parameters and to arrive at the final result based on the experimental measurements.	Analyze

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		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		I
PREREQUISITES		Category	BS	Credit		1.5
		Hours/Week	L	T	P	TH
			0	0	3	3

Course Learning 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 = 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 this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Summarize the applicability of the practical skill gained in various fields.	Understand
CO2	Calculate the composition of brass quantitatively and the molecular weight of polymers.	Apply
CO3	Understand the principle and applications of conductometric and ph titrations, spectrometer, and potentiometric titrations.	Understand

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		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)**															

22EE102	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY			Semester		I
PREREQUISITES		**Category**	**ES**	**Credit**		**1.5**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Learning Objectives

1	To impart hands on experience in use of measuring instruments, testing in transformers, and house wiring practices

LIST OF EXPERIMENTS

1. Verification of Kirchhoff's laws.
2. Verification of Superposition theorem.
3. Measurement of three-phase power in three-phase circuits.
4. Determination losses in single phase Transformer.
5. Demonstration of cut-out sections of machines: induction machine (squirrel cage rotor), and single-phase induction motor.
6. Speed control of DC shunt motor.
7. Study of basic safety precautions, measuring instruments – voltmeter, ammeter, multi-meter, and Electrical components.
8. VI Characteristics of PN Junction diode.
9. Staircase wiring.
10. Wiring for fluorescent lamp.

Total = 45 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Analyse DC and AC circuits.	Analyze
CO2	Calculate various losses in transformer.	Analyze
CO3	Recognise the parts of single-phase and three phase induction motors.	Understand
CO4	Demonstrate the characteristics of electron devices.	Understand
CO5	Practice electrical connections by wires of appropriate ratings.	Apply

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			
CO2	1	1									1	1			
CO3	1	0									1	1			
CO4	1	0									1	1			
CO5	1	0									1	1			
Avg	**1**	**0.4**									**1**	**1**			
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22EN101</td><td colspan="3">COMMUNICATIVE ENGLISH</td><td colspan="2">Semester</td><td>II</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>HS</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Basic language skills listening, speaking, reading and writing</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>4</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To develop the communicative skills of learners by engaging them in reading, writing and grammar learning activities</td></tr>
<tr><td>2</td><td colspan="6">To inculcate learners' ability to read texts, summaries, articles and user manuals</td></tr>
<tr><td>3</td><td colspan="6">To assist learners to acquire writing skills for academic, social and professional purposes</td></tr>
<tr><td>4</td><td colspan="6">To improve learners' vocabulary and grammar to supplement their language use at different contexts</td></tr>
<tr><td>Unit I</td><td colspan="2">COMPREHENSION</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit II</td><td colspan="2">RECOMMENDATION</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit III</td><td colspan="2">CONVERSATION</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit IV</td><td colspan="2">REPORTING</td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit V</td><td colspan="2"></td><td>6</td><td>0</td><td>6</td><td>12</td></tr>
</table>

Listening – An interview with career advisor and recruitment agent, Feedbacks, Meeting extracts.

Speaking – Qualities required for employability, Improving employee productivity, presentation on problem-solving skills, teamwork, creativity and leadership quality.

Reading - Reading brochures, telephone messages, social media messages relevant to technical contexts.

Writing - Letter Writing – Formal Letters and Informal Letters - cover letter with resume, Mind maps, Charts - interpreting statistical data, charts, graphs and tables.

Grammar - One word substitution, Abbreviations and acronyms in technical contexts and technical vocabulary, Idioms.

Total (30+30) = 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, PushpaLata. English Language and Communication Skills for Engineers. Oxford University Press, 2018.
E-References :	
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 Level**
CO1	Comprehend the main ideas, key details and inferred meanings of technical texts	Understand
CO2	Use language effectively at technical and professional contexts	Apply
CO3	Apply the academic and functional writing skills in formal and informal communicative contexts	Apply
CO4	Interpret pictorial representation of statistical data and charts	Apply

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	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)**															

22MA201	PARTIAL DIFFERENTIAL EQUATIONS, VECTOR CALCULUS AND COMPLEX VARIABLES		Semester		II
PREREQUISITES	**Category**	**BS**	**Credit**		**4**
Basic 12th level knowledge of Partial Derivatives, Vector algebra and Complex Numbers.	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**1**	**0**	**4**

Course Learning Objectives

1	To familiarize with the formation and solutions of first-order partial differential equation.
2	To familiarize with the solutions of higher-order partial differential equations.
3	To acquire knowledge of vector differentiation and integration and its applications.
4	To know about analytic functions with properties, construction of analytic functions and conformal transformations.
5	To obtain the knowledge of Cauchy's integral theorems, calculus of residues and complex integration around unit circle and semi-circle.

Unit I	**PARTIAL DIFFERENTIAL EQUATIONS – FIRST ORDER**	**9**	**3**	**0**	**12**
Formation of partial differential equations by elimination of arbitrary constants and functions – Solutions to first order partial differential equations - Standard types of first order linear and non-linear PDE- Lagrange's linear PDE.					
Unit II	**PARTIAL DIFFERENTIAL EQUATIONS – HIGHER ORDER**	**9**	**3**	**0**	**12**
Solution to homogeneous and non-homogeneous linear partial differential equations of second and higher-order by complementary function and particular integral method - Separation of variables method: simple problems in Cartesian coordinates, Laplace equation in Cartesian and polar coordinates, one-dimensional diffusion equation, one-dimensional wave equation.					
Unit III	**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 parallelepipeds.					
Unit IV	**COMPLEX DIFFERENTIATION**	**9**	**3**	**0**	**12**
Functions of a complex variable – Analytic functions – Cauchy – Riemann equation and sufficient conditions (excluding proof) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Conformal mappings: w= z+c, cz, 1/z, z^2 and Bilinear transformations.					
Unit V	**COMPLEX INTEGRATION**	**9**	**3**	**0**	**12**
Cauchy's integral theorem - Cauchy's integral formula – Taylor's and Laurent's theorems (Statements only) and expansions – Poles and Residues – Cauchy's Residue theorem – Contour integration: Circular and semi-circle contours with no poles on the real axis.					
Total (45+15) = 60 Periods					

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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand how to solve the given standard partial differential equations.	Understand
CO2	Solve higher order partial differential equations.	Apply
CO3	Use Gauss, Stokes and Green’s theorems for the verification of line, surface and volume integrals.	Apply
CO4	Familiar with the concept of Conformal and Bilinear transformations.	Understand
CO5	Acquire the knowledge of Contour integration over unit circle and semi-circle.	Apply

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

<table>
<tr><td>22CY201</td><td colspan="2">ENVIRONMENTAL SCIENCE AND ENGINEERING</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">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">Principles of environmental resources.</td></tr>
<tr><td>2</td><td colspan="6">Preservation of ecosystem and biodiversity.</td></tr>
<tr><td>3</td><td colspan="6">Principles of environmental threats and pollution.</td></tr>
<tr><td>4</td><td colspan="6">Principles of solid waste management.</td></tr>
<tr><td>5</td><td colspan="6">Environmental issues and ethics.</td></tr>
<tr><td>Unit I</td><td colspan="2">ENVIRONMENTAL RESOURCES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Forest resources – importance, deforestation – water resources – sources - hydrologicalcycle - Food resources – effects of modern agriculture, fertilizers, and pesticides – Mineral resources – types – mining – environmental effects of extracting and using mineral resources – Land resources – land degradation – soil erosion.</td></tr>
<tr><td>Unit II</td><td colspan="2">ECOSYSTEM AND BIODIVERSITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Environment – biotic and abiotic components – ecosystem components food chain and food web, tropic levels – energy flow in ecosystem, ecological pyramids – ecological succession, types – Biodiversity- types, values of biodiversity, hot spots of biodiversity, threat to biodiversity, endangered and endemic species, conservation of biodiversity – IN-situ and Ex-situ conservation.</td></tr>
<tr><td>Unit III</td><td colspan="2">ENVIRONMENTAL POLLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Air pollution – classification of air pollutants gaseous, particulates – sources, effects and control of gaseous pollutants, SO_2, NO_2, H_2S, CO and particulates – control methods – cyclone separator, electrostatic precipitator, catalytic convertor – Water pollution – heavy metal ions pollutants – organic pollutants, oxygen demanding waste, aerobic and anaerobic decomposition BOD and COD – experimental determination of BOD only – treatment of domestic and industrial wastewater – Noise pollution – decibel scale – sources, effects and control measures.</td></tr>
<tr><td>Unit IV</td><td colspan="2">ENVIRONENTAL THREATS AND SOLID WASTE MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Acid rain, greenhouse effect and global warming, ozone depletion, photo chemical smog, eutrophication, bio-amplification – disaster management – origin, effects and management of earthquake and floods. Solid waste management – solid wastes classification, origin, effects – treatment methods – 3R approach - composting, sanitary land filling – destructive methods – incineration, pyrolysis.</td></tr>
<tr><td>Unit V</td><td colspan="2">SOCIAL ISSUES AND ENVIRONMENTAL ETHICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">From unsustainable to sustainable development - aim and ways of achieving – urban problems related to energy – water conservation and management- rain water harvesting – waste land reclamation – consumerism – human population – population growth – characteristics of population growth – variation of population among nations and based on age structure – population explosion - reason, effects and remedy – family welfare program , family planning program – HIV and AIDS.</td></tr>
<tr><td colspan="7">Total = 45 Periods</td></tr>
</table>

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), Revised Edition, Dr. S.S. Dara, D.D. Mishra Published by S. Chand & Company Ltd, 20 14.
Reference Books:	
1	IntroductiontoEnvironmentalEngineeringandScience,GilbertM.Masters;WendellP.ElaPublisher:Prentice-HallIndia,3rdEdition,2008.
2	Environmental Science, F;ldren D. Enger, BredleyF.Smith, WCD McGraw Hill 14"Edition 2015.
E-References	
1	www.onlinecourses.nptel.ac.in/
2	www.ePathshala.nic.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Play an important role in conservation of natural resources for future generation.	Creating
CO2	Paraphrase the importance of ecosystem and biodiversity.	Understanding
CO3	Analyze the impact of pollution and hazardous waste in a global and social context.	Analyzing
CO4	Understand contemporary issues that result in environmental degradation that would attempt to provide solutions to overcome the problems.	Understanding
CO5	Consider the issues of environment and human population in their professional undertakings.	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	3	2			1	3	2				1	2		1
CO2	3	3	2			1	3	2				1	2		1
CO3	3	3	2			1	3	2				1	2		1
CO4	3	3	2			1	3	2				1	2		1
CO5	3	3	2			1	3	2				1	2		1
Avg	3	3	2			1	3	2				1	2		1

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

22CS101	PROBLEM SOLVING AND C PROGRAMMING		Semester			II
PREREQUISITES		**Category**	**ES**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

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

Unit I	SYSTEM SOFTWARE, PROBLEM SOLVING, AND C PROGRAMMING	9	0	0	9

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

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

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

Unit II	CONTROL STATEMENTS	9	0	0	9

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

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

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

Unit III	ARRAYS, POINTERS, AND STRINGS	9	0	0	9

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

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

Unit IV	FUNCTIONS	9	0	0	9

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

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

Unit V	STRUCTURES, UNIONS AND FILE	9	0	0	9

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

Total = 45 Periods

Text Books:	
1	Balagurusamy E, "Programming in ANSI C", Tata McGraw-Hill, 8th Edition, 2022.
2	Yashvant P. Kanetkar, "Let Us C", BPB Publications, 2016.
Reference Books:	
1	Venugopal, "Mastering C", Second Edition", Tata McGraw-Hill. 2006
2	R. G. Dromey, "How to solve it by computers", Prentice Hall, 2007
3	Greg Perry and Dean Miller, "C Programming Absolute Beginner's Guide", Third Edition, Que Publishing, 20123
4	Brain W.Kernighan and Ritchie Dennis, "The C Programming Language", Second Edition, Pearson, 1988.
E-References	
1	https://www.learn-c.org/
2	https://www.programiz.com/c-programming

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Explain the concepts of C Programming and roles of system software in programming	Remember &Understand
CO2	Use general problem-solving techniques to develop solution to problems	Apply
CO3	Apply the concepts of C Programming to develop solutions by writing C programs	Apply &Analyze

COURSE ARTICULATION MATRIX

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

22CE101	ENGINEERING MECHANICS				Semester		II
PREREQUISITES			**Category**	**ES**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				2	**1**	**0**	**3**

Course Learning Objectives

1	To explain the importance of mechanics in the context of engineering and conservation equations.
2	To apply resolution of forces
3	To explain the significance of centroid, center of gravity and moment of inertia
4	To apply the different principles to study the motion of a body, and concept of relative velocity and acceleration
5	To apply Impulse Momentum principle

Unit I	**BASICS & STATICS OF PARTICLES**	**6**	**3**	**0**	**9**

Introduction – Units and Dimensions – Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Equilibrium of a particle in three dimensions – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

Unit II	**EQUILIBRIUM OF RIGID BODIES**	**6**	**3**	**0**	**9**

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

Unit III	**PROPERTIES OF SURFACES AND FRICTION**	**6**	**3**	**0**	**9**

Determination of Areas and Volumes –Theorems of Pappus and Guldinus-First moment of area and the Centroid of sections –Second and product moments of plane area of various sections –Parallel axis theorem and perpendicular axis theorem-Polar moment of inertia –Principal moments of inertia of plane areas-Principal axes of inertia- Frictional force-Laws of Coulomb friction-simple contact friction-Rolling resistance –Belt friction.

Unit IV	**KINEMATICS AND KINETICS OF PARTICLES**	**6**	**3**	**0**	**9**

Displacemnt, Velocity and acceleration, their relationship-Relative motion-Newton's low of motion-Work Energy Equation-Impulse and Momentum-Impact of elastic bodies

Unit V	**KINEMATICS AND KINETICS OF RIGID BODIES**	**6**	**3**	**0**	**9**

Plane motion- Absolute motion- Relative motion- Translating ares and Rolling Axes- Work and Energy- Impulse and Momentum

Total= 45 Periods

Text Books:

1	Rajasekaran S and Sankara subramanian G., Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., 3rd Edition,2017.
2	Bansal R.K., Engineering Mechanics, Laxmi Publications (P) Ltd., 8th Edition, 2015.
3	Palanichamy M.S. and Nagan S, Engineering Mechanics, Laxmi Publication(P) Ltd.,2022

Reference Books:

1	Kumar K.L., Engineering Mechanic, Tata McGraw–Hill Publishing Company Limited, New Delhi, 4th Edition, 2017.

2	Beer F.P and Johnson Jr. E.R. Vector Mechanics for Engineers, Vol. 1 Statics and Vol. 2 Dynamics, McGraw–Hill International Edition, 12th Edition, 2019
3	Hibbeller R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 14th Edition, 2017.
4	Irving H. Shames, Engineering Mechanics – Statics and Dynamics, IV Edition – Pearson Education Asia Pvt. Ltd., 4th Edition, 2005.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the basics and statics of the particle by applying, knowledge of mathematics and engineering sciences	Apply
CO2	Explain the equilibrium of rigid bodies and draw the free body diagram and mention the supports and the reaction for the diagram.	Apply
CO3	Select and apply appropriate techniques to determine the areas of the surfaces using the various theorems and find the moment of inertia of different body shapes	Apply
CO4	Understand the complex engineering problems to solve the dynamics of particles	Apply
CO5	Understand the mechanisms of rigid bodies using Civil engineering solutions for sustainable development.	Apply

COURSE ARTICULATION MATRIX

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

22HS201	UNIVERSAL HUMAN VALUES			Semester		II
PREREQUISITES		**Category**	**HS**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			2	**1**	**0**	**3**

Course Learning Objectives

1	Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
3	Strengthening of self-reflection.
4	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	**UNDERSTANDING 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	**UNDERSTANDING 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	**UNDERSTANDING 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 UNDERSTANDING 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(30 L +15T) = 45 Periods

Text Books:	
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
Reference Books:	
1	JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3	The Story of Stuff (Book)
4	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5	Small is Beautiful - E. F Schumacher.
6	Slow is Beautiful - Cecile Andrews
7	Economy of Permanence - J C Kumarappa
8	Bharat Mein Angreji Raj - PanditSunderlal
9	Rediscovering India - by Dharampal
10	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11	India Wins Freedom - Maulana Abdul Kalam Azad
12	Vivekananda - Romain Rolland (English)
13	Gandhi - Romain Rolland (English)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Become more aware of themselves, and their surroundings (family, society, nature) and become more responsible in life	Evaluate
CO2	Handle problems with sustainable solutions, while keeping human relationships and human nature in mind	Apply
CO3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society)	Evaluate
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.	Apply

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		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)**															

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

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

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

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

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

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	2								2	2	2
CO2	3	3	3	2	3								3	3	2
CO3	1	2	2	1	1								2	2	2
CO4	3	3	3	2	2								3	3	3
CO5	2	3	3	3	3								3	3	3
AV G	**2.2**	**2.8**	**2.6**	**2**	**2.2**								**2.6**	**2.6**	**2.4**
0: No correlation, 1: Low correlation, 2: Medium correlation, 3: High correlation															

<table>
<tr><td>22MC201</td><td colspan="2">தமிழரும் தொழில்நுட்பமும்
B.E (Common to all Branches)</td><td colspan="2">Semester</td><td colspan="2"></td><td>II</td></tr>
<tr><td colspan="2">முன்நிபந்தனைகள்:</td><td>Category</td><td>HS MC</td><td colspan="3">Credit</td><td>1</td></tr>
<tr><td colspan="2" rowspan="2">இலக்கணம் மற்றும் இலக்கியத்தின் அடிப்படைகள்</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td colspan="2">P</td><td>TH</td></tr>
<tr><td>1</td><td>0</td><td colspan="2">0</td><td>1</td></tr>
<tr><td colspan="8">பாடநெறிநோக்கங்கள்: மாணவர்களால்</td></tr>
<tr><td>1.</td><td colspan="7">நெசவுத் தொழிலின் நன்மைகள்,அதன் பயன்கள்,பானைத் தொழில் நுட்பத்தைப் பற்றிநன்குஅறிந்துகொள்ளமுடியும்.</td></tr>
<tr><td>2.</td><td colspan="7">கட்டிடம் கட்டுதல் மற்றும் கட்டிடத் தொழிலுள்ளநுட்பங்கள் பற்றிஅறிந்துகொள்ளமுடியும்.</td></tr>
<tr><td>3.</td><td colspan="7">உற்பத்திதொழில் நுட்பம், இரும்பு,உலோகம்,கனிமம்,தொழிற்சாலைகள் பற்றிஅறிந்துஅவற்றின் பயன்பாடுகளைவெளிப்படுத்தமுடியும்.</td></tr>
<tr><td>4.</td><td colspan="7">வேளாண்மைமற்றும் நீர் பாசனமுறைகள்,தொழில் நுட்பம்,ஏர் உழுதல் போன்றபண்டையகாலநெறிமுறைகளைப் பற்றிதெரிந்துநடைமுறைப் படுத்தமுடியும்.</td></tr>
<tr><td>5.</td><td colspan="7">இன்றையகாலகட்டத்தில் உள்ளவாறுஅறிவியல் வளர்ச்சி,கணினித் தமிழ் பற்றிதெரிந்துகொண்டுஅறிவைவிரிவாக்கமுடியும்.</td></tr>
<tr><td>அலகுI</td><td colspan="2">நெசவுமற்றும் பானைதொழில்நுட்பம்</td><td>3</td><td>0</td><td colspan="2">0</td><td>3</td></tr>
<tr><td colspan="8">சங்ககாலத்தில் நெசவுத் தொழில் - பானைதொழில் நுட்பம் - கருப்புசிவப்புபாண்டங்கள்- பாண்டங்களில் கீறல் குறியீடுகள்</td></tr>
<tr><td>அலகுII</td><td colspan="2">வடிவமைப்புமற்றும் கட்டிடத் தொழில்நுட்பம்</td><td>3</td><td>0</td><td colspan="2">0</td><td>3</td></tr>
<tr><td colspan="8">சங்ககாலத்தில் வடிவமைப்புமற்றும் கட்டுமானங்கள் &சங்ககாலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்ககாலத்தில் கட்டுமானபொருட்களும் நடுகல்லும்- சிலப்பதிகாரத்தில் மேடைஅமைப்புபற்றியவிவரங்கள் - மாமல்லபுரச் சிற்பங்களும்,கோவில்களும் - கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிறவழிபாட்டுத் தலங்கள்- நாயக்கர் காலக் கோயில்கள் - மாதிரிகட்டகமைப்புகள் பற்றிஅறிதல்,மதுரைமீனாட்சிஅம்மன் ஆலயம் மற்றம் திருமலைநாயக்கர் மஹால் - செட்டிநாட்டுவீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோசாரோசெனிக் கட்டிடக் கலை.</td></tr>
<tr><td>அலகுIII</td><td colspan="2">உற்பத்தித் தொழில் நுட்பம்</td><td>3</td><td>0</td><td colspan="2">0</td><td>3</td></tr>
<tr><td colspan="8">கப்பல் கட்டும் கலை-உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பைஉருக்குதல்,எஃகு - வரலாற்றுச் சான்றுகளாகசெம்புமற்றும் தங்கநாணயங்கள் - நாணயங்கள் அச்சிடித்தல் - மணிஉருவாக்கம் தொழிற்சாலைகள் - கல்மணிகள்,கண்ணாடிமணிகள் - சுடுமண் மணிகள் - சங்குமணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.</td></tr>
<tr><td>அலகுIV</td><td colspan="2">வேளாண்மைமற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</td><td>3</td><td>0</td><td colspan="2">0</td><td>3</td></tr>
<tr><td colspan="8">அனை,ஏரி,குளங்கள்,மதகு, - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடைபராமரிப்பு - கால்நடைகளுக்காகவடிவமைக்கப்பட்டகிணறுகள் - வேளாண்மைமற்றும் வேளாண்மைசார்ந்தசெயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்துமற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்தபண்டையஅறிவு - அறிவுசார் சமூகம்.</td></tr>
<tr><td>அலகுV</td><td colspan="2">அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</td><td>3</td><td>0</td><td colspan="2">0</td><td>3</td></tr>
<tr><td colspan="8">அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களைமின் பதிப்புசெய்தல் - தமிழ் மென் பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.</td></tr>
<tr><td colspan="8" align="right">Total = 15 Periods</td></tr>
</table>

Text Books:	
1	தமிழகவரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல் மற்றும் கல்வியல் பணிகள் கழகம்)
2	கணினித் தமிழ் - முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்)
3	கீழடி - வைகைநதிக்கரையில் சங்ககாலநகரநாகரிகம் (தொல்லியல் துறைவெளியீடு)
4	பொருநை - ஆற்றங்கரைநாகரிகம். (தொல்லியல் துறைவெளியீடு)

பாடநெறிமுடிவுகள்: இந்தப் படிப்புமுடிந்ததும்,மாணவர்களால்		**Bloom's Taxonomy Mapped**
CO1	சங்காலத்தில் இருந்தநல்லதொழில்களையும் கைவிணைகலைகளால் ஏற்படும் நன்மைகளையும் பற்றிஅறிந்துகொண்டனர்.	Understanding
CO2	கட்டிடங்கள் மற்றும் வீட்டுப்பொருட்களைவடிவமைப்பது,சங்காலத்தில் இருந்தகோவில்களைபற்றிஅறிந்துகொண்டனர்	Understanding
CO3	உலோகவியல், இரும்புதொழிற்சாலைகள்,தொல்லியல் சான்றுகள்,உற்பத்திதொழல் நுட்பத்தைபற்றிஅறிந்துகொண்டனர்.	Applying
CO4	பழங்காலத்தில் வோளண்மை,நீர்பாசனம்,மீன் வளம்,கால்நடைபராமரிப்பு,அறிவுசார் சமுகம் பற்றிஅறிந்துகொண்டனர்.	Applying
CO5	அறிவியல் தமிழன் வளர்ச்சி,கணித்தமிழ் வளர்ச்சி,மென்பொருள் உருவாக்கம், இணையகல்விகழகம், இணையத்தில் தமிழ் அகராதிகள் பற்றிஅறிந்துகொண்டனர்.	Understanding

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22MC201</td><td colspan="3">TAMILS AND TECHNOLOGY
B.E (Common to all Branches)</td><td colspan="3">Semester</td><td>II</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>HS MC</td><td colspan="2">Credit</td><td>1</td></tr>
<tr><td colspan="3" rowspan="2">Basics of Tamil Language and Literature</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="7">To obtain the knowledge of weaving and ceramic technology</td></tr>
<tr><td>2.</td><td colspan="7">To familiarize about design and construction technology during sangam age and British period</td></tr>
<tr><td>3.</td><td colspan="7">To know about the manufacturing technologies</td></tr>
<tr><td>4</td><td colspan="7">To obtain the knowledge of agriculture and irrigation technology</td></tr>
<tr><td>5</td><td colspan="7">To know about the development of Scientific Tamil and Tamil computing</td></tr>
<tr><td>Unit I</td><td colspan="3">WEAVING AND CERAMIC TECHNOLOGY</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.</td></tr>
<tr><td>Unit II</td><td colspan="3">DESIGN AND CONSTRUCTION TECHNOLOGY</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)-ThirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.</td></tr>
<tr><td>Unit III</td><td colspan="3">MANUFACTURING TECHNOLOGY</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and goldCoins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.</td></tr>
<tr><td>Unit IV</td><td colspan="3">AGRICULTURE AND IRRIGATION TECHNOLOGY</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.</td></tr>
<tr><td>Unit V</td><td colspan="3">SCIENTIFIC TAMIL & TAMIL COMPUTING</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8">Total = 15 Periods</td></tr>
</table>

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

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

COURSE ARTICULATION MATRIX

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		
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
PREREQUISITES		**Category**	**NC**	**Credit**			**3***
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning 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, APJ.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'ts – Natural Disasters, Man Made Disasters; Health &Saniation – 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 = 45 Periods

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

22CS102	COMPUTER PRACTICE AND C PROGRAMMING LABORATORY				Semester		II
PREREQUISITES			Category	ES	Credit		1.5
			Hours/Week	L	T	P	TH
				0	0	3	3

Course Learning 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 (45+15) = 60 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Demonstrate the usage of features supported by word processing applications.	Apply
CO2	Demonstrate the usage of features supported by spread sheet applications.	Apply
CO3	Apply general programming techniques to develop digital solution to problems	Apply
CO4	Implement solutions develop with general programming techniques in C programming language	Apply

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

22ME102	WORKSHOP MANUFACTURING PRACTICES			Semester		II
PREREQUISITES		**Category**	**ES**	**Credit**		**2**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**2**	**2**

Course Learning Objectives

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

LIST OF EXPERIMENTS

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

Total = 30 Periods

Reference Books:

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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Familiarize the working of various equipment and safety measures.	Understand
CO2	Prepare fitting of metal and wooden pieces using simple fitting and carpentry tools manually.	Apply
CO3	Fabrication of components using welding, lathe and drilling machine.	Analyze
CO4	Make the model using sheet metal works.	Analyze

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	0	0		0	0	3									0
CO2	0	3		2	1										2
CO3	0	3		2	1										2
CO4	0	3		2	1										2
CO5	0	3		2	1										2
Avg	**0**	**2.4**		**1.6**	**0.8**	**0.6**									**1.6**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td colspan="2">22MA301</td><td colspan="2">TRANSFORMS AND NUMERICAL METHODS
B.E. (Civil)</td><td colspan="3">Semester</td><td>III</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>BS</td><td colspan="2">Credit</td><td>4</td></tr>
<tr><td colspan="3" rowspan="2">Basic 12th level knowledge of Differential and Integral Calculus, Solution of equations and Matrices.</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To familiarize with Fourier, transform a function and its sine and cosine transforms.</td></tr>
<tr><td>2</td><td colspan="7">To obtain the knowledge of solving second order ODE using Laplace transform techniques and inverse Laplace transform using convolution theorem.</td></tr>
<tr><td>3</td><td colspan="7">To familiarize the numerical solution of linear systems of equations and interpolation.</td></tr>
<tr><td>4</td><td colspan="7">To impart the knowledge in solving numerical differentiation, integration and initial value problems for ordinary differential equations.</td></tr>
<tr><td>5</td><td colspan="7">To obtain the finite difference solution of one-dimensional wave equation and two-dimensional Laplace and Poisson equations.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="2">FOURIER TRANSFORM</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="8">Statement of Fourier integral theorem – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval’s Identity.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">LAPLACE TRANSFORM</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="8">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- solutions of linear ODE of second order with constant coefficients using Laplace transformation techniques- statement and application of convolution theorem.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">SOLUTION OF EQUATIONS AND INTERPOLATIONS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="8">Solving equations: Iterative method, Newton Raphson Method-Solutions of linear system of equations by Gauss Elimination, Gauss Jordan, Gauss Jacobi and Gauss Seidel methods- Interpolation: Newton Forward and Backward differences, Newton’s divided difference, Lagrangian polynomial.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">NUMERICAL DIFFERENTIATION, INTEGRATION AND INITIAL VALUE PROBLEMS FOR ODE</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="8">Numerical differentiation by Newton’s methods, Numerical integration by Trapezoidal rule-Simpson’s 1/3 rule and Simpson’s 3/8 rule –Single step methods: Taylor series method, Euler method, Modified Euler Method and Fourth order Runge-Kutta method for first order differential equations- Multistep method: Milne and Adam’s-Bash forth predictor and corrector methods.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="2">BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8" align="right">Total (45L+15T) = 60 Periods</td></tr>
</table>

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. Ganapathy, "Engineering Mathematics, Volume III", S. Chand & Company ltd., New Delhi, 1996.
3	Kandasamy. P, Thilagavathy. K, Gunavathi. K, "Numerical Methods", S. Chand & Co., New Delhi, 2005.
Reference Books:	
1	Grewal, B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2015.
2	Jain M.K. Iyengar, K & Jain R.K., "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Ltd. Publishers, 2003.
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, S. Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai, 2002.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the knowledge of Fourier transform in engineering problems.	Apply
CO2	Apply the knowledge of Laplace transforms method to solve second order differential equations.	Apply
CO3	Obtain the numerical solutions of linear, non-linear equations and interpolations for given data.	Understand
CO4	Use the numerical differentiation, integration and IVP on Ordinary differential equations.	Apply
CO5	Solve the Boundary value problems in ordinary and partial differential equations	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	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	2	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
Avg	3	2	2	2	-	-	-	-	-	-	-	-	2	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CE301</td><td colspan="4">MECHANICS OF FLUIDS</td><td colspan="3">Semester</td><td>III</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="3">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">MATRICES, Calculus and Ordinary Differential Equations</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 Basic properties of fluid</td></tr>
<tr><td>2</td><td colspan="7">To understand the Fluid statics and Kinematics</td></tr>
<tr><td>3</td><td colspan="7">To study the problem related to Fluid dynamics</td></tr>
<tr><td>4</td><td colspan="7">To study losses, the boundary layer problems</td></tr>
<tr><td>5</td><td colspan="7">To understand the Dimensional, Model Analysis</td></tr>
<tr><td>Unit I</td><td colspan="3">FLUID PROPERTIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Introduction, Fluid properties – Density, Specific Weight, Specific Volume, Specific Gravity, Viscosity, Compressibility, Vapour pressure, Capillarity and Surface Tension. Pressure – Pascal’s law - Relationship between Pressures – Pressure Measurements by Manometers.</td></tr>
<tr><td>Unit II</td><td colspan="3">FLUID STATICS & KINEMATICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Fluid Statics: Hydrostatic forces on plane and curved surfaces – Total Pressure and Centre of Pressure– equilibrium of floating and submerged bodies - Meta centre – Metacentric height.

Fluid Kinematics: Flow visualization – Types of flow – lines of flow - velocity and acceleration - Continuity equation (one, two, three-dimensional forms) – Stream function – velocity potential function – flow nets – Measurement of Velocity</td></tr>
<tr><td>Unit III</td><td colspan="3">FLUID DYNAMICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Equations of motion – Euler’s equation of motion along a streamline - Bernoulli’s equation – Applications – Venturimeter, Orifice meter, Pitot tube- Laminar flow – viscous flow through pipes and between parallel plates – Hagen- Poiseuille equation-turbulent flow.</td></tr>
<tr><td>Unit IV</td><td colspan="3">FLOW THROUGH PIPES AND BOUNDARY LAYER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Major Loss, Darcy-Weisbach formula – Moody diagram, Minor losses of flow in pipes – Hydraulic Gradient Line – Total Energy Line - Pipes in series and in parallel – Power transmission through pipes.

Definition of boundary layer – Thickness and classification – Separation of boundary layer – Methods of preventing separation.</td></tr>
<tr><td>Unit V</td><td colspan="3">DIMENSIONAL AND MODEL ANALYSIS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Dimensional Analysis – Rayleigh’s method, Buckingham’s π-Theorem.

Model analysis – Types of Similitude – Dimensionless numbers – Model Laws – classification of Models - Scale effect.</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Bansal R.K., Fluid Mechanics and Hydraulic Machines, 10thEdition, Laxmi Publications(P) Ltd, New Delhi, 2018
2	Modi P.N., Seth S.M., Hydraulics and Fluid Mechanics Including Hydraulic Machines, 23rd Edition, Standard Book House, 2022
3	Ramamrutham S., Fluid Mechanics and Hydraulics and Fluid Machines, Dhanpat Rai and Sons, New Delhi, 9th Edition, 2014
4	Rama Durgaiah D., Fluid Mechanics and Machinery, New Age International Publishers, New Delhi, 2002
Reference Books:	
1	Rajput R.K., A text book of Fluid Mechanics in SI Units, S. Chand and Company, 10thEdition, New Delhi, 2016
2	Subramanya K, Fluid mechanics and hydraulic machines, Tata Mc Graw Hill, New Delhi 2010
3	Streeter, Victor L. and Wylie, Benjamin E., Fluid Mechanics, McGraw-Hill Ltd., 2010
4	White FM, Fluid mechanics, Tata Mc Graw Hill, New Delhi, 2017.
5	Jain AK, Fluid mechanics including hydraulic machines, Khanna Publication, 2015.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand Fluid Properties	Understand
CO2	Apply Fluid Statics, Kinematics concepts	Apply
CO3	Study Euler's equation, Bernoulli's equation, its applications	Apply
CO4	Analyze Boundary layer problems, flow through pipes	Analyse
CO5	Understand Dimensional and Model Analysis	Understand

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

22CE302	SURVEYING				Semester		III
PREREQUISITES		Category	PC	Credit			3
Mathematics		Hours/Week	L	T	P		TH
			3	0	0		3

Course Learning Objectives	
1	To understand the Fundamentals of surveying in the field of civil engineering
2	To know the basics of levelling and Contouring
3	To know the basics of theodolite survey and computation of Area and Volume for Different Field
4	To understand tacheometric surveying in different terrain
5	To introduce the Advanced equipment for surveying in the field of civil engineering

Unit I	**FUNDAMENTALS OF SURVEYING**	**9**	**0**	**0**	**9**
Definition- Classifications - Basic principles- Classification - Field work and office work - Types of chain - methods of ranging a line – Maps-Scale, adjustment in wrong observations- uses of chain, cross - staff and optical square - sources and limits of error and their correction. Magnetic and true north, magnetic declination and its variation - Bearings - Prismatic compass - Surveyor's compass - compass survey - local attraction and its elimination - Traversing.					
Unit II	**LEVELLING AND ITS APPLICATIONS**	**9**	**0**	**0**	**9**
Terminology - Dumpy level and levelling staff - Temporary and permanent adjustments - Methods of levelling - Differential Levelling, Fly levelling, Reciprocal levelling, Check levelling - Procedure in levelling - Booking- Problems - Reduction - Curvature and refraction - Problems- Contouring - Terminology - Methods - Characteristics and uses of contours					
Unit III	**THEODOLITE TRAVERSING**	**9**	**0**	**0**	**9**
Terminology - Reiteration and repetition- Vertical angles - Traversing - Types of traversing - Trigonometrical levelling - Co-ordinate System-Closing error and distribution - Omitted measurements - Problems - Conditions for closure - Balancing of Traverse - Computation of Area (Trapezoidal and Simpson’s rule) and Computation of Volume (Trapezoidal and Prismoidal formula)					
Unit IV	**TACHEOMETRIC SURVEYING AND CURVES**	**9**	**0**	**0**	**9**
Tacheometric surveying - Systems of Tacheometric measurement - Principle of Stadia method - Methods with staff held vertical and normal - The Analytic lens - Subtense bar - Tangential method (Elevation and Depression) Curves - Types of Curves-Elements of simple curve- length of curve - Vertical curves – Types and its application.					
Unit V	**ADVANCED SURVEYING**	**9**	**0**	**0**	**9**
Principle of Electronic Distance Measurement, Types of EDM instruments, Total Station - Advantage and Applications - Fundamental quantities measured - Parts & Accessories of a Total Station – working principle - Global Positioning Systems- Segments, GPS measurements, errors and biases, Surveying with GPS, Drone Surveying and its applications					
					Total= 45 Periods

Text Books:	
1	Punmia B.C., Surveying, Vols. I, II and III, Laxmi Publications, 17th Edition,2016.
2	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill,4th Edition, 2019.
3	N N Basak, Surveying and Levelling, Tata McGraw Hill,2nd Edition,2017.

Reference Books:	
1	Clark D., Plane and Geodetic Surveying, Vols. I and II, C.B.S. Publisher and Distributors, Delhi, 6th Edition,1971.
2	James M.Anderson and Edward M.Mikhail, Introduction to Surveying, McGraw-Hill Book Company, 1st Edition,1985.
3	Wolf P.R., Elements of Photogrammetry, McGraw-Hill Book Company, 2nd Edition,2013.
4	Robinson A.H., Sale R.D. Morrison J.L. and Muehrche P.C., Elements of Cartography, John Wiley and Sons, New York, 5th Edition, 1984.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use conventional surveying instruments in the field of civil engineering applications	Understand
CO2	Calculate the Elevation for Different terrain from the datum	Apply
CO3	Categorized the terrain and Calculate the Area and Volume for the Terrain	Analyse
CO4	Understand the concept of Tacheometric Surveying and Curves layout	Understand
CO5	Use Advanced Equipment in the field of civil engineering.	Apply

COURSE ARTICULATION MATRIX

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

22CE303	CONSTRUCTION MATERIALS AND TECHNOLOGY		Semester		III
PREREQUISITES		**Category**	**PC**	**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 – common building stones, composition, properties, uses and occurrence- tests on stones-quarrying and dressing. Bricks- constituents of brick earth - manufacture of clay bricks -classification-qualities- tests on bricks- bricks for special use- refractory bricks.

Unit II	**CEMENT, AGGREGATES, MORTAR**	**9**	**0**	**0**	**9**

Cement- composition- properties –types of cement and their uses- 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- characteristics- uses- classification - preparation of plain cement concrete- principles of hardened concrete- properties of cement concrete- Special concrete- types.

Timber- characteristics- uses- defects-seasoning-preservation- market forms- Industrial timber- Panels of laminates. Glass- properties- uses. Steel- Uses - market forms. Aluminium 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-floor finishing-brick flooring - cement concrete flooring -granolithic flooring - terrazzo flooring- marble flooring - timber flooring - asphalt flooring - rubber flooring- suitability of floors for various applications. damp proof course, causes of dampness- effect of dampness -methods of damp proofing - materials used for damp proofing. Stairs - requirements of good stairs - classification of stairs - quarter turn stairs- half turn stairs circular - spiral and helical stairs - stairs made up of different materials-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 - under pinning - form work - materials used - Indian Standard on form work Plastering - methods of plastering - defects in plastering - pointing - objectives- methods of pointing - external finishes.

Total= 45 Periods

Text Books:	
1	B.C. Punmia , Building Construction, Laxmi Publications; Eleventh edition -2021
2	S.C.Rangwala, Building Construction, Charotar Publishing 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 the properties of Stone and brick	Remember
CO2	Understand the manufacturing process of cement and functions of mortar	Understand
CO3	Basic knowledge about the construction materials	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)**															

22ES301	MECHANICS OF SOLIDS		Semester			III
PREREQUISITES		**Category**	**ES**	**Credit**		**3**
Engineering Mechanics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	Understand the basic concepts of stress, strain and their relationships based on linear elasticity and their behavior due to different types of loading.
2	Familiarize about the determination of shear force and bending moment in various types of beams with different loading conditions.
3	Know the mechanism of load transfer in beams and the induced stresses due to bending moment and shear force for different loading conditions.
4	Determine forces in plane trusses and deformations in thin cylinders and shells under pressure.
5	Understand the complex state of stresses and solve practical problems related to springs and shafts

Unit I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9	0	0	9

Stress and strain due to axial force – elastic limit – Hooke’s law – factor of safety – lateral strain – Poisson’s ratio – volumetric strain – changes in dimensions and volumes- shear stress – shear strain – relationship between elastic constants. Stepped bars – uniformly varying sections – composite bars – stresses due to temperature. Strain energy due to axial force- proof resilience and modulus of resilience

Unit II	SHEAR FORCE AND BENDING MOMENT DIAGRAMS	9	0	0	9

Relationship between load, shear force and bending moment – shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads and concentrated moment – maximum bending moment and point of contra flexure.

Unit III	STRESSES DUE TO BENDING AND SHEAR	9	0	0	9

Theory of simple bending and assumptions – analysis of beams for stresses – stresses distribution at a cross section due to bending moment and shear force for cantilever, simply supported and overhanging beams with different loading conditions.

Unit IV	ANALYSIS OF PLANE TRUSS, THIN CYLINDERS/SHELLS	9	0	0	9

Stability and Equilibrium of plane frames-types of trusses-analysis of forces in truss members-method of joints and method of sections -thin cylinders and shells- under internal pressure-deformation of thin cylinders and shells

Unit V	TORSION AND COMPLEX STRESSES (Two dimensions only)	9	0	0	9

Theory of torsion and assumptions – derivation of torsion formula – polar modulus – stresses in solid and hollow circular shafts – power transmitted by a shaft.

State of stress at a point – normal and tangential stresses and their planes – principal stresses and their planes – plane of maximum shear stress – analytical method

Total= 45 Periods

Text Books:	
1	Bhavikatti S S strength of materials, Vikas Publishing House Pvt ltd., New Delhi, Fourth edition 2013.
2	Rajput RK, Strength of materials, S. Chand & Company ltd, New Delhi, Seventh edition 2018.
3	James M. Gere, Stephen P. Timoshenko, Mechanics of Materials, Stanley Thornes publisher4th Edition,1997.
4	R. C. Hibbeler, Mechanics of Materials (SI Edition), Prentice Hall, Nineth Edition, 2018.
5	Bansal R.K., Strength of materials, Laxmi Publications (P) Ltd., Fifth edition 2014.
6	S. P. Timoshenko, "Strength of materials", third edition, Vols. 1 & 2, CBS Publishers, 2002.
Reference Books:	
1	EGOR P. Popov, Engineering Mechanics Of Solids, Pearson publishers, 2nd Edition, January 2018.
2	S S Rattan, Strength of Materials, Tata McGraw-Hill Education,3rd Edition, July 2017.
3	Punmia B C Jain and Jain AK, Strength of materials and theory of structures, vols. I and II, XI Edition, Laxmi Publications P Ltd, New Delhi,13th Edition 2017.
4	Ramamrutham S and Narayanan R, Strength of Materials, Dhanpat Rai Publishing Company Pvt Ltd,18th Edition Reprint 2014.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Thorough understanding of fundamental concepts of stress, strain in mechanics of solids and in composite structures and also able to develop constitutive relationships between stress and strain for linearly elastic solid.	Understand
CO2	The ability to analyze the determinate beams by determining shear force and bending moments.	Analyse
CO3	Determine shear stresses and bending stresses in beams of various types under different loading conditions with varying cross sections.	Analyse
CO4	Analyze the determinate trusses and the deformations in thin cylinders and shells.	Analyse
CO5	Sufficient knowledge in design shafts to transmit required power and springs for its maximum energy and is able to analyze complex stresses in 2D, principal stresses and their directions.	Create

COURSE ARTICULATION MATRIX

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	-	1	-	-	-	2	1	2	3	-
CO2	3	3	3	3	3	-	-	-	-	-	-	-	3	3	-
CO3	3	3	3	3	1	-	-	-	-	-	-	-	2	2	-
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	-
CO5	3	3	3	3	2	-	-	-	-	-	-	-	3	3	-
Avg	3	3	2.8	3	2.4	-	1	-	-	-	2	1	2.6	2.8	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22EN301	TECHNICAL ENGLISH				Semester		III
PREREQUISITES			Category	HS	Credit		3
1.Basic knowledge in reading skill and writing skill **2.Basic ability in listening skill and speaking skill**			Hours/Week	L	T	P	TH
				2	0	2	4

Course Learning Objectives

1	To enable the learners to be effective in technical writing
2	To implement grammatical knowledge of the learners in everyday communication
3	To train the learners to be professional at working environment
4	To assist learners to excel at oral communication in business contexts
5	To enable the learners to communicate with confidence in interview and group discussion

Unit	Title	L	T	P	TH
Unit I	**TECHNICAL COMMUNICATION**	**6**	**0**	**6**	**12**
Communication and its types, Technical Communication, Technical Writing - project reports and progress reports, newsletters, business letters and minutes of meetings.					
Unit II	**BASIC GRAMMAR**	**6**	**0**	**6**	**12**
Tenses, Articles, Prepositions, Conditional clauses, Cohesion and coherence, Idioms and phrases.					
Unit III	**PROFESSIONAL WORK HABITS**	**6**	**0**	**6**	**12**
Work Habits, Self-development and assessment, Personal goal setting, Career planning, E-mail etiquettes.					
Unit IV	**ORAL COMMUNICATION**	**6**	**0**	**6**	**12**
Public speaking, Speaking on technical topics, Welcome address, Vote of thanks, Telephone etiquettes.					
Unit V	**PROFESSIONAL COMMUNICATION**	**6**	**0**	**6**	**12**
Interview preparations, Power-point presentations, Group discussions.					
					Total (30L+30P) = 60 Periods

Text Books:

1	Meenakshi Raman, Sangeeta Sharma, Technical Communication: Principles and Practice. CUP, India, 2018

Reference Books:

1	Muralikrishna, C and Sunita Mishra, Communication Skills for Engineers, Pearson Education, India, 2011
2	Ronald Carter, Michael McCarthy, Geraldine Mark and Anne O'Keeffe, English Grammar Today, Cambridge University Press, India, 2016.
3	N.P. Sudharshana and C.Savitha, English for Engineers, CUP, India, 2018

E-RESOURCES:

1	https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/index.html
2	https://techwhirl.com/what-is-technical-writing/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Draft effective technical documents	Create
CO2	Attain perfection in grammar and communication	Remember
CO3	Apply professional skills at the work place	Apply
CO4	Communicate in everyday life effectively	Understand
CO5	Participate in interview and group discussion confidently	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	3	-	3	-	-	1
CO2	-	-	1	-	-	2	-	-	2	3	-	2	-	-	1
CO3	-	-	3	-	-	2	-	-	2	3	-	3	-	-	3
CO4	-	-	2	-	-	3	-	-	1	3	-	2	-	-	3
CO5	-	-	2	-	-	2	-	-	3	3	-	3	-	-	3
Avg	-	-	2	-	-	2	-	-	2	3	-	2.6	-	-	2.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

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

Course Learning Objectives

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

Unit I	**CHALLENGE CURATION**	**0**	**0**	**6**	**6**

Introduction : Design Thinking Principles - Design Thinking Values - Design Thinking Methods - Challenge impact setting - Framing the design challenge.

Unit II	**CUSTOMER - CENTRIC INNOVATION**	**0**	**0**	**6**	**6**

Understanding Customer needs - Empathy building techniques - gap analysis - adoption barriers - observations and insights - Translating insights into innovation opportunities.

Unit III	**IDEA GENERATION**	**0**	**0**	**6**	**6**

Identifying pains & gains - crafting value proposition - Ideation - Divergent Thinking - Ideation methods - Rules of brainstorming -Managing risks - Concept of minimum usable prototypes - Generating solution concepts.

Unit IV	**PRETOTYPING**	**0**	**0**	**6**	**6**

Pretotyping concepts - Palm Pilot Experiment - Fake it before make it - Prototyping - The Law of Failure - Building a Prototype - Testing the Prototypes

Unit V	**PITCH & PRESENTATION**	**0**	**0**	**6**	**6**

Science of Storytelling - the blueprint for storytelling - Pitch Script - Pitch Presentations - Best Practices to creating a compelling pitch - communication fundamentals.

Total = 30 Periods

Text Books:

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

Reference Books:

1	Savoia.Alberto, 2009, The Pretotyping Manifesto - https://sites.google.com/a/pretotyping.org/www/the-pretotyping - manifesto-
2	Jazz Factory, All about Presentations - http://bog.jazzfactory.in/
3	Pretotyping Methodology - https://www.pretotyping.org/methodology.html
4	How to give a killer presentation - https://hbr.org/2013/06/how-to-give-a-killer-presentation

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Level
CO1	Identify real-world problems	L3: Applying
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	L3: Applying

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1	1	1							1	1	1	2
CO2	1	2	1	1	1	2			2	1		1	1	1	1
CO3	2	3	3	2	2							1	3	3	2
CO4	2	2	3	2	3							1	3	3	3
CO5	1	2	1	1	1				2	3	1	1	1	1	1
AVG	**1.4**	**2.4**	**1.8**	**1.4**	**1.6**	**2**			**2**	**2**	**1**	**1**	**1.8**	**1.8**	**1.8**

0: No correlation, 1: Low correlation, 2: Medium correlation, 3: High correlation

22CE304	ADVANCED SURVEYING AND BASIC GIS PRACTICAL				Semester		III
PREREQUISITES		Category	PC		Credit		2
NIL		Hours/Week	L	T	P		TH
			0	0	4		4

Course Learning Objectives

1	To understand the Fundamentals of surveying in the field of civil engineering
2	To know the basics of levelling and Contouring
3	To know the basics of theodolite survey and computation of Area and Volume for Different Field
4	To understand tacheometric surveying in different terrain
5	To introduce the Advanced equipment for surveying

LIST OF EXPERIMENTS

1. Study of Conventional Equipment for Surveying
2. Levelling - Height of Collimation and Rise & Fall Method
3. Heights and Distances of Inaccessible stations by Double plane method
4. Stadia Tacheometry
5. Tangential Tacheometry.
6. Calculation of Area and Volume using Total Station
7. Setting out works Building using Total station
8. Setting out works - Simple curve (right/left-handed) Using Total Station
9. Determination of Coordinates using Differential Global Positioning System
10. Measurement of Radial Distance using Differential Global Positioning System

Total = 60 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use conventional surveying instruments in the field of civil engineering applications	Understand
CO2	Calculate the Elevation for Different terrain from the datum	Apply
CO3	Categorized the terrain and Calculate the Area and Volume for the Terrain	Analyse
CO4	Understand the concept of Tacheometric Surveying and Curves layout	Understand
CO5	Use Advanced Equipment in the field of civil engineering.	Apply

COURSE ARTICULATION MATRIX

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

22CE305	MATERIAL TESTING & EVALUATION LABORATORY			Semester			III
PREREQUISITES		Category		PC	Credit		2
Mechanics of Solids		Hours/Week		L	T	P	TH
				0	0	4	4

Course Learning Objectives

1	To find the strength properties of different construction materials like Steel
2	To evaluate stiffness properties of springs
3	To find the hardness properties of various metals
4	To find the deflection behaviour of beams
5	To find the quality of construction material

LIST OF EXPERIMENTS

1. Tension test on mild steel specimen
2. Deflection test on simply supported beam
3. Deflection test on double cantilever beam
4. Double shear test on mild steel rod
5. Torsion test
6. Test of springs
   i. Compression Spring
   ii. Tension spring
7. Compression test on concrete cube
8. Crushing test on bricks
9. Hardness test on metals like mild steel, brass and aluminium
10. Split tensile test on concrete
11. Charpy Impact test

Total = 60 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the type of materials	Understand
CO2	Adopt appropriate test to find the properties of materials	Apply
CO3	Arrive the required properties of materials	Apply
CO4	Justify the quality of the materials	Analyze
CO5	Recommend the material for a construction work	Analyze

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

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

Course Objectives:

1. To maintain the unity and disciplines to the students

UNIT I	**SOCIAL SERVICE & COMMUNITY DEVELOPMENT**	**9**	**0**	**0**	**9**
Basic of social service and it's need - Rural Development Program – NGOs Roles &Contribution – Drug abuse and Trafficking – Civic Responsibilities – Causes & prevention of AIDS/HIV – Counter Terrorism – Corruption – Social Evil – RTI & RTE – Traffic Control Organization – Anti Drunken Driving.					
UNIT II	**GENERAL AWARENESS & ADVENTURE**	**9**	**0**	**0**	**9**
General Knowledge – Logical & Analytical Reasoning - Modes of Entry to Army, CAPF, Police – SSB Procedure; Para Sailing – Slithering – Rock climbing – Cycling and Trekking.					
UNIT III	**AEROENGINES & NAVIGATION**	**9**	**0**	**0**	**9**
Introduction to aero engines and its type – Components of aero engines – Principles of Propulsion – Basic Terminology – Jet engines – Brayton Cycle – Turbo prop engines and its types; Requirements of Navigation - Lines on Earth – Maps and its types - Symbols used in map – Scales of map – Map reading procedure and its aids.					
UNIT IV	**AIRFRAME & METEOROLOGY**	**9**	**0**	**0**	**9**
Aircraft Control – Primary and Secondary –Fuselage – Main Plain and Tail Plain – Ailerons, Elevators& Rudders – Landing Gear; Importance of METT in Aviation – Atmosphere – Clouds and Precipitation – Flying Hazards.					
UNIT V	**FLIGHT INSTRUMENTS & AEROMODELLING**	**9**	**0**	**0**	**9**
Airspeed Indicator – Altimeter – Artificial Horizon – Radar and Its Type – Instruments Battery Test, Compass; History of Aero Modeling – Basic Materials & Tools – Types of Aero Modelling – Flying/Building of Aero Models – General Safety Procedure.					
					Total = 45 Periods

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

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
CO2	3	3	2	3									3	2	1
CO3	3	2	3	1		2							3	2	1
CO4	3	2	2	2		0							3	2	1
CO5	3					1							3	3	1
Avg	**3**	**1.6**	**1.4**	**1.2**		**0.6**							**3**	**2**	**1**
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22CE401	STRENGTH OF MATERIALS			Semester		IV
PREREQUISITES		**Category**	**PC**	**Credit**		**4**
Mechanics of solids and Engineering Mechanics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**1**	**0**	**4**

Course Learning Objectives

1	To study the different methods of determining deflection of determinate and indeterminate beam.
2	To analyse the column with different end conditions
3	To Understand the behaviour of member subjected to various loads
4	To know about unsymmetrical bending and shear centre
5	To analysis of simple and special structures to find internal forces / stresses using various theorems / theories

Unit I	DEFLECTION OF DETERMINATE BEAMS	9	3	0	12

Governing differential equation –Double integration method- Macaulay's method Moment Area method -Strain energy and Dummy unit load approaches – Castigliano's first and second theorems.

Unit II	STATICALLY INDETERMINATE BEAMS	9	3	0	12

Propped cantilever beams – Fixed beams – Continuous beams – Theorem of three moments – Calculation of reactions – Bending Moment and Shear Force diagrams

Unit III	THEORY OF COLUMNS	9	3	0	12

Members subjected to axial Load – Slenderness ratio – End conditions – Buckling load for columns- Euler's theory – Assumptions and limitations – Rankine-Gordon formula – Empirical formula – Straight line formula – Columns subjected to eccentric loading

Unit IV	UNSYMMETRICAL BENDING AND SHEAR CENTRE	9	3	0	12

Stresses due to unsymmetrical bending of beams for symmetrical sections – Shear Centre - Definition – Shear centre for sections symmetrical about one axis – Moment of Inertia – Product of Inertia – Principal axes and Principal moment of Inertia – Deflection of beams due to unsymmetrical bending

Unit V	THICK CYLINDERS AND THEORIES OF FAILURES	9	3	0	12

Lame's equation – Hoop stress and radial stress distribution – Compound cylinders – Wire wound cylinders.

THEORIES OF FAILURE: Maximum principal stress theory – Maximum principal strain theory – Maximum shear stress theory - Maximum strain energy theory – Maximum shear strain energy theory – simple problems

Total= 60 Periods

Text Books:

1	Rajput.R.K. "Strength of Materials" fifth Edition ,S.Chand and Co, New Delhi, 2015
2	Bhavikatti. S., "Solid Mechanics", Vikas publishing house Pvt. Ltd, New Delhi, 2010.

Reference Books:	
1	Timoshenko.S.B. and Gere.J.M, “Mechanics of Materials”, Van Nos Reinbhold, New Delhi 1995.
2	Junnarkar.S.B. and Shah.H.J, “Mechanics of Structures”, Vol I, Charotar Publishing House, New Delhi 1997.
3	Gambhir. M.L., "Fundamentals of Solid Mechanics", PHI Learning Private Limited., New Delhi, 2009.
4	Kazimi S.M.A, “Solid Mechanics”, Tata McGraw-Hill Publishing Co., New Delhi, 2003
5	William A .Nash, “Theory and Problems of Strength of Materials”, Schaum’s Outline Series, Tata McGraw Hill Publishing company,2007

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Apply the principle of various theorems in measurement of slope and deflection for beams	Apply
CO2	Plot shear force and bending moment diagram for indeterminate beams	Apply
CO3	Visualize the behaviour of column for combined bending and axial loading	Apply
CO4	Apply the different methods in unsymmetrical bending analysis	Apply
CO5	Demonstrate the different theories of failure for brittle and ductile materials and Different stress developed in thick cylinders and spherical shells	Apply

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	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	2	3	2	-	-	-	-	-	-	-	-	-	-
CO4	2	3	-	2	2	1	-	-	-	-	-	-	-	-	-
CO5	-	3	-	2	2	1	-	-	-	-	-	-	2	-	-
Avg	2	2.8	2	2.2	1.8	1	-	-	-	-	-	-	2	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CE402	**STEEL STRUCTURAL ELEMENTS** **(Use of IS 800 – 2007 & Steel tables are permitted)**		**Semester**			**IV**
PREREQUISITES		**Category**	**PC**	**Credit**		**4**
Strength of Materials & Structural Analysis		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**1**	**0**	**4**

Course Learning Objectives

1	To learn limit state design concepts and different types of loads
2	To study the behaviour and design of compression and tension members using simple and built-up sections
3	To understand the behaviour of flexural members and the design laterally restrained and unrestrained beams
4	To study the design of bolted and welded connections
5	To study the behaviour of beams and design of laterally supported and unsupported beams

Unit I	**INTRODUCTION**	**9**	**3**	**0**	**12**

Structural systems - Mechanical properties of steel - Various uses of steel in civil engineering - Advantages and disadvantages of steel structures - various loads and their combinations - Design considerations - Limit state method of design - failure criterion of steel - codes of steel, rolled structural steel sections and specifications - Elastic modulus, concept of allowable stress design and ultimate load method - Limit state design - strength and serviceability - Partial safety factors - load factor - working loads and ultimate loads - Other properties: durability – fatigue – fire protection

Unit II	**CONNECTIONS**	**9**	**3**	**0**	**12**

Bolted Connections: Introduction - Terms used in bolted connections - Types of bolted connections - Behavior of bolted joints - Design of axially loaded joints with ordinary black bolts and High strength Friction Grip (HSFG) bolts - Efficiency of joints.

Welded Connections: Introduction - Welding process - Advantages of welding - Types and properties of welds - Types of welded joints - Weld symbols and specifications - Effective areas of welds - Design of welds - Analysis and design of Simple joints-

Unit III	**TENSION MEMBERS**	**9**	**3**	**0**	**12**

Introduction - Types of tension members - slenderness ratio - behavior of axially loaded tension members - Net area – Net effective sections for angles and Tee in tension - failure modes of tension members - Factors affecting the strength of tension members - Concept of shear lag - Design of axially loaded tension members with bolted and welded connections – Use of lug angles.

Unit IV	**COMPRESSION MEMBERS**	**9**	**3**	**0**	**12**

Introduction - Behavior of compression members - types - rolled steel sections used for compression members - current codal provision for compression member design – slenderness ratio - Effective length of compression members - Design of compression members using single section - Design of built-up compression members with lacing and batten - Design of simple slab base and gusseted base.

Unit V	**BEAMS**	**9**	**3**	**0**	**12**

Introduction - sections used for beams - types of beams - classification of sections factors affecting lateral stability and behavior of simple rolled steel beams in bending – simple and compound sections – calculation of plastic modulus of sections - behavior of web under shear – shear check – deflection check - bearing strength of web – buckling strength of web - web buckling –web crippling -Design of laterally supported and laterally unsupported rolled steel beams.

Total= 60 Periods

Text Books:	
1	Duggal S.K., Limit State Design of Steel Structures, Tata McGraw-Hill Publishing Company, New Delhi, 3rd Edition, 2017.
2	Subramanian N., Design of Steel Structures, First edition, OXFORD university press, 2013.
3	Gambir. ML., Fundamentals of Structural Steel Design, McGraw Hill education India Pvt.Ltd., 2017
Reference Books:	
1	Bhavikatti S. S., Design of Steel Structures by Limit Method, I.K. International Pvt Ltd, New Delhi, 2016.
2	Ramchandra S., & Virendra Gehlot., Limit State Design of Steel Structures, Standard Publication, New Delhi, 2011.
3	Jayagopal L S, 'Structural Steel Design", Vikas Publications, 2016.
4	Teaching Resources for Structural Steel Design – Vol. I & II, INSDAG, Kolkatta.
5	IS 800:2007 Code of practice for general construction steel
6	SP 6 IS Structural steel Design Illustrated Hand book
7	E-learning resources: http://nptel.ac.in/courses/105106112/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the concepts of steel structures and its design philosophies.	Understand
CO2	Design structural steel bolted and welded connections for steel structures	Apply
CO3	Design structural steel members subjected to tension	Apply
CO4	Design compression members using simple and built-up sections and column bases	Apply
CO5	Understand the behaviour of beams and design of laterally supported and unsupported beams.	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	3	-	-	-	-	-	1	-	-	2	3	-
CO2	1	2	3	3	-	-	-	-	-	1	-	-	2	3	-
CO3	1	2	3	3	-	-	-	-	-	1	-	-	2	3	-
CO4	1	2	3	3	-	-	-	-	-	1	-	-	2	3	-
CO5	1	2	3	3	-	-	-	-	-	1	-	-	2	3	-
Avg	1	2	3	3	-	-	-	-	-	1	-	-	2	3	-

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

<table>
<tr><td>22CE403</td><td colspan="3">MECHANICS OF SOILS</td><td colspan="3">Semester</td><td>IV</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Mechanics of Fluids</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 acquire knowledge on the basic and Engineering properties of soils</td></tr>
<tr><td>2</td><td colspan="7">To understand stress distribution due to self-weight of soils and also due to externally applied loads</td></tr>
<tr><td>3</td><td colspan="7">To study flow through soil and to gain knowledge about flow net diagrams</td></tr>
<tr><td>4</td><td colspan="7">To get idea about the Engineering behaviour of soils such as compaction, consolidation of soils</td></tr>
<tr><td>5</td><td colspan="7">To know the different methods for finding shear strength of soils</td></tr>
<tr><td>Unit I</td><td colspan="3">BASIC PROPERTIES OF SOILS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Soil formation – Soil problems in Engineering – Physical properties of soil – Phase relations – Index properties of soil – Grain size distribution – Atterberg’s limits – Classification of soils – BIS classification – Field identification.</td></tr>
<tr><td>Unit II</td><td colspan="3">STRESSES IN SOILS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Soil water –Static pressure in water-Effective stress concepts in soils – Capillary phenomenon –Vertical stress distribution in soils – Boussinesq equation – Vertical stress distribution diagrams -Line load – Uniformly loaded areas – Newmark’s Influence Chart – Construction and Use –Approximate methods – Isobars – Westergaard’s Analysis-Contact Pressure.</td></tr>
<tr><td>Unit III</td><td colspan="3">PERMEABILITY AND SEEPAGE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">One dimensional flow through soil – Permeability – Darcy’s Law – field and laboratory test- flow through stratified soil – Factors affecting permeability of soil.

Seepage pressure – Quick sand condition – Two dimensional flow – Laplace equation – Electrical analogy – Flow net – Methods of construction, properties and applications – earth dam – Phreatic line.</td></tr>
<tr><td>Unit IV</td><td colspan="3">COMPACTION AND CONSOLIDATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Compaction – laboratory tests – Standard Proctor’s Compaction test – Modified Proctor’s Compaction –Moisture density relation – factors affecting compaction – Field compaction methods – Compaction control.

Consolidation – Components of settlement – Laboratory test – Terzaghi’s One Dimensional Consolidation – Definition – Normally consolidated clay – Over Consolidated clay – Under Consolidated clay – e -log ρ relationship – Boundary condition – Time factor – Time rate of consolidation -√t and log t methods-Factors influencing compression behavior of soils.</td></tr>
<tr><td>Unit V</td><td colspan="3">SHEAR STRENGTH</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Shear strength of soil – importance and use – Mohr – Coulomb’s theory – Laboratory test – Direct shear test – Triaxial Compression test – Types of Triaxial test based on drainage conditions –Unconfined Compression Test – Vane Shear test – Factors affecting the Shear Strength.</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Punmia B.C Soil Mechanics and Foundations, Laxmi Publications Pvt. Ltd., New Delhi, 2017.
2	Gopal Ranjan and Rao A.S.R., Basic and Applied Soil Mechanics, New Age International Publishers (P) Ltd., New Delhi, 2016.
3	Venkataramaiah, C., Geotechnical Engineering, New Age International Publishers, New Delhi, 2017.
Reference Books:	
1	Arora K.R., Soil Mechanics and Foundation Engineering, Standard Publishers and Distributors, New Delhi, 2009.
2	Braja M. Das, Fundamentals of Geotechnical Engineering, Thomson Asia Pvt. Ltd, Singapore,2005
3	Braja M. Das, Principles of Geotechnical Engineering, Thomson Asia Pvt. Ltd, Singapore,2008.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the soil based on the tests conducted.	Understand
CO2	Do proper stress estimation for various types of foundation loads.	Analyze
CO3	Analyze any practical problems related to soil stresses estimation, permeability and seepage including flow net diagram	Analyze
CO4	Solve practical problems related to consolidation settlement and time rate of settlement	Apply
CO5	Estimate shear strength of soil using the parameters obtained from different lab tests.	Analyze

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

22CE404	WATER SUPPLY ENGINEERING			Semester		IV
PREREQUISITES		Category	PC	Credit		3
NIL		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To find the sources of water supply and analyse the characteristics of water
2	To design of intake structure and conveyance system for water transmission.
3	To understand the process of conventional treatment of water and design of water treatment system.
4	To Recognize and design the various advanced treatment system and gain knowledge about the recent advances in water treatment process
5	To design and evaluate water distribution system and water supply in buildings

Unit I	SOURCES OF WATER	9	0	0	9

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

Unit II	CONVEYANCE FROM THE SOURCE	9	0	0	9

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

Unit III	WATER TREATMENT	9	0	0	9

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, Sedimentation - theory, settling tanks, types and design. Coagulation and flocculation, Clarriflocculators (circular and rectangular). Types of coagulants. Filtration: mechanism, theory of filtration, types of filters: slow sand, rapid sand and pressure filters. Operation, cleaning. Operational problems in filters., aerators of flash mixers -Plate and tube settlers - Disinfection - Residue Management –Construction, Operation and Maintenance aspects

Unit IV	ADVANCED WATER TREATMENT METHODS	9	0	0	9

Water softening – Iron and Manganese removal - Defluoridation - Adsorption - Desalination- R.O. Plant – demineralization process –Ion exchange– Membrane Systems – RO Reject Management - Operation & Maintenance aspects – Recent advances.

Unit V	WATER DISTRIBUTION AND SUPPLY	9	0	0	9

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design –– Analysis of distribution networks -Computer applications- Appurtenances – Leak detection.

Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

Total= 45 Periods

Text Books:	
1	Garg, S.K. Environmental Engineering, Vol.I Khanna Publishers, New Delhi, 2010.
2	Modi, P.N., Water Supply Engineering, Vol.I Standard Book House, New Delhi, 2010.
3	Punmia, B. C., Ashok Jain and Arun Jain, Water Supply Engineering, Laxmi Publications(P) Ltd., New Delhi, 2010.
Reference Books:	
1	Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2	Syed R. Qasim and Edward M. Motley Guang Zhu, Water Works Engineering Plant.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the sources of water supply, analyse the characteristics of water and an understanding of water quality criteria and standards and their relation to public health.	Analyze
CO2	Get an insight into water transport and classification of intake structures, pipes and pumps.	Analyze
CO3	Get the knowledge in various unit operations and processes in water treatment.	Remember
CO4	Assess the various advanced water treatment methods	Evaluate
CO5	Express the analysis of distribution network and house service connections.	Understand

COURSE ARTICULATION MATRIX

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	-	2	3	3	-	-	1	2	1	3	1	2
CO2	3	3	2	-	-	3	3	-	-	-	2	1	3	-	2
CO3	3	3	3	2	1	3	3	-	-	2	2	1	3	1	1
CO4	2	2	1	1	-	3	1	-	2	3	2	3	3	1	2
CO5	2	2	1	1	1	3	1	1	2	3	2	1	3	1	2
Avg	2.6	2.2	1.8	1.3	1.3	3.0	2.2	1.0	2.0	2.3	2.0	1.4	3.0	1.0	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CE405	APPLIED HYDRAULICS AND FLUID MACHINERY			Semester		IV
PREREQUISITES		**Category**	**PC**	**Credit**		**3**
'Mechanics of Fluids'		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand basic of open channel flow
2	To understand Varied flow, hydraulic jump and surges.
3	To study Momentum principle
4	To study about different turbines
5	To study about Classification of pumps

Unit I	OPEN CHANNEL FLOW	9	0	0	9

Open channel flow – Types and regimes of flow – Velocity Distribution – Wide open channel – Specific energy – Critical flow and its computation. Uniform flow – Velocity measurement – Manning's and Chezy's formula – Determination of roughness coefficients – Determination of normal depth and velocity – Most economical sections.

Unit II	VARIED FLOW	9	0	0	9

Dynamic equation of Gradually Varied Flow – Assumptions – Draw down and Back water curves -Characteristics of flow profiles — Profile determination – Graphical integration, direct step and standard step method - Hydraulic jump – Types – Energy dissipation.

Unit III	MOMENTUM PRINCIPLE	9	0	0	9

Impulse Momentum equation – Application of linear momentum principle – Impact of jet – force exerted by a jet on normal, inclined and curved surfaces for stationary and moving cases – angular momentum principle –construction of velocity Triangle – Jet propulsion.

Unit IV	TURBINES	9	0	0	9

Classification – working principles of Pelton Wheel, Francis and Kaplan turbines – Velocity triangles – efficiencies– Draft tube - theory and types – Specific speed –Governing of Turbines.

Unit V	PUMPS	9	0	0	9

Classification - Centrifugal pump – working principle –velocity triangle - Minimum speed to start the pump– Multistage pumps – Specific speed - performance curves – Reciprocating Pump– components and working – slip - indicator diagram - Air vessel – working principle of Jet pump, Submersible pump and Gear pump, Air lift Pump.

Total= 45 Periods

Text Books:

1	Bansal R.K., Fluid Mechanics and Hydraulic Machines, 10thEdition, Laxmi Publications(P) Ltd, New Delhi, 2018
2	Ramamrutham S., Fluid Mechanics and Hydraulics and Fluid Machines, Dhanpat Rai and Sons, Delhi, 9th Edition, 2014
3	Rama Durgaiah D., Fluid Mechanics and Machinery, New Age International Publishers, New Delhi, 2002

Reference Books:

1	Rajput R.K., A textbook of Fluid Mechanics in SI Units, S. Chand and Company, 10thEdition, New Delhi, 2016
2	Subramanya K., Flow in Open channels, Tata McGraw-Hill Publishing Company, 1994

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand open channel flow,	Understand
CO2	Analyse varied flow, hydraulic jump problems	Analyse
CO3	Apply momentum principle in Hydraulic machines	Apply
CO4	Analyse the characteristics, performance of various turbines	Analyse
CO5	Understand about working of different pumps and Efficiency	Understand

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22CE406</td><td colspan="4">CONCRETE TECHNOLOGY
(Use of IS456:2000; IS10262-2019 (pg:1 to 15) and ACI 211.1.91 (pg: 1 to 13, 21 to 23)</td><td colspan="3">Semester</td><td>IV</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td colspan="2">Category</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Construction Materials and Technology</td><td colspan="2" rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">Have a good knowledge about constituent materials in concrete.</td></tr>
<tr><td>2</td><td colspan="8">Understand the concept and procedure for concrete mix design as per IS code standards.</td></tr>
<tr><td>3</td><td colspan="8">Get awareness about the properties of fresh and hardened concrete.</td></tr>
<tr><td>4</td><td colspan="8">Know about the types of special concrete.</td></tr>
<tr><td>5</td><td colspan="8">Acquire awareness about quality control in concrete.</td></tr>
<tr><td>Unit I</td><td colspan="4">MATERIALS AND THEIR PROPERTIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Cement – constituents – tests on cement – types of cement – aggregates – M-Sand – properties and uses – classification of aggregates – properties and tests on aggregates – gradation – quality of water– admixtures – accelerators – retarders.</td></tr>
<tr><td>Unit II</td><td colspan="4">CONCRETE MIX DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Nominal mixes – design mixes – factors influencing the design – Theory and Design problems - ACI method, DOE method and IS method (IS 10262:2019).</td></tr>
<tr><td>Unit III</td><td colspan="4">PROPERTIES OF FRESH AND HARDENED CONCRETE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Properties of fresh concrete – workability – segregation – bleeding – properties of hardened concrete – strength – stress-strain characteristics – modulus of elasticity – shrinkage – creep – thermal conductivity – permeability – test for tension, compression and flexure.</td></tr>
<tr><td>Unit IV</td><td colspan="4">SPECIAL CONCRETES AND CONCRETING METHODS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Special concrete and mortar, concrete chemicals, special elements for accelerated strength gain, 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. Light weight concrete – ready mix concrete – fibre reinforced concrete.</td></tr>
<tr><td>Unit V</td><td colspan="4">QUALITY CONTROL AND ASSURANCE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Frequency of sampling – statistical analysis of test results – standard deviation – coefficient of variation – characteristic strength – acceptance and rejection criteria. Non-Destructive tests. Introduction on Forensic Testing in concrete.</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
<tr><td colspan="9">Text Books:</td></tr>
<tr><td>1</td><td colspan="8">Neville A.M Properties of Concrete, Pearson publication, 2012.</td></tr>
<tr><td>2</td><td colspan="8">Shetty M. S Concrete technology, S. Chand and Company Ltd, New Delhi 2018.</td></tr>
<tr><td>3</td><td colspan="8">Santhakumar A.R Concrete Technology, Oxford university Press, New Delhi, 2018.</td></tr>
<tr><td>4</td><td colspan="8">Mehta K.P Concrete Technology, Chand & Co, New Delhi, 2006.</td></tr>
<tr><td>5</td><td colspan="8">Robert RatayForensic Structural Engineering Handbook, McGraw Hill LLC, 2009</td></tr>
</table>

Reference Books:	
1	Indian Standard Recommended Guidelines for Concrete Mix Design, IS:10262 – 2019, Bureau of Indian Standards, New Delhi.
2	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete IS:383-1970 R2011, Bureau of Indian Standards, New Delhi.
3	Gambhir.M. Concrete technology, Volume I &II , Tata McGraw-Hill Book Company, Third print, 2003
4	Krishnaraju N. Design of Concrete Mixes, CBS publishers. New Delhi, 2002.
5	Stephen E. Petty,Forensic Engineering: Damage Assessments for Residential and Commercial Structures, CRC press, Taylor & Francis,2013.
6	IS 456:2000 Indian standard plain and reein forced concrete -Code of practice
7	ACI 211.1.91 Standard practice for selecting proportions for normal heavy weigh and mass concrets.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Test all the concrete materials as per IS code.	Evaluate
CO2	Design the concrete mix using ACI and IS code methods.	Create
CO3	Determine the properties of fresh and hardened concrete.	Apply
CO4	Know about the applications of special concretes and different concreting methods.	Apply
CO5	Ensure quality control while testing/ sampling and acceptance criteria.	Evaluate

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	-	-	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)**															

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

Course Learning Objectives

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

Unit I	**DESIGN FUNDAMENTALS**	**0**	**0**	**6**	**6**
Introduction to Visual Design, History and Modernism, Design Thinking methodology, seven elements of design, principles of design, principles of good design, designing a product and a service					
Unit II	**SYSTEM THINKING AND REVERSE ENGINEERING**	**0**	**0**	**6**	**6**
System Thinking for Engineering Problem Solving, Understanding Systems, Examples and understandings, Complex Systems, Reverse Engineering Methodology, Identify building blocks/Components - Re-Engineering a complex system					
Unit III	**USER INTERFACE & USER EXPERIENCE**	**0**	**0**	**6**	**6**
Introduction to UI/UX, Human-Computer interface, user-centered Design Principles, User research techniques, UX Design workflow, Information Architecture, UI Components, need for UI prototyping, Wireframes					
Unit IV	**MECHANICAL PROTOTYPING**	**0**	**0**	**6**	**6**
Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Introduction - Working with Fusion 360 - 3D Modeling - 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing					
Unit V	**ELECTRONIC & SOFTWARE PROTOTYPING**	**0**	**0**	**6**	**6**
Introduction to Lumped Circuits - Electronic Prototyping - Tinker CAD - Designing in KI CAD - PCB design - Source code management and version control - GitHub - GitHub Actions - GitBash - Continuous Integration - Platform as service - Heroku - Build Packs					
					Total = 30 Periods

Text Books:

1	Thinking in systems - Donella Meadows, 2015
2	Rapid Prototyping And Engineering Applications: A Toolbox For Prototype Development - Frank W.Liou, 2007
2	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 this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the elements and principles of product and service design	L2: Understanding
CO2	Apply system thinking concepts in reverse engineering	L3: Applying
CO3	Apply user research techniques to meet the UX needs of a customer and design a visual prototype	L3: Applying
CO4	Develop prototyping models using the tools from mechanical prototyping models	L3: Applying
CO5	Develop prototyping models using the tools from electrical and software prototyping methods	L3: Applying

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	1	1								3	2	2
CO2	2	3	3	2	2								3	3	3
CO3	2	2	3	1	3								3	2	2
CO4	3	2	3	1	3								3	3	3
CO5	3	2	3	2	3								3	3	3
AVG	**2.4**	**2**	**3**	**1.4**	**2.4**					**1**			**3**	**2.6**	**2.6**

0: No correlation, 1: Low correlation, 2: Medium correlation, 3: High correlation

22CE407	COMPUTER AIDED BUILDING DRAWING			Semester			IV
PREREQUISITES		**Category**		**PC**	**Credit**		**1.5**
Construction materials and Practice		**Hours/Week**		**L**	**T**	**P**	**TH**
				0	**0**	**3**	**3**

Course Learning Objectives

1	To impart knowledge on development and control rules satisfying orientation and functional requirements
2	At the end of this course the student should be able to draft the building drawings manually
3	At the end of this course the student should be able to draft the building drawings by using software
4	Understand the plan and elevation of buildings according to Indian standards.
5	At the end of this course the student should be able to draft the perspective view of building manually and by using software

LIST OF EXPERIMENTS

1. Part-A (Manual drawing)

Building drawing in accordance with development and control rules satisfying orientation and functional requirements for the following: (30 hours)

1. Residential buildings with load bearing walls (RCC roof).
2. RCC framed structures.
3. Office buildings (RCC roof).
4. Industrial Buildings-North light roof truss.
5. Perspective view for small buildings

2. Part-B

Fundamental Commands of Drafting Software to Draft the building Drawings (10 Hours)

Building drawing in accordance with development and control rules satisfying orientation and functional requirements using computer aided software for the following :(20 Hours)

1. Residential buildings with load bearing walls (RCC roof)
2. RCC framed structures
3. Office buildings (RCC roof)
4. Perspective view for small buildings

Total = 45 Periods

Reference Books:

1	Verma B.P., Building Drawing- Khanna publishers.
2	IS: 962-1967 Code of Practice for Architectural and Building Drawing.

E-Reference:

1	https://nptel.ac.in/courses/112102101/- Computer Aided Design (NPTEL)
2	https://www.autodesk.in/campaigns/autocad-tutorials-
3	https://knowledge.autodesk.com/support/civil-3d/getting-startedl-

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Draft the plan, elevation and sectional views of the Residential buildings with load bearing walls manually and using computer software.	Understand
CO2	Draft the plan, elevation and sectional views of the framed buildings using computer software and manually.	Apply
CO3	Draft the plan, elevation and sectional views of the office building using computer software and manually.	Understand
CO4	Draft the plan, elevation and sectional views of the industrial structures, manually.	Understand
CO5	Draft the perspective views for small buildings,	Apply

COURSE ARTICULATION MATRIX

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	-	-	-	-	2	-	2	2	1	-	2	3	2
CO2	-	-	-	-	-	-	2	-	2	2	2	-	2	3	2
CO3	-	-	-	-	-	-	2	-	2	2	2	-	2	3	2
CO4	-	-	-	-	-	-	2	-	2	2	2	-	2	3	3
CO5	-	-	-	-	-	-	-	-	2	2	-	-	2	3	1
Avg	-	-	-	-	-	-	2	-	2	2	1.75	-	2	2.8	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CE408	APPLIED HYDRAULIC & MACHINERY LABORATORY		Semester			IV
PREREQUISITES		Category	PC	Credit		1.5
Engineering Mathematics, physics and Fluid mechanics		Hours/Week	L	T	P	TH
			0	0	3	3

Course Learning Objectives

1	At the end of this course the student should be able to evaluate co-efficient of discharge of various hydraulic devices
2	At the end of this course the student should be able to evaluate the hydraulic characteristics of pipes
3	At the end of this course the student should be able to evaluate the hydraulic characteristics of minor losses in pipes
4	At the end of this course the student should be able to evaluate the hydraulic characteristics of turbines
5	At the end of this course the student should be able to evaluate the hydraulic characteristics of pumps

LIST OF EXPERIMENTS

1	Determination of coefficient of discharge of flow through orifice
2	Determination of coefficient of discharge of flow throughmouthpiece
3	Determination of coefficient of discharge of flow over notches
4	Determination of coefficient of discharge for venturi meter
5	Determination of coefficient of discharge for orifice meter
6	Determination of friction factor of pipes
7	Determination of minor losses in pipes
8	Study on performance characteristics of Pelton wheel turbine
9	Study on performance characteristics of Kaplan turbine
10	Study on performance characteristics of Centrifugal pump
11	Study on performance characteristics of reciprocating pump
12	Study on performance characteristics of jet pump
13	Study on performance characteristics of self-priming pump
14	Study on performance characteristics of gear oil pump
	Total = 45 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the operations of various types of flow measuring devices and determine the frictional and minor losses.	Understand
CO2	Calibrate flow measuring devices used in pipes, channels and tanks	Apply
CO3	Determine fluid and flow properties	Apply
CO4	Design and study the performance of various types of hydraulic turbines	Apply
CO5	Design and study the performance of various types of hydraulic turbines	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	-	-
CO2	3	3	3	3	-	-	-	2	-	-	-	2	2	1	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-	2	1	-
CO4	3	3	1	1	-	1	-	-	-	-	-	-	2	1	1
CO5	3	3	3	3	-	1	1	2	-	-	-	-	2	1	1
Avg	2.6	2.6	2.2	2.2	-	1	1	2	-	-	-	2	1.8	1	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22MC401</td><td colspan="2">DISASTER PREPAREDNESS AND PLANNING</td><td colspan="3">Semester</td><td>IV</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>MC</td><td colspan="2">Credit</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.</td></tr>
<tr><td>2</td><td colspan="6">To identify the risk prone areas in India</td></tr>
<tr><td>3</td><td colspan="6">To critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.</td></tr>
<tr><td>4</td><td colspan="6">To develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.</td></tr>
<tr><td>5</td><td colspan="6">To critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.</td></tr>
<tr><td>Unit I</td><td colspan="2">REPERCUSSIONS OF DISASTERS AND HAZARDS</td><td>6</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td colspan="7">Introduction, Disaster-Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts, And Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor, Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease, Epidemics, War and Conflicts.</td></tr>
<tr><td>Unit II</td><td colspan="2">DISASTER PRONE AREAS IN INDIA</td><td>6</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td colspan="7">Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches, Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami.</td></tr>
<tr><td>Unit III</td><td colspan="2">DISASTER PREPAREDNESS AND MANAGEMENT</td><td>6</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td colspan="7">Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard, Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.</td></tr>
<tr><td>Unit IV</td><td colspan="2">DISASTER MITIGATION</td><td>6</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td colspan="7">Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.</td></tr>
<tr><td>Unit V</td><td colspan="2">REHABILITATION OF ENVIRONMENT</td><td>6</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td colspan="7">Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmentally friendly recovery; reconstruction and development methods.</td></tr>
<tr><td colspan="7" align="right">Total= 30 Periods</td></tr>
</table>

Text Books:	
1	Sahni, Pardeep, “Disaster Mitigation Experiences and Reflections”, Prentice Hall of India, New Delhi. 4th Edition, 2011.
2	Goel S.L, “Disaster Administration and Management Text and Case Studies”, Deep & Deep

Reference Books:	
1	Disaster Management and Preparedness by Dhawan, CBS Publication.
2	Environment And Disaster Management 3Rd Edition by Dr Khul, Mc graw Hill Education India Private Limited.
3	An Introduction To Disaster Management: Natural Disasters & Man Made Hazards by Vaidyanathan S, Ikon.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identifying the different disasters and its causes.	Remember
CO2	Identifying the vulnerable areas of disasters in India.	Understand
CO3	Getting knowledge about preparedness during disasters.	Evaluate
CO4	Analyzing the risk in disasters.	Analyse
CO5	Knowing the corrective measures to mitigate disasters.	Apply

<u>COURSE ARTICULATION MATRIX</u>

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

22CE501	**BASIC STRUCTURAL ANALYSIS**		**Semester**				**V**
PREREQUISITES		**Category**	**PC**	**Credit**			**4**
Fundamentals of Mechanics of Solids and Strength of Materials		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**1**	**0**		**4**

Course Learning Objectives

1	To analyse the determinate and indeterminate structures for rolling loads using Influence Line Diagram
2	To analyse the indeterminate structures for static loads
3	To understand the effect of arch shape in loaded structures
4	To analyse the cable and suspension bridge
5	To understand the concept of Plastic Analysis for beams and frames

Unit I	**INDETERMINANCIES AND INFLUENCE LINES FOR STATICALLYDETERMINATE BEAMS ROLLING LOADS**	**9**	**3**	**0**	**12**

Concept of Determinancy and Indeterminancy-static and Kinematic indeterminancies -examples - single concentrated load moving on the span – UDL longer than the span – UDL shorter than the span – two concentrated loads at a fixed distance apart - several concentrated loads(CONCEPT ONLY) – equivalent UDL. Influence lines for reactions, shear force and bending moment – Calculation of shear force and bending moment at a point – Calculation of position of load for maximum shear force and bending moment – Uniformly distributed load shorter than the span on simply supported beam – Concentrated loads - Absolute maximum shear force and bending moment.

Unit II	**INFLUENCE LINES FOR STATICALLY INDETERMINATE BEAMS**	**9**	**3**	**0**	**12**

Clark Maxwell’s theorem of reciprocal deflection – Betti’s theorem- Muller’s Breslau’s Principle andits applications to determine the influence lines for continuous beams(two span only)Analysis of plane trusses with maximum two redundant members by displacement and forcemethods-Trusses with lack of fit-Thermal stresses.

Unit III	**THREE HINGED, TWO HINGED ARCHES**	**9**	**3**	**0**	**12**

Symmetrical arches – Analysis of three hinged and two hinged arches – shear force Normal thrust and bending moment – Effect of rib – shortening – Parabolic arch subjected to UDL.

Unit IV	**CABLES AND SUSPENSION BRIDGES**	**9**	**3**	**0**	**12**

Analysis of cable under concentrated loads - Analysis of cable under UDL – Shape of cable under self-weight – Anchorage of suspension cables – shear force and bending moment in three hinged stiffened girders – Maximum bending moment due to single concentrated load – UDL - Two hinged stiffening girders.

Unit V	**PLASTIC ANALYSIS OF STRUCTURES**	**9**	**3**	**0**	**12**

Plastic moment capacity of sections – Plastic section modulus – Shape factor for rectangular, triangular, circular and hollow circular sections – Plastic hinge concept – Load factor – Plastic analysis – Basic theorems – Principle of virtual work – Determination of collapse load for simply supported beam, propped cantilever beam, fixed beam, continuous beam subjected to concentrated load and UDL – Collapse load for single storey single bay portal frames.

Total= 60 Periods

Text Books:	
1	Devdas Menon “Structural Analysis”, Alpha Science International Limited, 2017
2	S.Ramamrutham and R.Narayanan, “Theory of Structures”, Dhanpat Raj Publishing Company, 11th edition, 2020
3	R.C. Hibbeler, “Structural Analysis”, Pearson Education, 9th Edition, 2017

Reference Books:	
1	Timoshenko S.P. and Young D.H., Theory of Structures, McGraw – Hill Book Company, New Delhi, Second Edition, 2017
2	Gupta S.P.,Pandit G.S and Rajesh Gupta, Theory of structures-Vol I & II, Tata McGraw-Hill Publishing Company Limited, New Delhi,2022
3	Reddy C.S., Basic Structural Analysis, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010
4	Punmia B.C., Theory of structures - Vol. II, Laxmi Publications (P) Ltd, 2017.
5	Negi L.S. and Jangid R.S., Structural Analysis, Tata McGraw - Hill Publishing Company, New Delhi, 2019

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Construct influence line diagram for determinate and indeterminate beams	Analyse
CO2	Analyse beams and trusses by strain energy method	Analyse
CO3	Adopt the arch shape in construction	Apply
CO4	Analyse the cable stayed bridges under different loads	Analyse
CO5	Analyse the beams and single bay frames in plastic behavior	Analyse

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	1	-	-	-	-	-	2	1	-
CO2	2	1	1	3	1	1	1	-	-	-	-	-	2	1	-
CO3	3	1	1	2	3	1	1	-	-	-	-	-	2	1	-
CO4	2	1	1	2	1	1	1	-	-	-	-	-	2	1	-
CO5	2	1	1	3	1	1	1	-	-	-	-	-	2	1	-
Avg	2.2	1	1	2.6	1.4	1	1	-	-	-	-	-	2	1	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CE502	FOUNDATION ENGINEERING		Semester			V
PREREQUISITES		**Category**	**PC**	**Credit**		**3**
Mechanics of Soils		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To acquire knowledge on the soil investigation and exploration techniques
2	To evaluate the bearing capacity and settlement of foundation
3	To calculate the load carrying capacity of pile and pile groups and to design pile foundation
4	To improve the knowledge of slope stability
5	To calculate the earth pressure of retaining wall

Unit I	**SOIL EXPLORATION AND SELECTION OF FOUNDATION**	**9**	**0**	**0**	**9**

Soil exploration methods – Disturbed and Undisturbed sampling – Samplers – Depth of Exploration – Number and Spacing of boreholes – Sounding tests – Standard Penetration Test, Static Cone and Dynamic Cone Penetration Tests – Bore log.

Requirements of good foundation – factors governing location and depth- Types of foundation – Choice of foundation – Floating Foundation – Foundation on Expansive soil.

Unit II	**BEARING CAPACITY OF SOIL AND SETTLEMENT**	**9**	**0**	**0**	**9**

Bearing Capacity – Terzhaghi's Bearing Capacity Equation – Types of Failure – Effect of Water Table – Skempton's Formula – Bearing Capacity based on IS method- Effect of eccentricity of load on bearing capacity of soil – Bearing Capacity based on 'N' value - Allowable bearing pressure – Plate Load test.

Settlement – immediate and time dependent settlement – Differential settlement – Causes – BIS Code provisions

Unit III	**PILE FOUNDATION**	**9**	**0**	**0**	**9**

Classification of Piles – Functions – Merits – Load Carrying Capacity – Static Analysis – Dynamic Analysis – Pile load test – Pile group – Spacing and Group action – Efficiency of Pile group – Engineering News Formula – Hiley's formula – Settlement – Negative Skin Friction - Construction of Under Reamed Pile Foundation.

Unit IV	**STABILITY OF SLOPES**	**9**	**0**	**0**	**9**

Stability of Slopes – Infinite and Finite Slopes – Types of Failure – Culmann's methods –Swedish Slip Circle Method – Friction Circle method – Bishop's method – Taylor's Stability Number – Slope protective measures- Improvement Techniques.

Unit V	**EARTH PRESSURE ON RETAINING WALLS**	**9**	**0**	**0**	**9**

Plastic equilibrium in soils – Active and Passive states – Rankine's theory – Cohesionless and cohesive soils – Couloumb's wedge theory – Earth pressure on retaining walls of simple configurations – Stability of retaining walls.

Total= 45 Periods

Text Books:	
1	Punmia B.C Soil Mechanics and Foundations, Laxmi Publications Pvt. Ltd., New Delhi, 2017.
2	Purushothama Raj P, Soil Mechanics and Foundation Engineering, Perason Education, 2008
3	Gopal Ranjan and Rao A.S.R., Basic and Applied Soil Mechanics, New Age International Publishers (P) Ltd., New Delhi, 2016.
4	Venkataramaiah, C., Geotechnical Engineering, New Age International Publishers, New Delhi, 2017.
Reference Books:	
1	Swamisaran, Analysis and Design of Structures – Limit State Design, OxfordIBH Publishing Co-Pvt. Ltd., New Delhi, 1998.
2	Som N.N and Das S.C., Theory and Practice of Foundation Design, Prentice Hall Pvt. Ltd., NewDelhi, 2003.
3	Arora K.R., Soil Mechanics and Foundation Engineering, Standard Publishers and Distributors, New Delhi, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Characterise the soil investigation for any civil engineering construction.	Understand
CO2	Estimate the bearing capacity and settlement of soils	Analyse
CO3	Calculate the load carrying capacity	Analyse
CO4	Analyse the stability of slopes	Analyse
CO5	Calculate the earth pressure on retaining walls	Analyse

<u>COURSE ARTICULATION MATRIX</u>

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO2	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO3	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO4	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO5	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
Avg	**3**	**2.8**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CE503</td><td colspan="5">WATER RESOURCES ENGINEERING</td><td colspan="2">Semester</td><td>V</td></tr>
<tr><td colspan="4">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="4" rowspan="2">Mechanics of Fluids, Applied Hydraulics and Fluid Machinery</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="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To know the importance of the hydraulic cycle, as water is the main source for nature. Storage of water by means of reservoirs and wells are taught.</td></tr>
<tr><td>2</td><td colspan="8">To impart the knowledge of various types of reservoirs and design aspects.</td></tr>
<tr><td>3</td><td colspan="8">To impart the knowledge of ground water hydrology.</td></tr>
<tr><td>4</td><td colspan="8">To understand the designs of various distribution systems .</td></tr>
<tr><td>5</td><td colspan="8">To know the importance of drainage systems and river training works.</td></tr>
<tr><td>Unit I</td><td colspan="4">SURFACE WATER HYDROLOGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Hydrologic cycle – Surface Water potential in India –Rain gauges – Types of rain gauges –Average rainfall over a basin by arithmetic mean, Thiessen polygon and Isohyetal method – Runoff – Runoff process – abstractions- Infiltration, evaporation, transpiration, interception and depression storage – Estimation of Runoff by empirical formula and infiltration indices. Storm Hydrograph and Unit Hydrograph – Flood estimation by Dicken’s formula.</td></tr>
<tr><td>Unit II</td><td colspan="4">RESERVOIR PLANNING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Importance of Reservoirs – Purpose of storage work – Large Reservoirs in India and Tamil Nadu – Types of reservoirs– Investigation for reservoir planning – Selection of site for a reservoir – Zones of storage in reservoirs – Single and multipurpose reservoir – Determination of capacity of reservoir – Reservoir sedimentation and their control – Reservoir losses – Basics of flood routing.</td></tr>
<tr><td>Unit III</td><td colspan="4">GROUND WATER HYDROLOGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">History of Groundwater Development in the world and India – Occurrence of ground water – types of aquifers – storage coefficient – coefficient of transmissibility – Steady radial flow into a well located in unconfined and confined aquifers – description of various types of open and tube wells – Yield from an open well by constant level pumping test and recuperation test – Estimation of Yield (steady state condition) – Site selection for a tube well.</td></tr>
<tr><td>Unit IV</td><td colspan="4">DISTRIBUTION SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Classification of canals – canal alignment – Kennedy’s theory – Wood table – Lacey’s theory – Design of canal cross sections – Comparisons of two theories – Use of Garret’s diagram in channel design – Balancing depth of cutting – Design procedure for an irrigation channel – Longitudinal section of canal and schedule of area statistics – types of canal cross sections – component parts of a cross section – Construction and maintenance of canals – Canal lining – GIS application in distribution system.</td></tr>
<tr><td>Unit V</td><td colspan="4">WATER LOGGING, DRAINAGE AND RIVER CONTROL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Water logging – importance, Causes and effects of water logging– Remedial measures – Drainage – Advantages – Types of drainage system – Rivers and their behaviour – Objectives – Classification and method of river training works – GIS application.</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Linsley R.K. and Franzini J.B, Water Resources Engineering, McGraw-Hill Inc, 2002.
2	Sharma R.K. and Sharma T.K., Hydrology and Water Resources Engineering, Dhanpat Rai and Sons, 2017.
3	Punmia B.C. and Pande B.B.Lal, Irrigation and water Power Engineering, Laxmi Publications Pvt Ltd., New Delhi,2016.
4	Santhosh Kumar Garg, Hydrology and Water Resources Engineering, Khanna Publications Pvt.Ltd., New Delhi, 2002.
Reference Books:	
1	Chow V.T. and Maidment, Hydrology for Engineers, McGraw-Hill Inc., Ltd., 2000.
2	Raghunath H.M., Hydrology, Wiley Eastern Limited, New Delhi,1990.
3	Subramanya K., Engineering Hydrology, Tata-McGraw Hill, 1993.
4	Sahasrabudhe S.D., Irrigation Engineering and Hydraulics Structures, Katson Publications, 1990.
5	Das M.M., Saikia M.D., Hydrology, Prentice Hall of India, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the various concepts in the surface water hydrology	Understand
CO2	Identify the various types of reservoirs and design aspects	Remember
CO3	Understand the various concepts in ground water hydrology	Understand
CO4	Design the various components of distribution system	Apply
CO5	Assess the problems and remedies of water logging	Evaluate

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22CE504</td><td colspan="4">DESIGN OF REINFORCED CONCRETE ELEMENTS
(Use of IS 456-2000 and tables and charts from SP16 Pg:5-10,17-95,101-106,109-171,178-179, 184-186, 189-190, 193-209, 215-230 are permitted)</td><td colspan="3">Semester</td><td>V</td></tr>
<tr><td colspan="4">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="2">Credit</td><td>4</td></tr>
<tr><td colspan="4" rowspan="2">Structural Analysis, Building Materials</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To understand the concepts of various design philosophies related to Reinforced concrete design and to study stress-strain behaviours of concrete and steel.</td></tr>
<tr><td>2</td><td colspan="8">To gain the knowledge of limit state design for flexure</td></tr>
<tr><td>3</td><td colspan="8">To study the limit state design for shear, torsion and bond.</td></tr>
<tr><td>4</td><td colspan="8">To study the behaviour of columns subjected to axial load, eccentric load and use of interaction diagrams.</td></tr>
<tr><td>5</td><td colspan="8">To design the isolated foundation and staircases.</td></tr>
<tr><td>Unit I</td><td colspan="4">INTRODUCTION</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="9">Objective of structural design - Various Phases in construction Process – Design Code: Purpose of Codes, Basic Code for Design and Loading standards - Standard concrete mixes for RCC works – Types of reinforcements : Plain and deformed bars – Type of Loads on Structures and Load combinations – Concepts of Working Stress Method, Ultimate Load Method and Limit State Method – Characteristic Strength and load – Partial Safety Factor – Stress-Strain behaviour of concrete and steel.</td></tr>
<tr><td>Unit II</td><td colspan="4">LIMIT STATE DESIGN FOR FLEXURE</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="9">Analysis, design and detailing of singly and doubly reinforced rectangular and flanged beams –Analysis, design and detailing of one way and two way rectangular slabs subjected to uniformly distributed load for various boundary conditions and corner effects.</td></tr>
<tr><td>Unit III</td><td colspan="4">LIMIT STATE DESIGN FOR SHEAR, TORSION, BOND & ANCHORAGE</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="9">Behaviour of Reinforced Concrete beams in shear and torsion : Modes of Cracking , Shear Transfer Mechanisms, Shear Failure Modes – Design for Shear : Nominal Shear Stress, Design Shear Strength with and without Shear Reinforcement , Critical section for Shear design, Code Recommendations – Design and detailing of RC members for combined bending, shear and torsion as per IS Code.Behaviour of RC members in bond and anchorage.</td></tr>
<tr><td>Unit IV</td><td colspan="4">LIMIT STATE DESIGN OF COLUMNS</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="9">Types of columns – Braced and Unbraced columns – Design of short column for axial, uniaxial and biaxial bending – Interaction diagrams – Design concepts of long columns – Standard method of detailing RC columns.</td></tr>
<tr><td>Unit V</td><td colspan="4">LIMIT STATE DESIGN OF FOOTINGS & STAIRCASES</td><td>9</td><td>3</td><td>0</td><td>12</td></tr>
<tr><td colspan="9">Design of wall footing – Design of isolated footing – Square, Rectangular and Circular shape for axial load – Eccentrically loaded isolated footing – Design of staircase (ordinary & dog-legged).</td></tr>
<tr><td colspan="9" align="right">Total= 60 Periods</td></tr>
</table>

Text Books:	
1	"Reinforced Concrete Design" Unnikrishnan Pillai S &Devdas Menon, McGraw Hill Education (India) Private Ltd, Chennai 2018.
2	Limit state Design of Reinforced Concrete Varghese P.C, 2013 PH1 Learning P.Ltd. Delhi.
3	Punmia B.C., Ashok Kumar Jain & Arun Kumar Jain., Limit State Design of Reinforced Concrete, Laxmi Publications Pvt. Ltd., New Delhi, 2016.
Reference Books:	
1	Sinha S.N. Reinforced Concrete Design, Tata McGraw Hill Publishing Company Ltd., New Delhi ,2017.
2	Karve S.R and Shah V.L. Limit State Theory and Design of Reinforced Concrete, Structures Publications, Pune 2017.
3	Krishna Raju N., Design of Reinforced Concrete Structures, CBS Publishers & Distributors, NewDelhi,2017.
4	IS 456:2000 Plain and Reinforced concrete Code of practice (Third Revision).
5	SP :16 Design aids for Reinforced Concrete to IS 456-1978.
6	SP: 34 – 1987 Handbook on Concrete Reinforcement and Detailing.
7	IS 875(Part 1)-1987: Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures. Part 1: Dead Loads–Unit Weights of Building Materials and Stored Materials (Second Revision)
8	IS 875(Part 2)-1987: Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures. Part 2: Imposed Loads (Second Revision)
9	IS 875(Part3)-2015: Wind Loads on Buildings and Structures
10	IS 875(Part4)-1984: snow loads
11	IS 875(Part5)-1987: special loads and combinations
12	IS 1893 (part 1): 2016 Criteria for earthquake resistant design of structures
13	IS 13920 – 2016 Ductile design and detailing of reinforced concrete structures subjected to Seismic forces

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the objective of the structural design and to apply the fundamental concepts of various design philosophies. Use IS code of practice to design the basic reinforced concrete elements	Understand
CO2	Analyse, design and to present detailing of reinforcement for flexure members.	Analyse
CO3	Analyse, design and to present detailing of Slab and beam elements for bond, anchorage, shear and torsion.	Analyse
CO4	Analyse, design and detailing of Columns	Analyse
CO5	Analyse, design and detailing of Footings and staircases.	Analyse

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22CE505</td><td colspan="3">WASTEWATER ENGINEERING</td><td colspan="3">Semester</td><td>V</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td colspan="2">Category</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">NIL</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 evaluate sewage generation and design sewerage system</td></tr>
<tr><td>2</td><td colspan="7">To improve the ability to analyse characteristics of sewage</td></tr>
<tr><td>3</td><td colspan="7">To develop the ability of the students to apply basic understanding of physical, chemical, and biological treatment methods for successful design, operation and maintenance of sewage treatment plants.</td></tr>
<tr><td>4</td><td colspan="7">To emphasize the need for sludge separation, thickening and volume reduction and design the facilities for biological sludge handling and treatment of biological sludge</td></tr>
<tr><td>5</td><td colspan="7">To identify the treatment to be carried out to reuse the water.</td></tr>
<tr><td>Unit I</td><td colspan="3">SEWERAGE SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Definition – classification – systems of sewerage – quantity of sewage – Fluctuation in flow pattern – estimation and storm runoff – design flow for separate and combined system – hydraulics of sewers – self cleansing velocities – full flow / partial flow conditions – sewer sections – material for sewers – sewer joints – jointing materials – sewer laying under various conditions – test on sewers – sewer maintenance – sewer appurtenances –sewage pumping – types of pumps.</td></tr>
<tr><td>Unit II</td><td colspan="3">WASTEWATER CHARACTERISTICS & PRIMARY TREATMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Characteristics and composition of sewage – physical and chemical analysis – DO and BOD and their significances – cycles of decomposition – fundamentals of microbiology of wastewater – preliminary and primary treatment – screens – skimming tank – grit chamber – design of proportional flow weir– principle, types of sedimentation – design of sedimentation tanks</td></tr>
<tr><td>Unit III</td><td colspan="3">BIOLOGICAL TREATMENT OF WASTEWATER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Basic principles of biological treatment – Activated sludge process – recirculation – diffuser – mechanical aeration – Process modifications – oxidation ditch – Trickling filter – Principles and design –NRC equation – RBC Principle – Principles and design of waste stabilization ponds – Principle and design of a lagoon – septic tanks and effluent disposal system.</td></tr>
<tr><td>Unit IV</td><td colspan="3">SLUDGE MANAGEMENT & HOUSE DRAINAGE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Objectives of sludge treatment – properties and characteristics of sludge – sludge thickening – sludge digestion – drying beds – conditioning and dewatering – sludge disposal – Sanitary fixtures and fitting – Pipe system – general layout of house drainage – street connections.</td></tr>
<tr><td>Unit V</td><td colspan="3">DISPOSAL OF SEWAGE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Methods – dilution – self purification of streams – oxygen sag curve – Streeter Phelp’s model – wastewater reclamation techniques – land disposal – sewage farming – deep well injection – Eutrophication – recycle and reuse of wastewater.</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Garg S.K., Wastewater Engineering, Khanna publishing Co., New Delhi – 2007.
2	Punmia B.C., Ashok Jain, Environmental Engineering (Vol.-II), Wastewater Engineering, Laxmi Publications, New Delhi, 2008.

Reference Books:	
1	Duggal K.N., Elements of Public Health Engineering, S. Chand and Co., 2007.
2	Manual on Sewerage and Sewage Treatment, CPHEEO, Government of India, New Delhi, 2013.
3	Metcalf and Eddy, M.C., Wastewater Engineering – Treatment &Reuse, TataMcGraw-Hill Publications, New Delhi,2017.
4	Birdie G.S., Water Supply and Sanitary Engineering, DhanpatRai and sons, 2014.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Estimate sewage generation and design sewer system including sewage pumping stations	Create
CO2	Summarize the characteristics and composition of sewage, preliminary and primary treatment of sewage	Understand
CO3	Perform basic design of the biological treatment processes that are used in sewage treatment	Analyze
CO4	Gain knowledge on sludge treatment and disposal	Remember
CO5	Justify the methods for disposal of sewage and reuse of wastewater	Evaluate

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	2	-	2	-	-	3	-	3	2	2
CO2	-	1	3	-	1	3	2	2	-	-	3	-	3	-	-
CO3	-	-	2	-	1	3	-	2	-	-	3	-	3	-	1
CO4	-	-	2	1	1	3	2	2	-	-	3	-	3	-	2
CO5	-	-	3	-	1	3	-	2	1	1	3	-	3	-	3
Avg	2.0	2	2.4	1	1	2.8	2	2	1	1	3	-	3	2	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CE506</td><td colspan="5">TRANSPORTATION ENGINEERING</td><td colspan="3">Semester</td><td>V</td></tr>
<tr><td colspan="5">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="5" rowspan="2">Surveying</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 educate the students on highway planning and various components of highway Engineering</td></tr>
<tr><td>2</td><td colspan="9">To educate the design concepts of components of highway engineering</td></tr>
<tr><td>3</td><td colspan="9">To develop skills on evaluation and maintenance.</td></tr>
<tr><td>4</td><td colspan="9">Ability To Plan various civil Engineering aspects of Railways .and educate various components of railways</td></tr>
<tr><td>5</td><td colspan="9">To educate the design concepts of components of railway engineering. And maintenance of railway track</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="4">HIGHWAY PLANNING AND ALIGNMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Highway Development in India –Jayakar Committee Recommendations and Realisations–Requirements of Ideal Alignment-Factors Controlling Highway Alignment-Engineering Surveys for Alignment –Conventional Methods and Modern Methods (Remote Sensing, GIS and GPS techniques)-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], Cross sections of different Class of Roads.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="4">GEOMETRIC DESIGN OF HIGHWAYS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Design of Horizontal Alignments – Superelevation, Widening of Pavements on Horizontal Curves and Transition Curves [Derivation of Formulae and Problems] Design of Vertical Alignments – Rolling, Limiting, Exceptional and Minimum Gradients, Summit and Valley Curves-Sight Distances – Factors affecting Sight Distances, Stopping Sight Distance (SSD), Overtaking Sight Distance (OSD), Sight Distance at Intersections, Intermediate Sight Distance and Illumination Sight Distance [Derivations and Problems in SSD and OSD]-Geometric Design of Hill Roads [IRC Standards Only]- Lidar Survey</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="4">HIGHWAY MATERIALS, CONSTRUCTION, MAINTENANCE AND OPERATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Desirable Properties of Highway Materials-Bitumen – Penetration, Ductility, Viscosity, Binder content and Softening point Tests. Construction Practice – Water Bound Macadam Road, Bituminous Road and Cement Concrete Road [as per IRC and MORTH specifications]Highway Drainage [IRC Recommendations]Types of defects in Flexible pavements –Surface defects, Cracks, Deformation, Disintegration – Symptoms, Causes and Treatments. Types of Pavement, Failures in Rigid Pavements – Scaling, Shrinkage, Warping, Structural Cracks Spalling of Joints and Mud Pumping – and Special Repairs.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="4">RAILWAY PLANNING AND DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Role of Indian Railways in National Development –Engineering Surveys for Track Alignment – Obligatory points – Conventional and Modern methods (Remote Sensing, GIS & GPS, EDM and other equipments) 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, Ballastless Tracks Geometric Design of Railway Tracks – Gradients and Grade Compensation, Super-Elevation, Widening of Gauges in Curves, Transition Curves, Horizontal and Vertical Curves (Derivations of Formulae & Problems)</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="4">RAILWAY TRACK CONSTRUCTION MAINTENANCE AND OPERATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="10">Points and Crossings – Design of Turnouts, Signalling, Interlocking, Construction & Maintenance – Conventional, Modern methods and Materials, Track Drainage Track Modernisation– Automated maintenance and upgrading, Technologies, Re-laying of Track, Layouts of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance, Level Crossings.</td></tr>
<tr><td colspan="10" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Khanna K., Justo C.E.G., Highway Engineering revised 10thedition Khanna Publishers, Roorkee, 2014.
2	Kadiyali L. R, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2019.
3	ChandolaS.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, 14thEdition, 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	Understand surveys involved in highway alignment	Understand
CO2	Design cross section elements and compute sight distance, horizontal and vertical profile of a road	Analyse
CO3	Apply construction procedure & maintenance for highways	Apply
CO4	Describe the components of railways way and compute superelevation of railways	Understand
CO5	Apply the various methods for track alignment, procedure for construction of railway & maintenance of track	Analyse

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	-	-	-	-	-	-	-	-	3	-	1
CO2	2	3	2	-	2	-	-	-	-	-	1	1	3	-	-
CO3	1	1	-	1	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	1	-	-	-	-	-	-	1	-	3	-	1
CO5	1	-	3	-	3	-	-	-	-	-	1	-	2	-	1
Avg	1.8	2	2.2	1	2.5	-	-	-	-	-	1	1	2.4	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

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

Course Objectives:

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

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

Text Books:

1.	Tim Brown, Change by Design:How design thinking transforms organizations and inspires innovation – HarperCollins e-books, 2009
2.	Alexander Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want (Strategyzer) - John Wiley & Sons, 2014
3.	Ulrich Karl and Eppinger Steven D, Product Design and Development - McGraw Hill, 5th edition, 2020
4.	Blank Steve, Four Steps to Epiphany: Successful strategies for products that win, KS Ranch, 5th edition, 2013

Reference Books:

1.	Everything you need about value proposition: https://blog.forgeforward.in/everything-you-need-to-know-about-value-proposition-7247493c940c
2.	Test your Value Proposition:http://businessmodelalchemist.com/2012/09/test-your-value-proposition-supercharge-lean-startup-and-custdev-principles.html
3.	Valuation Risk versus Validation Risk in Product Innovations:https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624
4.	User Guide for Product Innovation Rubric:https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd
5.	Innovation Risk Diagnostic - Product Innovation Rubric:https://blog.forgeforward.in/product-innovation-rubric-adf5ebdfd356

6.	Evaluating Product Innovations - proof, potential, & progress:https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Apply a scientific method to understand the inherent risks of product innovation	
CO2	Apply innovation tools & techniques to validate the problem scenario and to assess the market potential of product innovation;	L3: Applying
CO3	Design solution concept based on the proposed value by exploring various alternate solutions to achieve value-price fit;	L6: Creating
CO4	Demonstrate technical skills by applying technology to build and demonstrate proof of concept for the solution proposed;	L2: Understanding
CO5	Develop skills to articulate the solution concept into a proposal for grants.	L3: Applying

COURSE ARTICULATION MATRIX

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	1	1								2	2	3
CO2	2	3	3	2	2								3	3	3
CO3	2	2	3	1	1	1			1	1			3	2	2
CO4	3	3	3	2	2								3	3	3
CO5	3	3	3	3	3								3	3	3
AVG	**2.4**	**2.8**	**2.8**	**1.8**	**1.8**	**1**			**1**	**1**			**2.8**	**2.6**	**2.8**

0: No correlation, 1: Low correlation, 2: Medium correlation, 3: High correlation

22CE507	GEOTECHNICAL ENGINEERING LABORATORY			Semester		V
PREREQUISITES		**Category**	**PC**	**Credit**		**1.5**
Mechanics of Soils		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Learning Objectives	
1	To learn the methods of finding index properties of soil by conducting various tests in the laboratory.
2	To Classify the type of soil based on the index properties of soil.
3	To assess the bearing capacity of the soil
4	To get knowledge about the permeability of the soil
5	To find the shear parameters and shear strength of soil from laboratory and field tests.

LIST OF EXPERIMENTS

1. Determination of Moisture Content by Oven drying method
2. Determination of Moisture Content by Pycnometer method
3. Determination of Grain Size Distribution by Sieve Analysis
4. Determination of Specific Gravity of Soil grains
5. Determination of Relative Density of Sand
6. Determination of Atterberg's Limits of Soil
7. Determination of OMC and Maximum Dry Density by Standard Proctor Compaction Test
8. Determination of Field Density by Core Cutter Method
9. Determination of Field Density by Sand Replacement Method
10. Determination of Permeability of soil by Constant Head Method
11. Determination of Permeability of soil by Variable Head Method
12. Determination of Shear Parameters of non-cohesive soil by Direct Shear Test
13. Determination of Shear Parameters of Cohesion less soil by Vane Shear Test
14. Determination of Shear Parameters of Cohesive soil by Unconfined Compression Test
15. Determination of CBR Value by California Bearing Ratio Test
16. Determination of Grain Size Distribution by Hydrometer Analysis (Demonstration)
17. Determination of Settlement in soil due to primary consolidation by One Dimensional Consolidation Test (Demonstration)
18. Determination of Shear Parameters of Cohesive soil by Triaxial Compression Test (Demonstration)
19. Determination of Safe Bearing Capacity of soil by Standard Penetration Test (Demonstration)
20. Determination of Ultimate Bearing Capacity and Probable Settlement by Plate Load Test (Demonstration)

Total= 45 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the index properties of soil by conducting laboratory tests.	Apply
CO2	Classify the type of soil.	Understand
CO3	Determine the bearing capacity of the soil	Evaluate
CO4	Estimate the permeability of the soil	Evaluate
CO5	Find the shear parameters and shear strength of soil from laboratory tests.	Apply

COURSE ARTICULATION MATRIX

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**2**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**-**
CO2	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**-**
CO3	**3**	**2**	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**1**
CO5	**3**	**2**	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**-**
Avg	**2.8**	**1.8**	**2.2**	**1.6**	**2**	**2.2**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**1**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CE508</td><td colspan="4">ENVIRONMENTAL QUALITY MEASUREMENTS LABORATORY</td><td colspan="3">Semester</td><td>V</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="3">Credit</td><td>1.5</td></tr>
<tr><td colspan="3" rowspan="2">Water supply Engineering, Wastewater Engineering</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td colspan="2">P</td><td>TH</td></tr>
<tr><td>0</td><td>0</td><td colspan="2">3</td><td>3</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To determine the physical, chemical and biological characteristics of water and wastewater</td></tr>
<tr><td>2</td><td colspan="8">To conduct experiments to determine the concentrations of water and waste water pollutants</td></tr>
<tr><td>3</td><td colspan="8">To conduct experiments to determine the concentrations of water and waste water pollutants</td></tr>
<tr><td>4</td><td colspan="8">To understand the environmental significance and application in environmental engineering practice</td></tr>
<tr><td>5</td><td colspan="8">To realize the treatment required for specific pollutant</td></tr>
<tr><td colspan="9">LIST OF EXPERIMENTS</td></tr>
<tr><td colspan="9">1.Determination of pH value for the given water sample
2.Determination of Turbidity value for the given water sample
3.Determination of Alkalinity present in the given sample of water
4.Determination of Hardness (Total, temporary and permanent) present in the given water sample
5.Determination of Chlorides present in the given sample of water
6.Determination of Sulphates present in the given sample of water
7.Determination of Total, Dissolved, Suspended, Volatile and Fixed Solids
8.Determination of Optimum coagulant dose using Jar test apparatus
9.Determination of Residual Chlorine present in the given water sample
10. Determination of Dissolved Oxygen present in the given water sample
11.Determination of B.O.D for the given sample
12. Determination of C.O.D for the given sample</td></tr>
<tr><td colspan="9">Total= 45 Periods</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>Acquire knowledge about type and degree of pollutant for water and wastewater.</td><td>Understand</td></tr>
<tr><td>CO2</td><td>Obtain capability to conduct experiments and estimate the concentration of various parameters in water and wastewater samples</td><td>Analyze</td></tr>
<tr><td>CO3</td><td>Interpret the results with standards and discuss based on the purpose of analysis.</td><td>Understand</td></tr>
<tr><td>CO4</td><td>Recommend the type of treatment required for water sample which is suitable for drinking purpose</td><td>Evaluate</td></tr>
<tr><td>CO5</td><td>Suggest the treatment required for wastewater sample for its disposal in various environment</td><td>Apply</td></tr>
</table>

COURSE ARTICULATION MATRIX

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	2	-	-	1	-	-	-	-	-	2	1	-	-
CO2	2	2	-	1	-	1	-	-	-	-	-	2	-	-	-
CO3	-	-	2	2	-	2	3	-	-	-	-	-	1	-	2
CO4	-	1	3	1	1	2	3	-	2	3	3	2	3	-	3
CO5	-	1	3	1	1	2	3	-	2	3	3	2	3	-	3
Avg	1.5	1.3	2.0	1.0	1.0	1.6	3.0	-	2.0	3.0	1.5	2.0	2.0	-	2.7
3/2/1 – indicates strength of correlation (3- High, 2- Medium, 1- Low)															

22MC301	INDIAN CONSTITUTION			Semester		V
PREREQUISITES		**Category**	**MC**	**Credit**		**0**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**0**	**0**	**2**

Course Learning Objectives

1	To learn the Fundamental Rights and Fundamental Duties of the Indian Constitution.
2	To list the Union and Territories in our Nation
3	To know the Finance, Trade and Commerce of our Nation
4	To present a systematic analysis of all dimensions of Indian Political System
5	To understand the power and functions of the Parliament, the Legislature and the Judiciary

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

Text Books:

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

Reference Books:

1	Indian Constitution And Indian Polity 3Rd Edition 2021 by Ganesha Subramanian, Pearson.
2	The Indian Constitution Oxford India Short Introductions 2012 Edition by Madhav Khosla , OUP India

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understanding the Fundamental Rights and Duties	Understand
CO2	Listing the agreement between the Union and the Territories	Remember
CO3	Analysing the role of the constitution in a democratic society.	Analyse
CO4	Explaining the key concepts of the Indian Political System.	Apply
CO5	Presenting the structure and functions of the Central and State Governments, the Legislature and the Judiciary	Understand

COURSE ARTICULATION MATRIX

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

PROTOSEM COURSES SYLLABUS

22PSPE01	COMPUTATIONAL HARDWARE		Semester			VI
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

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)**

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

Course Learning Objectives

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

Unit I	**INDUSTRIAL CONTROLLERS - I**	**9**	**0**	**0**	**9**

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

Unit II	**INDUSTRIAL CONTROLLERS - II**	**9**	**0**	**0**	**9**

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

Unit III	**INDUSTRIAL COMMUNICATION PROTOCOLS**	**9**	**0**	**0**	**9**

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

Unit IV	**FPGA AND RT CONTROLLER PROGRAMMING**	**9**	**0**	**0**	**9**

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

Unit V	**INDUSTRIAL CIRCUIT BOARD DESIGN**	**9**	**0**	**0**	**9**

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

Total = 45 Periods

Text Books:

1	Ed Doering, NI myRIO Project Essential Guide, National Instruments, 2016.
2	Willian Bolton, Programmable Logic Controllers, 6th edition, Newnes Publications, 2015
3	Richard Zurawski, Industrial Communication Technology Handbook, Second edition, CRC Press, 2014
4	Simon Monk, Make Your Own PCBs with EAGLE, McGraw Hill Education, 2014.

References Books:	
1	Jeffrey Travis, Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun,3rd edition, Prentice Hall
2	Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing,Fourth edition, Pearson Education, 2016
3	Michael J. Hamill, Industrial Communications and Control Protocols, PDH centre, 2016
4	Ema Design Automation, The Hitchhiker's Guide to PCB Design, First edition, Blurb Publishers,December 2021

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

COURSE ARTICULATION MATRIX

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

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

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

Course Learning Objectives

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

Unit I	DESIGN THINKING PRINCIPLES	9	0	0	9
Exploring Human – Centered Design – Understanding the innovation process, discovering areas of opportunity, interviewing &empathy –building techniques, Mitigate validate risk with FIR(Forge Innovation Rubric) – Case Studies.					
Unit II	**CUSTOMER-CENTRIC INNOVATION**	**9**	**0**	**0**	**9**
Importance of customer-centric innovation – Problem Validation and Customer Discovery – Understanding problem significance and problem incidence- Customer Validation. Target user, User persona & user stories. Activity : Customer development process – Customer interviews and field visit.					
Unit III	**APPLIED DESIGN THINKING TOOLS**	**9**	**0**	**0**	**9**
Concept of Minimum Usable Prototype(MUP) – MUP challenge brief – Designing & Crafting the value proposition – Designing and Testing Value Proposition: Design a compelling value proposition: Process, tools and techniques of Value Proposition Design.					
Unit IV	**CONCEPT GENERATION**	**9**	**0**	**0**	**9**
Solution Exploration, Concepts Generation and MUP design – Conceptualize the solution concept: explore, iterate and learn; build the right prototype: Assess capability, usability and feasibility. Systematic concept generation; evaluation technology alternatives and the solution concepts.					
Unit V	**SYSTEM THINKING & REVERSE ENGINEERING**	**9**	**0**	**0**	**9**
System Thinking, Understanding Systems, Examples and Understandings, Complex Systems, Reverse Engineering Methodology, Identify building blocks/Components – Re-Engineering a complex system.					
					Total = 45 Periods

Text Books:

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

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

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

COURSE ARTICULATION MATRIX

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

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

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

Course Learning Objectives

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

Unit I	**ENTREPRENEURIAL MINDSET & METHOD**	**9**	**0**	**0**	**9**

Introduction to Innovation-led, tech-powered entrepreneurship - Understand from research the attributes of an expert entrepreneur - Effectuation principles - Dealing with the unknowns - Case studies of startup failures.

Unit II	**IDEA TO ENTERPRISE**	**9**	**0**	**0**	**9**

Design and Planning of Product Concept - Business Model - Business Planning - Building Proof of Product and Value Testing - Target Market and Revenue Planning

Unit III	**MINIMUM VIABLE BUSINESS**	**9**	**0**	**0**	**9**

Framework for Minimum Viable Business - Disruptive Innovation - Theory of Disruption - Competitive advantage - Building proof of viable business model - Demystifying Scalability - Funding Opportunities

Unit IV	**INTELLECTUAL PROPERTY**	**9**	**0**	**0**	**9**

Introduction and the need for Intellectual Property Rights - IPR Genesis and Development - Copyright - Trademark - Trade Secret - Geographical Indicators - Industrial Designs - Types of Patent – Sample Patent Application - IPR in INDIA; Global trends - Patent fees

Unit V	**PRIOR ART SEARCH AND PATENT DRAFTING**	**9**	**0**	**0**	**9**

Prior Art Search - IP Licensing – IP Commercialization - IP Infringement- Case Study on Apple vsSamsung, Case study on basmati rice.

The invention as a concept - Keywords formation - Structure of patent - Key attributes in patent drafting -Drafting provisional specifications - Drafting complete specifications - Draft claims - Case studies onpatent drafting

Total = 45 Periods

Text Books:

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

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

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

COURSE ARTICULATION MATRIX

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

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

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

Course Learning Objectives

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

Unit I	**UI/UX**	**9**	**0**	**0**	**9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Colour theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

Unit II	**APP DEVELOPMENT**	**9**	**0**	**0**	**9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

Unit III	**INDUSTRIAL DESIGN**	**9**	**0**	**0**	**9**

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

Unit IV	**MECHANICAL RAPID PROTOTYPING**	**9**	**0**	**0**	**9**

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

Unit V	**ELECTRICAL RAPID PROTOTYPING**	**9**	**0**	**0**	**9**

Electronic Prototyping: Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

Total = 45 Periods

Text Books:

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

E - References:

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

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

COURSE ARTICULATION MATRIX

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

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

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

Course Learning Objectives

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

Unit I	**INTRODUCTION TO ROBOT KINEMATICS**	**9**	**0**	**0**	**9**
Introduction to Robotics - Transformations - Forward Kinematics - Kinematics equations - Link transformations - Inverse Kinematics - Kinematic analysis - Numerical Inverse Kinematic Solutions - Analytical Inverse Kinematic Solutions					
Unit II	**SELECTION OF SENSORS AND ACTUATORS**	**9**	**0**	**0**	**9**
Introduction - Sensors & Actuators - Types - Selection criteria - Design considerations: Motor sizing - Selection of motors based on torque and speed characteristics - Hardware Interface & Assembly					
Unit III	**INTRODUCTION TO ROBOT OPERATING SYSTEM**	**9**	**0**	**0**	**9**
Introduction to ROS framework and prerequisites - Understanding communications in ROS - ROS Ecosystem - Introduction to ROS programming - ROS nodes, topics, messages - ROS services - ROS Tools and Utilities - URDF , Rviz - Simulation - Gazebo - ROS Motion					
Unit IV	**INTRODUCTION TO ROBOTICS VISION SYSTEM**	**9**	**0**	**0**	**9**
Image basics - Image Processing - Histograms - Gray scale, Color, Equalization - Smoothing andblurring/filtering - Averaging, Gaussian, Median, Bilateral - Thresholding - Simple, Adaptive, Otsu -Gradients and Edge detection - Laplacian, Sobel, Canny - Contours - Camera calibration					
Unit V	**INTEGRATION OF ROS AND COMPUTER VISION**	**9**	**0**	**0**	**9**
Introduction - Installation - CV Bridge - Image publisher node - Image subscriber node - Nodes buildingand launching - Building real world applications					
					Total = 45 Periods

Text Books:

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

Reference Books:	
1	https://www.intechopen.com/chapters/379
2	https://www.plantengineering.com/articles/eight-selection-criteria-for-actuation-components/
3	https://www.controleng.com/articles/tips-on-sensor-selection/
4	https://www.toptal.com/robotics/introduction-to-robot-operating-system
5	https://www.thomasnet.com/articles/automation-electronics/machine-vision-systems/
6	https://automaticaddison.com/working-with-ros-and-opencv-in-ros-noetic/

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

COURSE ARTICULATION MATRIX

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

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

22CE701	ADVANCED STRUCTURAL ANALYSIS			Semester		VII
PREREQUISITES		Category	PC	Credit		3
Basic Structural Analysis, Mechanics of Solids, Strength of Materials		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives	
1	To impart knowledge on students about advanced methods of analysis of structures such as slope deflection method
2	To impart knowledge on students about the analysis of structures using s moment distribution methods
3	To understand about the matrix flexibility method and its applications for computer-based analysis of structure.
4	To understand about the matrix stiffness method and its applications for computer-based analysis of structure.
5	To know about the basics of Finite Element Method and its application

Unit I	**SLOPE DEFLECTION METHOD**	**9**	**0**	**0**	**9**
Slope deflection equations-Analysis of continuous beams-Analysis of single storey single bay rectangular portal frames with and without side sway					
Unit II	**MOMENT DISTRIBUTION METHOD**	**9**	**0**	**0**	**9**
Analysis of continuous beams – Carry over factor – Distribution factor – Analysis of single storey single bay – Symmetry and anti-symmetry structures.					
Unit III	**MATRIX FLEXIBILITY METHOD**	**9**	**0**	**0**	**9**
Analysis of continuous beams, Indeterminate frames and trusses with maximum two degrees of static indeterminacy.					
Unit IV	**MATRIX STIFFNESS METHOD**	**9**	**0**	**0**	**9**
Analysis of continuous beams, Indeterminate frames and trusses with maximum two degrees of kinematic indeterminacy.					
Unit V	**FINITE ELEMENT METHOD**	**9**	**0**	**0**	**9**
Introduction – Discretisation of a structure – Displacement functions – Truss element – Beam element – Plane stress and plane strain – Triangular elements.					
					Total= 45 Periods

Text Books:	
1	Punmia B C., Theory of Structures Vol. II, Laxmi Publications (P) Ltd., New Delhi. 2004.
2	Devados Menon, Structural Analysis, Narosa Publishing House, NewDelhi, 2009.
3	Rajasekaran S., Sankara Subramanian G., Computational Structural Mechanics, PHI, India, 2010.
4	Vaidyanathan, R. And Perumal, P., “Structural Analysis – Vol. II”, Laxmi Publications, New Delhi, 2016
Reference Books:	
1	Negi L.S and Jangid R.S.,Structural Analysis, Tata McGraw-Hill Publishing Company
2	Manickaselvam V.K., Elements of Matrix and Stability Analysis of structures , Khanna Publishers, 1999, New Delhi.
3	Pandit G.S and Gupta S.P.,Structural Analysis-A matrix approach, TataMcGraw-Hill Publishing Company Limited,NewDelhi, 2006.
4	Devados Menon, Advanced Structural Analysis, Narosa Publishing House, NewDelhi, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Have the knowledge on classical method (SDM) of analysis of indeterminate structures	Analyse
CO2	Have the knowledge on classical method (MDM) of analysis of indeterminate structures.	Analyse
CO3	Analyse indeterminate structures using force methods	Analyse
CO4	Analyse indeterminate structures using displacement methods	Analyse
CO5	Analyse the indeterminate structures and frames by using modern method of analysis	Analyse

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	-	1	2	-	-	-	-	2	3	-	-
CO2	3	1	1	1	-	1	2	-	-	-	-	2	3	-	-
CO3	2	3	1	1	-	1	2	-	-	-	-	2	3	-	-
CO4	2	3	1	1	-	1	2	-	-	-	-	2	3	-	-
CO5	2	3	1	1	-	1	2	-	-	-	-	2	3	-	-
Avg	2.4	2.2	1	1	-	1	2	-	-	-	-	2	3	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CE702</td><td colspan="3">HUMAN VALUES, PROFESSIONAL PRACTICE, ETHICS AND BUILDING BY-LAWS</td><td colspan="3">Semester</td><td>VII</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>HS</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession.</td></tr>
<tr><td>2</td><td colspan="7">To enhance the professional skills of students and to improve the respective roles of stakeholders.</td></tr>
<tr><td>3</td><td colspan="7">To know the principles of contract and its management.</td></tr>
<tr><td>4</td><td colspan="7">To identify the Arbitration and Conciliation system.</td></tr>
<tr><td>5</td><td colspan="7">To understand the ideas of the building by-laws, legal and practical aspects of their profession related to intellectual property.</td></tr>
<tr><td>Unit I</td><td colspan="3">HUMAN VALUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.</td></tr>
<tr><td>Unit II</td><td colspan="3">PROFESSIONAL PRACTICE –RESPECTIVE ROLES OF VARIOUS STAKEHOLDERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies, Indian Roads Congress, Clients/ owners, Developers, Consultants, Manufacturers/ Vendors/ Service agencies. Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics; Professionalism, Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, Protected disclosures.</td></tr>
<tr><td>Unit III</td><td colspan="3">GENERAL PRINCIPLES OF CONTRACTS MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Indian Contract Act, 1972 and amendments covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /“Red Flag” conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms.</td></tr>
<tr><td>Unit IV</td><td colspan="3">ARBITRATION, CONCILIATION AND ADR
(Alternative Dispute Resolution) SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.</td></tr>
<tr><td>Unit V</td><td colspan="3">MANAGEMENT OF LABOUR & OTHER CONSTRUCTION RELATED LAWS & LAW RELATING TO INTELLECTUAL PROPERTY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
</table>

Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers(regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017, Meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; and their Law relating to Copyright, Trademarks, Patents and Designs, Secrets in India including Historical evolution of Copy Rights Act, 1957,Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies.
Total= 45 Periods

Text Books:	
1	Dutt (1994), Indian Contract Act, Eastern Law House
2	Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
3	Dutt (1994), Indian Contract Act, Eastern Law House
Reference Books:	
1	Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edition. Professional Offset
2	Avtarsingh (2002), Law of Contract, Eastern Book Co.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarise the students to what constitutes human values and professional practice	Remember
CO2	Importance of various stakeholders and their respective roles; understanding the fundamental ethics governing the profession.	Understand
CO3	Giving a good insight into contracts and contracts management in civil engineering, dispute resolution mechanisms; laws governing engagement of labour	Understand
CO4	Making the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession and Arbitration and Conciliation system.	Apply
CO5	Explaining different building by-laws	Understand

COURSE ARTICULATION MATRIX

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

22CE703	ESTIMATION, COSTING AND VALUATION			Semester		VII
PREREQUISITES		Category	PC	Credit		3
Construction Materials, Concrete Technology		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives	
1	To study the knowledge in estimation and will be able to prepare estimates
2	To understand procedure of rate analysis for all building
3	To study tender practices, specification and prepare report.
4	To study contract procedures
5	To understand valuation of building

Unit I	QUANTITY ESTIMATION	9	0	0	9
Principle of estimation- units- item work- different kinds of estimates- different methods of estimation- estimation of materials in single room building- two room building- multi storey buildings with different sections of walls ,foundation, floors and roofs, R.B and R.C.C works, Plastering, white washing, Distempering and painting, doors and windows, lump sum items- Estimates of joineries for panelled and glazed doors, window, ventilators, handrails etc.					
Unit II	**RATE ANALYSIS AND COSTING**	**9**	**0**	**0**	**9**
Purpose- importance and requirements of rate analysis- units of measurement preparation of rate analysis- Procedure of rate analysis for items- Earth work, concrete works, R.C.C works, reinforce brick work ,plastering ,painting ,finishing (white washing ,distempering)					
Unit III	**SPECIFICATIONS, REPORTS AND TENDERS**	**9**	**0**	**0**	**9**
Specifications – Detailed and general specifications – Constructions – Sources – Types of specifications – Principles for report preparation – report on estimate of residential building – Culvert – Roads – TTT Act 2000 – Tender notices – types – tender procedures – Drafting model tenders , E-tendering-Digital signature certificates- Encrypting –Decrypting – Reverse auctions.					
Unit IV	**CONTRACTS**	**9**	**0**	**0**	**9**
Contract – Types of contracts – Formation of contract – Contract conditions – Contract for labour, material, design, construction – Drafting of contract documents based on IBRD / MORTH Standard bidding documents – Construction contracts – Contract problems – Arbitration and legal requirements.					
Unit V	**VALUATION**	**9**	**0**	**0**	**9**
Definitions – Various types of valuations – Valuation methods – Necessity – Capitalised value – Depreciation – Escalation – Valuation of land – Buildings – Calculation of Standard rent – Mortgage – Lease.					
					Total= 45 Periods

Text Books:	
1	Dutta BN, Estimating & costing in Civil Engineering, UBS Publishers & Distributors Pvt. Ltd, 28th Edition 2020
2	Kohli, D.D and Kohli R.C Text book of Estimating and Costing (Civil), S.Chand& Company Ltd,13th Edition 2013
3	Rangwala SC Estimating & Costing, Charotar Publishing House, Pvt Ltd 1st January 2017

Reference Books:	
1	M. Chakraborty, Estimation, Costing, Specification & Valuation in Civil Engineering, Charotar Publishing House Pvt Ltd 1st January 2006
2	Hand Book of Consolidated Data – 8/2000, Vol.1, TNPWD
3	Standard Data Book for Analysis and Rates IRC, New Delhi 2003
4	Standard Data Book for Analysis and Rates, IRC, New Delhi, 2015

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the approximate cost of the projects through preliminary and detailed estimates	Understand
CO2	Analyze the rates of individual items for the preparation of the estimates	Analyse
CO3	Explain schedule of quantities required to be attached with the tender documents	Understand
CO4	Gain knowledge on types of contract.	Remember
CO5	Understand the valuation of assets	Evaluate

COURSE ARTICULATION MATRIX

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO2	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO3	**2**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO4	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO5	**2**	**2**	**3**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**
Avg	**2**	**2**	**1.8**	**1.5**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CE704</td><td colspan="3">CONCRETE TECHNOLOGY LABORATORY</td><td colspan="3">Semester</td><td>VII</td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PC</td><td colspan="2">Credit</td><td>1.5</td></tr>
<tr><td colspan="3" rowspan="2">Construction materials and technology and Concrete Technology</td><td 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>3</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">This course will help students to know about the properties of different building materials.</td></tr>
<tr><td>2</td><td colspan="7">To implement the idea of material properties in order to make a mix design for the design of various building members.</td></tr>
<tr><td>3</td><td colspan="7">To prepare the students to effectively link theory with practice and application and to demonstrate background of the theoretical aspects in concrete technology.</td></tr>
<tr><td>4</td><td colspan="7">To prepare the students to have hands-on experiments and to have exposure to use equipment and machines.</td></tr>
<tr><td>5</td><td colspan="7">To motivate the students to take up higher studies and innovative research projects.</td></tr>
<tr><td colspan="8">LIST OF EXPERIMENTS</td></tr>
<tr><td colspan="8">1. Determination of Normal consistency and setting time tests on cement Compass traversing
2. Determination of Fineness test on cement
3. Determination of Soundness test on cement
4. Determination of Aggregate Crushing and Impact Value
5. Determination of Aggregate Abrasion Test
6. Determination of Specific gravity of Cement
7. Concrete mix Design using IS method
8. Determination of Compressive strength of cement
9. Determination of Slump test on fresh concrete
10. Determination of Compaction factor test on fresh concrete
11. Determination of quality of Hardened concrete using Ultrasonic concrete tester (NDT)
12. Determination of compressive strength of concrete cubes by Rebound Hammer tester (NDT)</td></tr>
<tr><td colspan="8">Total= 45 Periods</td></tr>
</table>

Reference Books:	
1	Building and Construction Materials: Testing and Quality Control- Testing and Quality Control, M. L. Gambhir, Dhanpat Rai & sons New – Delhi,2014
2	Laboratory manual on concrete technology; Hemant Sood, CBS Publishers, First edition,2016
3	Concrete Technology (Theory & Practice),M.S.Shetty, S. Chand Publications,Eighth edition,2018

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the techniques to characterize various construction materials through relevant tests.	Evaluate
CO2	Test all the concrete materials as per IS code	Evaluate
CO3	Design the concrete mix using IS code	Create
CO4	Determine the properties of fresh and hardened concrete	Evaluate
CO5	Conduct tests on concrete using NDT methods	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	2	-	-	-	2	-	-	-	2	-	2
CO2	-	-	-	2	-	-	1	-	-	-	-	-	2	-	2
CO3	-	-	-	2	-	-	1	-	-	-	-	-	2	-	2
CO4	-	-	-	-	2	-	2	-	-	-	-	-	1	-	1
CO5	-	-	-	-	2	-	2	-	-	-	-	-	1	-	1
Avg	-	-	-	2	2	-	1.5	-	2	-	-	-	1.6	-	1.6
3/2/1 – indicates strength of correlation (3- High, 2- Medium, 1- Low)															

<table>
<tr><td>22CE705</td><td colspan="2">COMPUTER AIDED DESIGN ANDDRAWING
(Concrete and Steel)</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>1.5</td></tr>
<tr><td colspan="2" rowspan="2">Computer aided building drawing, Design of R.C elements and steel structural elements</td><td 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>3</td><td>3</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">This course will help students to perform structural design for retaining walls implanting manually and through the drafting process.</td></tr>
<tr><td>2</td><td colspan="6">This course will help students to perform structural design for slabs implanting manually and through the drafting process.</td></tr>
<tr><td>3</td><td colspan="6">This course will help students to perform structural design for water tanks implanting manually and through the drafting process.</td></tr>
<tr><td>4</td><td colspan="6">This course will help students to perform structural design for built up columns implanting manually and through the drafting process.</td></tr>
<tr><td>5</td><td colspan="6">This course will help students to perform structural design for girders implanting manually and through the drafting process.</td></tr>
<tr><td colspan="7">LIST OF EXPERIMENTS</td></tr>
<tr><td colspan="7">1.Design and drawing of RCC cantilever retaining wall with reinforcement details
2.Design and drawing of Counterfort retaining wall with reinforcement details
3.Design and drawing of RCC continuous slab with reinforcement details
4.Design and drawing of RCC Circular water tank with reinforcement details
5.Design and drawing of RCC rectangular underground water tank with reinforcement details
6.Design and drawing of built-up column with base plate with detailed drawings on connections
7.Design and drawing of Plate girder with detailed drawings on connections
8. Design and drawing of Gantry girder with detailed drawings on connections</td></tr>
<tr><td colspan="7">Total= 45 Periods</td></tr>
</table>

Reference Books:	
1	Duggal S.K., Limit State Design of Steel Structures, Tata McGraw-Hill Publishing Company , New Delhi, 3rd Edition, 2017.
2	Subramanian N., Design of Steel Structures, First edition, OXFORD university press, 2013.
3	Punmia B.C., Ashok Kumar Jain & Arun Kumar Jain ., Limit State Design of Reinforced Concrete, Laxmi Publications Pvt. Ltd., New Delhi, 2016.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire hands on experience on designing the concrete structures	Apply
CO2	Acquire hands on experience on designing the steel structures	Apply
CO3	Preparation of structural drawings of concrete structures with all details	Apply
CO4	Preparation of structural drawings of steel structures with all details	Apply
CO5	Analyse the RCC and Steel structures with safe limits and checking the design.	Apply

COURSE ARTICULATION MATRIX

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	2	-	-	-	2	-	-	-	2	-	2
CO2	-	-	-	2	-	-	1	-	-	-	-	-	2	-	2
CO3	-	-	-	2	-	-	1	-	-	-	-	-	2	-	2
CO4	-	-	-	-	2	-	2	-	-	-	-	-	1	-	1
CO5	-	-	-	-	2	-	2	-	-	-	-	-	1	-	1
Avg	-	-	-	2	2	-	1.5	-	2	-	-	-	1.6	-	1.6

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

PROFESSIONAL ELECTIVE COURSES

PROFESSIONAL ELECTIVE COURSES

22CEPE01	BUILDING INFORMATION MODELLING			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives	
1	To impart the knowledge about the tools in Building Information Modelling .
2	To understand the concepts in HVAC system
3	To gain knowledge in scheduling the construction projects
4	To provide knowledge in estimation of cost of the projects
5	To understand the various clash in the models

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction to Building Information Modelling (BIM) -BIM Benefits- Construction and fabrication Benefits Design Benefits-Discussions of the Roles and Impacts of BIM in the Design - Tools (Autodesk /Tekla/ Bentley) - hardware system requirements					
Unit II	**BUILDING INFORMATION MODELLING WORKFLOW**	**9**	**0**	**0**	**9**
Quantification - Perform Virtual Take off - Perform 2D takeoff - Manage Takeoff Data - Update and Analyze data - Export Takeoff Data - Autodesk Rendering - Autodesk Rendering Overview - Adding Materials to a Model - Creating and Editing Materials - Material Mapping - Lighting - Sun and Sky Lights -Exposure Control - Ground Planes - Photorealistic Rendering - Data visualization					
Unit III	**BUILDING INFORMATION MODELLING – ARCHITECTURE, STRUCTURE**	**9**	**0**	**0**	**9**
Creation of Architectural and Structural models 3D - Structure and MEP- Creating Sets- Building Elements Structural Systems- Planning and Design - Intrusion detection - Lighting Control - Indoor Air quality services - Elevators/ escalators - parking lot monitoring system - card and keypad access - fire safety - Model checking - Information retrieval					
Unit IV	**CONSTRUCTION MANAGEMENT**	**9**	**0**	**0**	**9**
Project Management- Construction Engineering and Management- Facility Management - BIM based Quantity and Cost Estimation - BIM 4D Simulation: Project scheduling and construction-based monitoring - Construction Cost Estimating and Scheduling - BIM 360 – Cloud based BIM Management					
Unit V	**BUILDING INFORMATION MODELLING DESIGN COORDINATION AND CLASH ANALYSIS**	**9**	**0**	**0**	**9**
BIM and Clash Detection- BIM and Elements of Cost Estimation 5D - Clash Detection - Over View of Clash Detective Tool - Clash detective Window - Working With Clash tests - Use Clash Tests - Set Clash Rules - Select Object for Clashing - View Clash results - Produce clash Reports - Introduction to Project life cycle information (6D) - Collaboration - data handling - Point cloud - Risk assessment - Decision making					
					Total= 45 Periods

Text Books:	
1	Hardin, B., & McCool, D. (2015). BIM and construction management: proven tools, methods, and workflows. John Wiley & Sons.
2	Eynon, J. (2016). Construction Manager's BIM Handbook. John Wiley & Sons

Reference Books:	
1	Eastman, C., Teicholz, P., Sacks, R., & Liston, C. "BIM handbook: A guide to building information", 2011
2	Teicholz, P. (Ed.). "BIM for facility managers", John Wiley & Sons. 2013
3	Pittard, S., & Sell, P. (Eds.). "BIM and Quantity Surveying", Routledge. 2016
4	Duell, R., Hathorn, T, and Hathorn, T.R. "Autodesk Revit Architecture 2016 Essentials", Wiley and Sons, Inc. 2015
5	Raymond Issa, Svetlana Olbina "Building Information Modeling: Applications and Practices", American Society of Civil Engineers, 2015
6	IS 875(Part3)-2015: Wind Loads on Buildings and Structures

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Model the architectural features	Create
CO2	Analyse the efficiency of HVAC system	Analysis
CO3	Plan the schedule for the construction projects	Analysis
CO4	Estimate the cost of project	Apply
CO5	Interpret the clash analysis report	Analysis

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**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**
CO2	**1**	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**
CO3	**1**	**2**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**-**	**3**	**-**
CO4	**1**	**2**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**3**	**-**
CO5	**1**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**3**	**-**
Avg	**1**	**2.4**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**2.2**	**2.3**	**-**	**-**	**3**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE02	ADVANCED STEEL STRUCTURES			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
Knowledge of mathematics, Strength of Materials, Structural analysis and design of steel structural elements.		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives

1	To study the codal provisions in IS 800-2007 for plate girder, Gantry Girder and beam-columns.
2	To obtain the knowledge of analysis and design of shear and moment resisting connections.
3	To acquire the design principles of water tanks
4	To analyse and design the building frames for vertical and lateral loads.
5	To analyse and design the Compression and Tension members

Unit I	**CONNECTIONS**	**9**	**0**	**0**	**9**
Design of bolts and weld connections (Stiffened and Seated connections) – Framed connections – Beam to Beam Connections-Beam to Column Connections					
Unit II	**BUILT-UP GIRDER**	**9**	**0**	**0**	**9**
Design of Plate girders bolted and welded –Design of stiffeners and splices-Gantry girder					
Unit III	**BEAM-COLUMNS**	**9**	**0**	**0**	**9**
Introduction-Behaviour of Beam-columns-Elastic-Torsional buckling-nominal strength-instability in the plane of bending-beam-column under biaxial loading-interaction equations for local capcity check-code design procedure-problems.					
Unit IV	**ROOF TRUSS**	**9**	**0**	**0**	**9**
Roof Trusses – different configuration of truss-Roof and Side coverings – Design of purlin and elements of truss; end bearing-Pre Engineered Structures					
Unit V	**COLD-FORMED STEEL MEMBERS**	**9**	**0**	**0**	**9**
Types of cross sections – local buckling and lateral buckling – concepts of elastic width – design of compression and tension members, beams, deflection of beams and design of beam webs.					
					Total= 45 Periods

Text Books:

1	Duggal S.K., Limit State Design of Steel Structures, Tata McGraw-Hill Publishing Company, New Delhi, 3rd Edition, 2017.
2	Subramanian N., Design of Steel Structures, First edition, OXFORD university press, 2013.
3	Gambir. ML., Fundamentals of structural steel design, McGraw Hill education India Pvt.Ltd., 2017

Reference Books:	
1	Chandra R., Limit State Design of Steel Structure Vol – I & II, ScientificPublisher, New Delhi,2009.
2	Ramachandra S., & Virendra Gehlot D.,Limit State Design of Steel Structures –,Standard Publication, New Delhi,2009
3	Teaching Resources for Structural Steel Design – Vol.I& II, INSDAG, Kolkatta
4	IS 800:2007 Code of practice for general construction steel
5	SP 6 IS Structural steel Design Illustrated Hand book
6	IS 875:1987 Code of practice for Design loads (other than earthquake) forbuildings and structures (Part – I) Dead loads (Part – II) Live loads (Part – III) Wind loads(2015)
7	IS: 801-1975, Code of practice for use of cold-formed light gauge steel structural members in general building construction
8	IS: 811-1987, Cold Formed Light Gauge Structural Steel Sections.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the different types of connections based on rotation capacity	Apply
CO2	Explain the loads on plate and gantry girder and design of plate and gantry girder.	Apply
CO3	Design the components of roof truss	Apply
CO4	Design and detailing of Connections, Plate Girder and Gantry Girder.	Create
CO5	Design and detailing of Beam-Columns and Light Gauge steel beams and columns	Create

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**1**
CO2	**1**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**2**	**1**	**-**	**-**	**-**	**2**	**1**
CO3	**2**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**2**	**1**	**1**	**-**	**-**	**2**	**2**
CO4	**2**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**2**	**1**	**2**	**-**	**-**	**2**	**2**
CO5	**2**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**2**	**1**	**-**	**-**	**-**	**2**	**1**
Avg	**1.6**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**2**	**1**	**1.5**	**-**	**-**	**2**	**1.4**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE03	DYNAMICS AND EARTHQUAKE RESISTANT DESIGN OF STRUCTURES			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
Design of Reinforced Concrete Elements **Advanced Structural Analysis**		**Hours/Week**	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Learning Objectives

1	To study the theory of vibrations
2	To learn about the multiple degree of freedom system
3	To understand the knowledge about seismic effect on building
4	To acquire a knowledge about peak acceleration and liquefaction
5	To study about the design methodology

Unit	Title	L	T	P	TH
Unit I	**THEORY OF VIBRATIONS**	**9**	**0**	**0**	**9**

Difference between static forces and dynamic excitation – Concept of inertia and damping – Types of Damping – Degrees of freedom – SDOF Idealisation – Equations of motion of SDOF system for mass as well as base excitation – Free vibration of SDOF system – Response to harmonic excitation – Impulse and response to unit impulse – Duhamel integral

Unit	Title	L	T	P	TH
Unit II	**MULTIPLE DEGREE OF FREEDOM SYSTEM**	**9**	**0**	**0**	**9**

Two degree of freedom system – Normal modes of vibration – Natural frequencies – Mode shapes- Introduction to MDOF systems – Decoupling of equations of motion – Concept of mode superposition (No derivations).

Unit	Title	L	T	P	TH
Unit III	**ELEMENTS OF SEISMOLOGY**	**9**	**0**	**0**	**9**

Causes of Earthquake – Geological faults – Tectonic plate theory – Elastic rebound – Epicentre – Hypocentre – Primary, shear and Rayleigh waves – Seismogram – Magnitude and intensity of earthquakes – Magnitude and Intensity scales – Spectral Acceleration – Information on some disastrous earthquakes

Unit	Title	L	T	P	TH
Unit IV	**RESPONSE OF STRUCTURES TO EARTHQUAKE**	**9**	**0**	**0**	**9**

Response and design spectra – Design earthquake – Concept of peak acceleration – Site specific response spectrum – Effect of soil properties and damping – Liquefaction of soils – Importance of ductility – Methods of introducing ductility into RC structures.

Unit	Title	L	T	P	TH
Unit V	**DESIGN METHODOLOGY**	**9**	**0**	**0**	**9**

IS 2293, IS 13920 and IS 4326 – Codal provisions – Design as per the codes – Base isolation techniques – Vibration control measures – Important points in mitigating effects of earthquake on structures

Total= 45 Periods

Text Books:

1	Damodarasamy S.R. and Kavitha S. Basics of Structural Dynamics and Aseismic Design,PHI learning private Ltd, New Delhi-1, 2009

Reference Books:	
1	D Paz, M., Structural Dynamics – Theory & Computation, CSB Publishers & Distributors, Darga Ganj, New Delhi-2, 2004.
2	Dr. Ashok K. Jain, **DYNAMICS OF STRUCTURES,** Pearson Education India; First Edition (20 March 2016), India
3	Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, PHI (30 July 2011), India
4	IS 4326 (1993): Code of practice for earthquake resistant design and construction of buildings [CED 39: Earthquake Engineering]

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the basics of Earthquake Engineering	Understand
CO2	Demonstrate the dynamics of structural system under earthquake load	Understand
CO3	Analyze the influence of the structural / geometrical design in building characteristics	Analyse
CO4	Demonstrate the cyclic loading familiar of RC steel and prestressed concrete elements	Apply
CO5	Apply codal provisions on different types of structures	Apply

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22CEPE04</td><td colspan="3">AIR POLLUTION CONTROL ENGINEERING</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To identify the sources, classification, effects of air pollutants, and measurement of air pollutants.</td></tr>
<tr><td>2</td><td colspan="7">To recognize the basic concepts of various meteorological factors which influence the dispersion of air pollutants and to create wind rose diagrams.</td></tr>
<tr><td>3</td><td colspan="7">Understand and analyse the basic mechanisms involved, working principle sand design aspects of various air pollution control equipment</td></tr>
<tr><td>4</td><td colspan="7">To carry out experiments on different monitoring tests for ambient air quality parameters and compare it with air quality standards</td></tr>
<tr><td>5</td><td colspan="7">To identify the sources, effects and control measures of noise pollution</td></tr>
<tr><td>Unit I</td><td colspan="3">SOURCES AND EFFECTS OF AIR POLLUTANTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution – Source inventory – Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles.</td></tr>
<tr><td>Unit II</td><td colspan="3">DISPERSION OF POLLUTANTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Elements of atmosphere – Meteorological factors – Wind roses – Lapse rate – Atmospheric stability and turbulence – Plume rise – Dispersion of pollutants – Dispersion models – Applications</td></tr>
<tr><td>Unit III</td><td colspan="3">AIR POLLUTION CONTROL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Concepts of control – Principles and design of control measures – Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation – Selection criteria for equipment – gaseous pollutant control by adsorption, absorption, condensation, combustion – Pollution control for specific major industries.</td></tr>
<tr><td>Unit IV</td><td colspan="3">AIR QUALITY MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Air quality standards – Air quality monitoring – Preventive measures – Air pollution control efforts – Zoning – Town planning regulation of new industries – Legislation and enforcement – Environmental Impact Assessment and Air quality</td></tr>
<tr><td>Unit V</td><td colspan="3">NOISE POLLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Sources of noise pollution – Effects – Assessment – Standards – Control methods – Prevention</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Rao, C.S., Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.
2	Anjaneyulu, D., Air Pollution and Control Technologies, Allied Publishers, Mumbai, 2002
Reference Books:	
1	Rao M.N., and Rao H. V. N., Air Pollution Control, Tata-McGraw-Hill, New Delhi, 1996.
2	Peavy S.W., Rowe D.R. and Tchobanoglous G. Environmental Engineering, McGraw Hill, New Delhi, 1985
3	Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers, New Delhi

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the sources and effects of air pollutants	Remember
CO2	Get the knowledge about dispersion of air pollutants	Remember
CO3	Know about air pollution control measures	Apply
CO4	Aware about air quality management	Evaluate
CO5	Understand the sources, effects and control methods of noise pollution	Analyze

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	1	-	-	3	-	1	1	-	1	1	3	-	1
CO2	-	-	1	-	-	3	-	-	2	-	-	-	1	-	2
CO3	-	-	3	3	2	3	3	3	3	3	1	3	3	1	3
CO4	-	2	2	1	2	3	2	-	2	-	1	2	3	-	2
CO5	-	-	3	3	3	3	3	3	3	3	1	2	3	-	3
Avg	-	2	2	2.3	2.3	3	2.7	0.2	2.2	3	1	2	2.6	1	2.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE05	SOLID WASTE MANAGEMENT			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives	
1	This subject covers the various sources and characterisation of municipal solid wastes and the on-site/off-site processing of the same and the disposal methods.
2	The student is expected to know about the various effects and disposal options for the municipal solid waste
3	Provide efficient and economical refuse collection, recycling, and disposal services.
4	This subject covers the various techniques and equipments of municipal solid wastes from off-site
5	This subject covers the various disposal methods

Unit I	**SOURCES AND TYPES OF MUNICIPAL SOLID WASTES**	**9**	**0**	**0**	**9**
Sources and types of solid wastes - Quantity – factors affecting generation of solid wastes; characteristics – methods of sampling and characterization-Effects of improper disposal of solid wastes – public health effects. Principle of solid waste management – social & economic aspects- Public awareness- Role of NGOs- Legislation.					
Unit II	**ON-SITE STORAGE & PROCESSING**	**9**	**0**	**0**	**9**
On-site storage methods – materials used for containers – on-site segregation of solid wastes – public health & economic aspects of storage – options under Indian conditions – Critical Evaluation of Options.					
Unit III	**COLLECTION AND TRANSFER**	**9**	**0**	**0**	**9**
Methods of Collection – types of vehicles – Manpower requirement – collection routes- transfer stations – selection of location, operation & maintenance; options under Indian conditions.					
Unit IV	**OFF-SITE PROCESSING**	**9**	**0**	**0**	**9**
Processing techniques and Equipment; Resource recovery from solid wastes – composting, incineration, Pyrolysis - options under Indian conditions.					
Unit V	**DISPOSAL**	**9**	**0**	**0**	**9**
Dumping of solid waste; sanitary landfills – site selection, design and operation of sanitary landfills – Leachate collection & treatment					
Total= 45 Periods					

Text Books:	
1	George Tchobanoglous etc.al., Integrated Solid Waste Management, McGraw-Hill, Publishers, 1993.
2	CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2014.
Reference Books:	
1	B. Bilitewski, G. HardHe, K. Marek, A. Weissbach, and H. Boeddicker, Waste Management, Springer, 1994.
2	Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000

3	R.E. Landreth and P.A. Rebers, Municipal Solid Wastes – problems and Solutions, Lewis Publishers, 1997
4	Peavy S.W., Rowe D.R. and Tchobanoglous G. Environmental Engineering, McGraw Hill, New Delhi, 1985.
5	Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers, New Delhi

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the characteristics, types and sources of municipal solid wastes and the present scenario of solid waste management	Remember
CO2	On-site processing of municipal solid wastes and apply knowledge for recycling and reuse of waste	Understand
CO3	Learn the collection methods of solid waste and to transfer it to the disposal site	Apply
CO4	Know about off-site processing of municipal solid wastes and its recovery	Remember
CO5	Apply the effective municipal solid waste disposal methods	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	1
CO2	-	3	-	-	-	2	1	-	-	-	1	-	3	2	2
CO3	1	-	2	-	-	3	-	-	-	-	1	-	2	2	-
CO4	1	2	1	-	1	2	1	1	1	1	1	-	3	1	2
CO5	2	1	1	1	1	1	2	-	2	-	1	1	3	1	1
Avg	1.3	1.8	1.5	1	1	2.0	1.3	1	1.5	1	1	1	2.6	1.6	1.5
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE06	SUBSURFACE INVESTIGATION AND INSTRUMENTATION		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Soil Mechanics and Foundation Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	Students are expected to understand the importance of site investigation, planning of sub soil investigation, interpretation of investigated data to design suitable foundation systems.
2	The student is expected to understand the importance and significance of soil sampling
3	To learn the various exploration techniques
4	To study the details about field test in soil exploration
5	To understand about the instrumentation in soil engineering

Unit I	**PLANNING OF EXPLORATION AND GEOPHYSICAL METHODS**	**9**	**0**	**0**	**9**

Scope and objectives, planning of exploration program – methods of exploration – exploration for preliminary and detailed design, spacing and depth of bores, data presentation. – Geophysical exploration and interpretation – reflection, refraction and resistivity: Spectral analysis of surface waves (SASW), Multichannel Analysis of Surface Waves (MASW), cross hole – up hole – down hole methods.

Unit II	**EXPLORATION TECHNIQUES**	**9**	**0**	**0**	**9**

Methods of boring and drilling, non-displacement and displacement methods, drilling in difficult subsoil conditions, offshore drilling, limitations of various drilling techniques, stabilization of boreholes, bore logs.

Unit III	**SOIL SAMPLING**	**9**	**0**	**0**	**9**

Sampling Techniques – quality of samples – factors influencing sample quality – disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation and handling of samples.

Unit IV	**FIELD TESTING IN SOIL EXPLORATION**	**9**	**0**	**0**	**9**

Field tests, penetration tests, Field vane shear, In Situ shear and borehole shear test, pressuremeter test, dilatometer test – plate load test–monotonic and cyclic; field permeability tests – block vibration test. Procedure, limitations, correction and data interpretation of all methods.

Unit V	**INSTRUMENTATION**	**9**	**0**	**0**	**9**

Instrumentation in soil engineering, functional components of data acquisition system – strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements – slope indicators, sensing units, case studies.

Total= 45 Periods

Text Books:

1	Alam Singh and Chowdhary, G.R., Soil Engineering in Theory and Practice, Volume-2, Geotechnical testing and instrumentation, CBS Publishers and Distributors, New Delhi, 2006.
2	Hunt, R.E., Geotechnical Engineering Investigation Manual, McGraw Hill,1984.
3	Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Hand Book, a Nostrand Reinhold 1994.

Reference Books:	
1	Nair, R.J. and Wood, P.M., Pressuremeter Testing Methods and Interpretation, Butter- worths, 1987.
2	Dunnicliff, J., and Green, G.E., Geotechnical Instrumentation for Monitoring Field Performance, John Wiley, 1993.
3	Hanna, T.H., Field Instrumentation in Geotechnical Engineering, Trans Tech., 1985.
4	Day, R.N., Geotechnical and Foundation Engineering, Design and Construction, McGraw- Hill, 1999.
5	Bowles, J.E., Foundation Analysis and Design, Fifth Edition, The McGraw-Hill Companies, Inc., New York, 1995.
6	Clayton C. R. I., Matthews M. C. and Simons N. E., Site Investigation, Second Edition Halsted Press, 1982.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Plan the subsurface investigation program for a given project.	Understand
CO2	Predict an appropriate methods of Soil Exploration	Apply
CO3	Apply the knowledge of soil sampling techniques	Apply
CO4	Determine the soil parameter by conducting appropriate field testing	Apply
CO5	Summarise the instrumentation in the field of geotechnical engineering	Remember

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22CEPE07</td><td colspan="2">AIRPORTS, DOCKS AND HARBOURS ENGINEERING</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">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">Planning of airports, docks and harbours structure</td></tr>
<tr><td>2</td><td colspan="6">Design of airports, docks and harbours structure</td></tr>
<tr><td>3</td><td colspan="6">Construction of airports, docks and harbours structure</td></tr>
<tr><td>4</td><td colspan="6">Maintenance of airports, docks and harbours structure</td></tr>
<tr><td>5</td><td colspan="6">Planning of coastal structure</td></tr>
<tr><td>Unit I</td><td colspan="2">AIRPORT PLANNING AND DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Advantages and Limitations of Air Transport, Components of Airports-Airport Planning – Air traffic potential, Site Selection, Design of Components, Cost Estimates, Evaluation and Institutional Arrangements-Runway Design- Orientation, Cross wind Component, Wind rose Diagram (Problems), Geometric Design and Corrections for Gradients (Problems), Drainage.</td></tr>
<tr><td>Unit II</td><td colspan="2">TAXIWAY DESIGN AND AIRPORT LAYOUTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Taxiway Design – Geometric Design Elements, Minimum Separation Distances, Design Speed, Airport Drainage –Airport Zoning – Clear Zone, Approach Zone, Buffer Zone, Turning Zone, Clearance over Highways and Railways-Airport Layouts – Apron, Terminal Building, Hangars, Motor Vehicle Parking Area and Circulation Pattern, Case studies of Airport Layouts-Airport Buildings – Primary functions, Planning Concept, Principles of Passenger Flow, Passenger Facilities.</td></tr>
<tr><td>Unit III</td><td colspan="2">VISUAL AIDS AND AIR TRAFFIC CONTROL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Visual Aids – Runway and Taxiway Markings, Wind Direction Indicators, Runway and Taxiway Lightings-Air Traffic Control – Basic Actions, Air Traffic Control Network Helipads, Hangars, Service Equipments.</td></tr>
<tr><td>Unit IV</td><td colspan="2">HARBOUR ENGINEERING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Definition of Terms – Harbours, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Area, Depth, Satellite Ports Requirements and Classification of Harbours Site Selection & Selection Investigation – Speed of water, Dredging, Range of Tides, Waves and Tidal Currents, Littoral Transport with Erosion and Deposition, Anchoring Grounds, Geological Characteristics, Winds & Storms- Proximity to Towns/Cities, Utilities, Construction Materials, Coast Lines</td></tr>
<tr><td>Unit V</td><td colspan="2">DOCKS AND OTHER STRUCTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Dry and Wet Docks, Planning and Layouts- Entrance, Position of LightHouses, Navigating Terminal Facilities – Port Buildings, Warehouse, Transit Sheds, Intermodal Transfer Facilities, Navigational Aids Coastal Structures- Piers, Breakwaters, Wharves, Jetties, Quays, Spring Fenders Coastal Shipping, Inland Water Transport and Container Transportation. Pipe Ways, Rope Ways.</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Khanna S.K, Arora M.G, Airport Planning and Design, Nemchand and Brothers, Roorkee, 2007.
2	Bindra S P., A Course in Docks and Harbour Engineering, Dhanpat Rai and Sons, New Delhi, 1992.
3	Hasmukh Pranshanker Oza, Gautam H. Oza., Dock and Harbour Engineering Charotar Publishing House, 1999

Reference Books:	
1	RangwalaS.C ,Rangwala P.C , Airport Engineering, Charotar Publishing House Pvt. Limited, 2008
2	Shahani P.B., Airport Techniques, 2nd edition, Oxford Publications, New Delhi
3	Srinivasan R., Harbour, Dock and Tunnel Engineering, Charotar Publishing House, Anand, India, 1995.
4	Norman J. Ashford , Paul H. Wright, Airport Engineering, John Wiley & Sons Inc; 1st edition

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe airport planning	Understand
CO2	Design of various Airport components	Apply
CO3	Get an overall knowledge about airport traffic control	Understand
CO4	Construct harbor	Apply
CO5	Protect the docks and coastal structures	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**	**3**	**-**	**1**	**-**	**1**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**2**	**3**	**-**	**3**	**3**	**-**	**1**	**-**	**1**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**2**	**2**	**-**	**3**	**3**	**-**	**1**	**-**	**1**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**2**	**-**	**3**	**3**	**-**	**1**	**-**	**1**	**3**	**3**	**-**	**1**
CO5	**-**	**-**	**-**	**2**	**-**	**1**	**1**	**-**	**1**	**-**	**2**	**2**	**2**	**-**	**2**
Avg	**3**	**-**	**2.25**	**2.2**	**-**	**2.4**	**2.6**	**-**	**1**	**-**	**1.2**	**2.8**	**2.8**	**-**	**1.2**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE08	HIGHRISE BUILDINGS					Semester		
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
Concrete technology, design of steel structures			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives

1	The design aspects and analysis methodologies of tall buildings are introduced. The stability analysis of tall buildings is another imperative in this course
2	To study different loads
3	To learn about behaviour of various structural systems
4	To study analysis, design of building
5	To study analysis, stability of tall building

Unit I	**DESIGN CRITERIA AND MATERIALS**	**9**	**0**	**0**	**9**

Development of High Rise Structures - General Planning Considerations - Design philosophies - Materials used for Construction - High Strength Concrete - High Performance Concrete - Self Compacting Concrete - Glass - High Strength Steel.

Unit II	**LOADING**	**9**	**0**	**0**	**9**

Gravity Loading - Dead Load - Live Load - Live load reduction technique - Impact Load - Construction Load - Sequential Loading. Lateral Loading - Wind load - Earthquake Load. Combination of Loads.

Unit III	**BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS**	**9**	**0**	**0**	**9**

Factors affecting growth, Height and Structural form. High rise behaviour of Various structural systems - Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubular structures, cores, outrigger - braced and hybrid mega systems.

Unit IV	**ANALYSIS AND DESIGN**	**9**	**0**	**0**	**9**

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural systems considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerised general three dimensional analysis.

Unit V	**STABILITY OF TALL BUILDINGS**	**9**	**0**	**0**	**9**

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

Total= 45 Periods

Text Books:

1	Bryan Stafford Smith, Alex coull, “Tall Building Structures, Analysis and Design”, John Wileyand Sons, Inc., 1991.
2	Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 2011

Reference Books:	
1	Lin.T.Y, Stotesbury.D, “Structural Concepts and systems for Architects and Engineers”, John Wiley, 1988.
2	Lynn S. Beedle, “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.
3	Wolfgang Schueller "High Rise Building Structures", John Wiley and Sons, New York 1977
4	Bownass David, building services design methodology Routledge, 2001

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Understand knowledge in types of concrete	Understand
CO2	Understand knowledge in types of loads	Understand
CO3	Analysis the various structural systems	Analyze
CO4	Analysis the building structures	Analyze
CO5	Stability evaluation of tall buildings with respect to various factors	Evaluation

COURSE ARTICULATION MATRIX

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

22CEPE09	COASTAL STRUCTURES		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Mechanics of Fluids		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To study purpose of coastal Engineering is to protect harbors, Classification of harbors
2	To analysis behaviors of waves in shallow water
3	To study shore transport, sediment movement
4	To study design of shore defense structures
5	To study modeling in coastal Engineering

Unit I	**INTRODUCTION IN COASTAL ENGINEERING**	**9**	**0**	**0**	**9**
Indian scenario –Classification of harbors. Introduction- wind and waves –sea and swell – introduction in small amplitude wave theory – use of waves table-Mechanics of water waves-linear (Airy) wave theory- introduction to Tsunami					
Unit II	**WAVES PROPERTIES AND ANALYSIS**	**9**	**0**	**0**	**9**
Behaviors of waves in shallow water, introduction to non-linear waves and their properties – waves in shallow water – water refraction , Diffraction and shoaling – Hind cast wave generation models, wave shoaling ; wave refraction ; wave breaking ; wave diffraction random and 3D waves – short term wave analysis- wave spectra and its utilities – long term wave analysis- statistics analysis of grouped wave data.					
Unit III	**COASTAL SEDIMENT TRANSPORT**	**9**	**0**	**0**	**9**
Dynamics beach profile; cross shore transport; along shore transport (Littoral transport) - sediment movement.					
Unit IV	**COASTAL DEFENSE**	**9**	**0**	**0**	**9**
Field measurement; models, groins, sea walls, offshore breakwater, artificial nourishment- planning of coast protection works- design of coastal defense structures					
Unit V	**MODELING IN COASTAL ENGINEERING**	**9**	**0**	**0**	**9**
Physical modeling in coastal Engineering- Limitation and advantages- Role of physical modeling in coastal Engineering- Numerical modeling-Modeling aspects- Limitation- Tsunami mitigation measure					
					Total= 45 Periods

Text Books:	
1	Mani J S , Coastal Hydrodynamics, PHI Pvt Ltd New Delhi- 2012
2	Dean R.G , And Darlympe R.A , Water wave mechanics for Engineering and Scientists, Prentice- Hall, Inc, Englewood Cliffs, New Jersey, 1994
Reference Books:	
1	Ippen A.T, Estuary and coastline Hydrodynamics, McGraw – Hill , Inc ., New York , 1978

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand coastal Engineering aspects of harbors methods to improve navigation	Understand
CO2	Understand wave properties and analysis of waves	Understand
CO3	Understand the concept of sediment transport	Understand
CO4	Design of shore defense structure	Analysis
CO5	Gain the knowledge in Modeling in Coastal Engineering	Remember

COURSE ARTICULATION MATRIX

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

<table>
<tr><td>22CEPE10</td><td colspan="2">WATERSHED MANAGEMENT</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">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">To impart basic knowledge in watershed management</td></tr>
<tr><td>2</td><td colspan="6">To learn about the soil conservation measures</td></tr>
<tr><td>3</td><td colspan="6">To identify the water harvesting techniques</td></tr>
<tr><td>4</td><td colspan="6">To know about the watershed management</td></tr>
<tr><td>5</td><td colspan="6">To learn the application of GIS and remote sensing in watershed management</td></tr>
<tr><td>Unit I</td><td colspan="2">WATERSHED CONCEPTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Watershed - Need for an Integrated Approach - Influencing Factors: Geology – Soil – Morphological Characteristics - Toposheet - Delineation – Codification – Prioritization of Watershed – Indian Scenario</td></tr>
<tr><td>Unit II</td><td colspan="2">SOIL CONSERVATION MEASURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Types of Erosion – Water and Wind Erosion: Causes, Factors, Effects and Control – Soil Conservation Measures: Agronomical and Mechanical - Estimation of Soil Loss - Sedimentation</td></tr>
<tr><td>Unit III</td><td colspan="2">WATER HARVESTING AND CONSERVATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Water Harvesting Techniques – Micro-Catchments - Design of Small Water Harvesting Structures – Farm Ponds – Percolation Tanks – Yield from a Catchment</td></tr>
<tr><td>Unit IV</td><td colspan="2">WATERSHED MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Project Proposal Formulation - Watershed Development Plan – Entry Point Activities – Estimation – Watershed Economics - Agroforestry – Grassland Management – Wasteland Management – Watershed Approach in Government Programmes – Developing Collaborative know how – People’s Participation – Evaluation of Watershed Management</td></tr>
<tr><td>Unit V</td><td colspan="2">GIS FOR WATERSHED MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Applications of Remote Sensing and Geographical Information System - Role of Decision Support System – Conceptual Models and Case Studies</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Suresh, R. 2020. Soil and Water Conservation Engineering, Standard Publishers & Distributors, New Delhi</td></tr>
<tr><td>2</td><td>Ghanashyam Das, “Hydrology and Soil Conservation Engineering”, Prentice Hall of India Private Limited, New Delhi, 2009.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1</td><td>Gurmel Singh et al. 2019. Manual of soil and water conservation practices. Oxford & IBH publishing Co. New Delhi.</td></tr>
<tr><td>2</td><td>Vir Singh, Raj, Watershed Planning and Management, Yash Publishing House, Bikaner, 2016</td></tr>
<tr><td>3</td><td>Tripathi R.P. and H.P.Singh 2008, Soil erosion and conservation, Wiley Eastern Ltd., New Delhi</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the basic concepts of watershed	Understand
CO2	Explain the various concepts in control measures	Understand
CO3	Interpret the water harvesting techniques	Understand
CO4	Describe the methods used for watershed management	Understand
CO5	Summarizing on the applications of GIS and remote sensing	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	1	-	2	1	-	-	-	1	-	2	-	-
CO2	-	-	3	1	-	3	-	-	-	2	-	-	3	-	-
CO3	-	-	2	-	-	1	3	-	-	-	-	-	1	-	-
CO4	1	-	2	1	-	-	3	-	-	-	-	-	-	-	1
CO5	-	1	-	2	-	3	1	-	-	-	-	-	1	-	-
Avg	1.5	1	2.5	1.25	-	2.25	2	-	-	2	1	-	1.75	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEPE11</td><td colspan="3">ROCK MECHANICS AND APPLICATIONS</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Engineering Geology, Mechanics of Soil, Foundation Engineering</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 provide the knowledge about the index properties of Rocks and its classification</td></tr>
<tr><td>2</td><td colspan="7">To gain the knowledge of failure criteria of Rocks</td></tr>
<tr><td>3</td><td colspan="7">To understand the influence of in situ stress in the stability of various structures</td></tr>
<tr><td>4</td><td colspan="7">To provide various technique in improving the in situ strength of rocks</td></tr>
<tr><td>5</td><td colspan="7">To develop a strong knowledge about the various technique to improve the in situ strength of rocks</td></tr>
<tr><td>Unit I</td><td colspan="3">CLASSIFICATION OF ROCKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Types of Rocks – Index properties and classification of rock masses, competent and incompetent rock – value of RMR and ratings in field estimations.</td></tr>
<tr><td>Unit II</td><td colspan="3">STRENGTH CRITERIA OF ROCKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Behaviour of rock under hydrostatic compression and deviatoric loading – Modes of rock failure – planes of weakness and joint characteristics – joint testing, Mohr – Coulomb failure criterion and tension cut-off. Hoek and Brown Strength criteria for rocks with discontinuity sets.</td></tr>
<tr><td>Unit III</td><td colspan="3">IN SITU STRESSES IN ROCKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">In Situ stresses and their measurements, Hydraulic fracturing, flat jack, over coring and under coring methods – stress around underground excavations – Design aspects of openings in rocks – case studies.</td></tr>
<tr><td>Unit IV</td><td colspan="3">SLOPE STABILITY AND BEARING CAPACITY OF ROCKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Rock slopes – role of discontinuities in slope failure, slope analysis and factor of safety – remedial measures for critical slopes – Bearing capacity of foundations on rocks – case studies- Tunneling</td></tr>
<tr><td>Unit V</td><td colspan="3">ROCK REINFORCEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Reinforcement of fractured and joined rocks – shotcreting, bolting, anchoring, installation methods – case studies-</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Goodman, R.E., Introduction to rock mechanics, John Willey and Sons, 1989.
2	Hudson, A. and Harrison, P., Engineering Rock mechanics – An introduction to the principles, Pergamon publications, 1997.
Reference Books:	
1	Hoek, E and Bray, J., Rock slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.
2	Hoek, E and Brown, E.T., Underground Excavations in Rock, Institute of Mining and Metallurgy, U.K. 1981.

3	Obvert, L. and Duvall, W., Rock Mechanics and the Design of Structures in Rock, John Wiley, 1967.
4	Bazant, Z.P., Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.
5	Wittke, W., Rock Mechanics. Theory and Applications with case Histories, Springer Verlag, Berlin, 1990.
6	Waltham, T, Foundations of Engineering Geology, Second Edition, Spon Press, Taylor & Francis Group, London and New York, 2002.
7	T. Ramamurthy, Editor, Engineering in Rocks for Slopes Foundations and Tunnels, PHI Learning Pvt. Ltd., 2007

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the various classification of rocks and its index properties.	Understand
CO2	Assess the various Behaviour of rocks and its Strength Criteria.	Evaluate
CO3	Evaluate the In Situ stresses in Rocks and the Design Aspects.	Evaluate
CO4	Analysis the stability of Rock Slopes and the remedial measures for critical slopes	Analyse
CO5	Evaluate the Bearing capacity of foundations on rocks and illustrate the various techniques to improve the in situ strength of rocks.	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO2	**2**	**1**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
Avg	**2.4**	**2.4**	**2.2**	**2.4**	**-**	**-**	**1.8**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE12	PRESTRESSED CONCRETE STRUCTURES		Semester		
PREREQUISITES		**Category**	**PE**	**Credit**	**3**
Fundamentals on properties of concrete and design of reinforced concrete structures		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To analyse the stresses of prestressed concrete structures
2	To compute losses and deflections of prestressed concrete structures
3	To design the prestressed concrete structures
4	To design the end block system
5	To design the prestressed concrete pipes and tank

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Principles – Pre Tensioning – Post tensioning – Types of prestressing – Systems of prestressing – Comparison of prestressed concrete with reinforced concrete Materials characteristics of concrete – Characteristics of high tensile steel.

Theory and behaviour of prestressed concrete beams in bending – calculating fibre stresses for various sections (Rectangle, I, T) of simply supported beam due to prestressing force, dead load and external live load – Stress method Moment of Resistance method – Load balancing method.

Unit II	**LOSSES AND DEFLECTIONS**	**9**	**0**	**0**	**9**

Various losses in prestressed concrete members – causes for losses in prestressed concrete – calculation of losses – losses due to elastic shortening of pretensioned and post tensioned members – losses due to creep, shrinkage of concrete – relaxation losses – friction and anchorage losses.

Deflection of prestressed concrete flexural members due to prestressing force, dead load, live load – BIS Code provisions – Effect of tendon Profile on deflection – Calculation of elastic short term deflection for simply supported beams – deflections due to creep effect – calculation of long term deflection.

Unit III	**DESIGN OF PRESTRESSED CONCRETE BEAMS**	**9**	**0**	**0**	**9**

Flexural strength of prestressed concrete member – IS Code Provisions - Pre-Tensioned and Post Tensioned simply supported rectangle, I and T sections- Stress method – Design for flexure, bond and shear- IS Code provisions.

Unit IV	**DESIGN OF END BLOCKS**	**9**	**0**	**0**	**9**

Introduction – Stress distribution in end block – Anchorage zone stresses – Anchorage design - Guyon, Magnel and Indian Standard method.

Unit V	**DESIGN OF PIPE, CONTINUOUS BEAM AND COMPOSITE CONSTRUCTION**	**9**	**0**	**0**	**9**

Design of prestressed concrete pipes – Advantages of prestressing in Poles and sleepers – Continuous beams – Concordant Cable Profile.

Types of composite construction – Transformation of composite sections – flexural analysis of composite section -simply supported beams – calculation of stresses – Partial prestressing.

Total= 45 Periods

Text Books:	
1	Sinha, N.C and Roy. S.K., Fundamentals of prestressed concrete S.Chand and Co. Ltd, Third edition, 2011
2	Krishnaraju.N., Prestressed Concrete, Tata McGraw Hill Publishing Company Ltd., New Delhi, 6 th Edition, 2018
3	Raja Gopalan N. “Prestressed Concrete”, Narosa Publishing House, New Delhi, 2017.
Reference Books:	
1	Dayaratnam.P., Prestressed Concrete Structures, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi, 6 th Edition, 2018
2	Mallic S.K. and Gupta A.P., Prestressed concrete, Oxford and IBH publishing Co. Pvt. Ltd. 1997.
3	Lin T.Y., Ned H. Burns., Design of Prestressed concrete Structures, A John Wiley & Sons, INC., Publication, Third Edition,1981
4	V. Natarajan., Fundamentals of Prestressed concrete, B.I., Publication, Second Edition,1983
5	IS 3370-1 (2009) Code of Practice Concrete Structures for the storage of liquids

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Differentiate pre-tensioned and post – tensioned prestressed concrete	Analyse
CO2	Design a prestressed concrete beam accounting for losses and deflection	Analyse
CO3	Design the prestressing members subjected to stress function	Apply
CO4	Design the anchorage zone for post tensioned members	Analyse
CO5	Know the partial and circular prestressing technique in various structures.	Analyse

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	1	-	-	-	-	-	2	1	-
CO2	2	1	1	3	1	1	1	-	-	-	-	-	2	1	-
CO3	2	1	1	2	2	1	1	-	-	-	-	-	2	1	-
CO4	2	1	1	2	1	1	1	-	-	-	-	-	2	1	-
CO5	2	1	1	3	1	1	1	-	-	-	-	-	2	1	-
Avg	2	1	1	2.6	1.2	1	1	-	-	-	-	-	2	1	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE13	ADVANCED CONCRETE DESIGN		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Knowledge of mathematics, Strength of Materials, Structural analysis and design of reinforced concrete elements.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To study the behaviour of combined footings, retaining walls and flat slab.
2	To obtain the knowledge of analysis and design of slabs with different shapes and end conditions using yield line theory.
3	To acquire the design principles of water tanks
4	To analyse and design the building frames for vertical and lateral loads.
5	To gain knowledge about the framed structures reinforcing details

Unit I	**COMBINED FOOTINGS**	**9**	**0**	**0**	**9**
Introduction – need for combined footing – Behaviour and design of rectangular combined footings – pad type – slab and beam type – Design of trapezoidal combined footings for axially loaded column – Behaviour and design of mat and raft foundation (Theory only).					
Unit II	**RETAINING WALLS**	**9**	**0**	**0**	**9**
Introduction – loads on retaining wall – stability requirements – types of retaining wall – Cantilever retaining wall – check for structural stability – design of concrete thickness and reinforcement for stem, heel and toe slab – counterfort retaining wall – check for structural stability– design of concrete thickness and reinforcement for stem, counter fort, heel and toe slab.					
Unit III	**FLAT SLAB DESIGN & YIELD LINE THEORY**	**9**	**0**	**0**	**9**
Design of flat slabs – interior panel and end panel – column strip – middle strip – with and without column head – reinforcement details – Yield line – characteristics – Application of virtual work method to square, rectangular, circular and triangular slabs.					
Unit IV	**WATER TANK DESIGN (L.S.D)**	**9**	**0**	**0**	**9**
Types of water tanks – joints – codal provisions – Elevated water tank – circular and rectangular tank – flat and domed roofs – Underground rectangular tanks– Design of staging and foundations					
Unit V	**BUILDING FRAMES**	**9**	**0**	**0**	**9**
Substitute frame method – load patterns – assumptions – portal and cantilever methods of analysis – Reinforcement detailing of frames- Methods of analysis					
					Total= 45 Periods

Text Books:	
1	Punmia B.C., Asokkumarjain& Arun kumarjain., Limit State Design of Reinforced Concrete, Laxmi Publications Pvt. Ltd., New Delhi,2007
2	Subramanian N., Design of Reinforced Concrete Structures, Oxford University Press, 2018.
3	Shah H.J., Reinforced Concrete Vol.-II, Charotar Publishing House, Anand, 2000.
4	Dayaratnam P., Brick and Reinforced Brick Structures, OXFORD & IBH Publishing Co. Pvt. Ltd., New Delhi,2004.

Reference Books:	
1	Krishna Raju N., Design of Reinforced Concrete Structures, CBS Publishers &Distributors,New Delhi,2008
2	Syal I.C. and Goel A.K., Reinforced Concrete Structures, A.H. Wheelers & Co. Pvt.Ltd., 1994
3	Ram Chandra, Limit State Design, Standard Book House.2006.
4	IS 456:2000, Plain and Reinforced concrete Code of practice (Third Revision).
5	SP :16, Design aids for Reinforced Concrete to IS 456-1978.
6	SP : 34 – 1987 Handbook on Concrete Reinforcement and Detailing
7	IS 3370:1967 Code of practice for Concrete Structures for Storage of liquids (Part – I, II & IV)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design the combined footings and draw the reinforcement details	Apply
CO2	Design and draw the reinforcement details of retaining walls and flat slab.	Apply
CO3	Analyse and design the slabs based on yield line theory and draw the reinforcement details.	Apply
CO4	Design the water tanks and draw the reinforcement details	Apply
CO5	Analyse and design the building frames by approximate method and draw the reinforcement details	Apply

COURSE ARTICULATION MATRIX

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

22CEPE14	HAZARDOUS WASTE MANAGEMENT		Semester			
PREREQUISITES		Category	PE	Credit		3
NIL		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To identify sources of hazardous waste and its management
2	To evaluate the composition and properties of hazardous waste and its source reduction methods
3	To prepare the transportation protocol for safe transport of hazardous wastes
4	To investigate effective hazardous waste processing techniques and enumerate on waste minimization and resource recovery techniques
5	To propose and design the treatment methods including Engineered landfill and containment

Unit I	SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK	9	0	0	9

Types and Sources of hazardous wastes – Need for hazardous waste management – Salient features of Indian legislations on management and handling of hazardous wastes, biomedical wastes, nuclear wastes - lead acid batteries, electronic wastes, plastics and fly ash – Elements of integrated waste management and roles of stakeholders – Financing and Public Private Participation for waste management

Unit II	WASTE CHARACTERIZATION AND SOURCE REDUCTION	9	0	0	9

Waste generation rates and variation – Composition, physical, chemical and biological properties of hazardous wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan – Source reduction of wastes – Waste exchange – Extended producer responsibility – Recycling and reuse

Unit III	STORAGE, COLLECTION AND TRANSPORT OF WASTES	9	0	0	9

Handling and segregation of wastes at source – storage and collection of hazardous wastes – Analysis of Collection systems –Need for transfer and transport – Transfer stations Optimizing waste allocation – compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport.

Unit IV	WASTE PROCESSING TECHNOLOGIES	9	0	0	9

Objectives of waste processing – material separation and processing technologies - biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes – treatment of biomedical wastes – Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment

Unit V	WASTE DISPOSAL	9	0	0	9

Waste disposal options –Disposal in landfills -Landfill Classification, types and methods –site selection –design and operation of sanitary landfills, secure landfills and landfill bioreactors –leachate and landfill gas management –landfill closure and environmental monitoring –Rehabilitation of open dumps –landfill remediation

Total= 45 Periods

Text Books:

1	George Tchobanoglous etc.al., Integrated Solid Waste Management, McGraw-Hill,Publishers, 1993.
2	Michael D. LaGrega, Philip L Buckingham, Jeffrey C. Evans and Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001.

Reference Books:	
1	CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2000.
2	Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.
3	Paul Twilliams, Waste Treatment and Disposal, Wiley, 2005

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Expertise on hazardous wastes management	Evaluate
CO2	Understand the characteristics of different types of hazardous waste management and suggest suitable technical solutions for source reduction	Understand
CO3	Knowledge about storage and collection of hazardous wastes	Remember
CO4	Analyze effective hazardous waste processing techniques	Analyze
CO5	Identify the hazardous waste disposal methods	Remember

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	1
CO2	-	3	-	-	-	2	1	-	-	-	1	-	3	2	2
CO3	1	-	2	-	-	3	-	-	-	-	1	-	2	2	-
CO4	1	2	1	-	1	2	1	1	1	1	1	-	3	1	2
CO5	2	1	1	1	1	1	2	-	2	-	1	1	3	1	1
Avg	**1.3**	**1.8**	**1.5**	**1**	**1.0**	**2.0**	**1.3**	**1**	**1.5**	**1**	**1.0**	**1**	**2.6**	**1.6**	**1.2**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE15	IRRIGATION ENGINEERING			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
Hydrology, Water Resource Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives	
1	To impart basic knowledge in Irrigation Engineering, Water Management
2	To take up the basic concepts of irrigation, construction of various hydraulic structures.
3	To introduce students to basic concepts of water, plants, their interactions, as well as irrigation and drainage systems design, planning and management.
4	To study the elementary hydraulic design of different structures and the concepts of maintenance shall also form part.
5	To develop the abilities to know land development, irrigation management.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Need, advantages and disadvantages of Irrigation - Environmental effects - Types of Irrigation systems - Gravity irrigation, canals, Tanks, Wells and Irrigation galleries - Water lifts. Soil -water - plant relationship: Soil and its function - Physical properties of soil and their importance in relation to irrigation - Classes and availability of soil water - Movement of water in soils - Measurement of soil moisture - Crop growth and moisture relationship - Salt problems in soil and effect of salts on plant growth.					
Unit II	**IRRIGATION REQUIREMENT**	**9**	**0**	**0**	**9**
Evaporation, Evapo-transpiration, Consumptive use and its estimation - Crop factor - Lysimeters - Effective rainfall and irrigation requirements - Water requirements of various crops - Duty of water - Quality of irrigation water.					
Unit III	**METHODS OF IRRIGATION**	**9**	**0**	**0**	**9**
Surface, subsurface and overhead methods - Check basin, border & furrow, Drip and sprinkler irrigation - Irrigation efficiency, Depth, Rate and frequency of irrigation - Irrigation schedule.					
Unit IV	**DESIGN OF CHANNELS**	**9**	**0**	**0**	**9**
Design of unlined and lined channels for irrigation - Location and design of canal regulation structures - Cross drainage structures - Measuring devices.					
Unit V	**LAND DEVELOPMENT AND IRRIGATION MANAGEMENT**	**9**	**0**	**0**	**9**
Reclamation and management of saline and alkaline soils, water logging, Causes and remedial measures - Design, construction and maintenance of drainage systems. Management of irrigation system - water charge assessment and water use management.					
					Total= 45 Periods

Text Books:	
1	Punmia B.C. and Lal, B.B., Irrigation and Water Power Engineering, Standard Publishers & Distributors, New Delhi, 2016.
2	Sharma R.K., and Sharma. T.K., Irrigation Engineering, S.Chand& Company Ltd, New Delhi, 2002.
3	Sahasra Budhe, Irrigation Engineering and Hydraulic Structures, S.K.Kataria& Sons, NewDelhi-110002;2012

Reference Books:	
1	A.M.Michael, Irrigation Theory and Practice, Vikas Publishing House Pvt. Ltd., 2004.
2	Hansen V.E., et.al., Irrigation Principles and Practices, John Wiley & Sons, 2001.
3	Sharma R.K., Text Book of Irrigation Engineering and Hydraulic Structures, Oxford & IBH Publishing Co., 2007.
4	Michael A.M., Irrigation Theory and Practice, Vikas Publishing House, New Delhi, 2004.
5	Das M.M, Saikia, M.S Irrigation and water power Engineering, PHI, Learning, (P) Ltd, New Delhi, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Assess the irrigation needs of crops	Understand
CO2	Understand the irrigation requirements	Understand
CO3	Knowledge of the methods of irrigation	Remember
CO4	Design the canal systems	Analyses
CO5	Design the drainage system	Analyses

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
CO2	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
CO3	**3**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO4	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO5	**3**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
Avg	**2.8**	**2.4**	**2**	**1.4**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.4**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE16	HYDROLOGY				Semester		
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
NIL			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives

1	To introduce the students about the components of the hydrological cycle
2	To impart basic knowledge about the mechanics of rainfall, its spatial and temporal measurement and their applications.
3	To make the students to acquire a wide knowledge in the key drivers on water resources, hydrological processes and their integrated behaviour in catchments
4	To develop the ability among students to construct and apply a range of hydrological models to surface water and groundwater problems such as Hydrograph
5	To make the students understand the simple methods in flood routing and basics of ground water hydrology

Unit I	**PRECIPITATION**	**9**	**0**	**0**	**9**

Hydrologic cycle – Types of precipitation – Forms of precipitation – Measurement of Rainfall – Spatial measurement methods – Temporal measurement methods – Frequency analysis of point rainfall – Intensity, duration, frequency relationship – Probable maximum precipitation.

Unit II	**ABSTRACTION FROM PRECIPITATION**	**9**	**0**	**0**	**9**

Losses from precipitation – Evaporation process – Reservoir evaporation – Infiltration process – Infiltration capacity – Measurement of Infiltration – Infiltration Indices – Effective rainfall.

Unit III	**HYDROGRAPHS**	**9**	**0**	**0**	**9**

Factors affecting Hydrograph – Base flow separation – Unit hydrograph – Derivation of unit hydrograph – S curve hydrograph – Unit hydrograph of different durations - Synthetic Unit Hydrograph

Unit IV	**FLOODS AND FLOOD ROUTING**	**9**	**0**	**0**	**9**

Flood frequency studies – Recurrence interval – Gumbel’s method – Flood routing – Reservoir flood routing – Muskingum’s Channel Routing – Flood control

Unit V	**GROUND WATER HYDROLOGY**	**9**	**0**	**0**	**9**

Types of aquifers – Darcy’s law – Dupuit’s assumptions – Confined Aquifer – Unconfined Aquifer – Recuperation test – Transmissibility – Specific capacity – Pumping test – Steady flow analysis only.

Total= 45 Periods

Text Books:

1	Chow V.T. and Maidment, Hydrology for Engineers, McGraw-Hill Inc., Ltd., 2000
2	Subramanya K., Engineering Hydrology, Tata McGraw-Hill Publishing Co., Ltd., 2017
3	Raghunath H.M., Hydrology, Wiley Eastern Ltd., 2011

Reference Books:

1	Singh V.P., Hydrology, McGraw-Hill Inc., Ltd., 2000
2	Jaya Rami Reddy P., A text book of Hydrology, Laxmi Publications Pvt Ltd.,2008
3	Patra K.C. Hydrology and Water resources Engineering, Narosa publishing house, New Delhi- 2006

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the various components of the hydrological cycle	Understand
CO2	Estimate the hydrological parameters such as precipitation, Evaporation and Infiltration	Evaluate
CO3	Construct and apply a range of hydrological models to surface water and groundwater problems such as Hydrograph	Create
CO4	Understand and apply the various concepts in Flood analysis and Routing	Apply
CO5	Apply the various concepts in ground water Hydrology	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	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	2	1	-	2	-	-	-	-	-	3	-	-
CO3	2	2	2	2	1	-	2	-	-	-	-	-	3	-	-
CO4	3	2	3	2	2	-	2	-	-	-	-	-	3	-	-
CO5	2	2	1	1	1	-	1	-	-	-	-	-	3	-	-
Avg	2.2	1.8	1.6	1.6	1.2	-	2.25	-	-	-	-	-	3	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE17	ADVANCED SURVEYING TECHNIQUES			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
Surveying and Levelling		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives	
1	To understand the electronics basics relevant to digital surveying techniques
2	To impart knowledge on data analysis and application of GIS
3	To impart knowledge to operate the Total station and EDM for both field and office surveying
4	To understand the basic principles behind advanced surveying techniques
5	To impart knowledge to operate the GPS and DGPS for field surveying

Unit I	**BASICS OF SURVEYING AND ELECTRONICS**	**9**	**0**	**0**	**9**
Methods of measuring distance, historical development, basic principles, classifications, applications and comparison with conventional surveying – Electro-optical system, measuring principle, working principle- Electromagnetic Distance Measuring system					
Unit II	**MODERN EQUIPMENTS AND GIS**	**9**	**0**	**0**	**9**
Total Station-Applications In various fields-Basics of Geographical information system (GIS), data base structure, various GIS software and Geographical Positioning system (GPS), Principles, Applications-Introduction to Drone Surveying and LIDAR.					
Unit III	**TOTAL STATION AND EDM**	**9**	**0**	**0**	**9**
Introduction to total station-Types of total station-Measurement with total station-Characteristic and features of Total station –Total Station Prism and Prism Constant –Principle of EDM – Setting and measurements- -EDM Instrument operation – Electronic Display & Data Recording-Rectangular and Polar Coordinate System-Terminology of open and closed traverse-Total station Export and Import Data-Use of excel and Auto CAD in TS					
Unit IV	**AERIAL PHOTOGRAPHY AND FUNDAMENTAL CONCEPTS OF REMOTE SENSING**	**9**	**0**	**0**	**9**
Definition, history, advantages and types of Remote Sensing –Active and Passive Principle and Mechanism of RS-Data Acquisition and Data Analysis – Sources of Energy and interaction with Atmosphere and land surface – spectral reflectance of earth materials and vegetation – Sensor Characteristics- Types of platforms in RS- Aerial Photography –Data collection and scanning systems And Visual Image Interpretation					
Unit V	**GPS AND DGPS SURVEYING**	**9**	**0**	**0**	**9**
GPS and its applications-Geographic Latitude and Longitude- Setup and Use of GPS equipment-Troubleshooting-four GNSS systems-GPS satellites and signals-Measurements in GPS and position determination- Components of GPS-Satellite Transmission signals – DGPS-types of Antenna- Setup and Use of DGPS equipment-Limitation & errors of GPS/DGPS					
Total= 45 Periods					

Text Books:	
1	“A Textbook of Advanced Surveying “ ,R.Agor, KHANNA PUBLISHERS
2	Anji Reddy, “Remote Sensing and Geographical Information system”, BS publications 2001
3	A M. Chandra and S.K .Ghosh, “Remote Sensing and Geographical Information System”, Narosa Publishing House, 2006.

Reference Books:	
1	Pearson Second Edition “ADVANCED SURVEYING TOTAL STATION, GPS, REMOTE SENSING” Satheesh Gopi, R. Sathikumar, N.Madhu
2	Laurila, S.H. Electronic Surveying in Practice, John Wiley and Sons Inc, 1983.
3	Lau Soastamoinen, J.J. Surveyor’s guide to electro-magnetic Distance Measurement, Adam Hilger Ltd., 1967. Rila, S.H. Electronic Surveying in Practice, John Wiley and Sons Inc, 1983.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Understand the electronics basics relevant to digital surveying techniques	Understand
CO2	Experiment on data analysis and application of GIS	Analyze
CO3	Employ the Total station and EDM for both field and office surveying	Apply
CO4	Understand the basic principles behind advanced surveying techniques	Understand
CO5	Employ the both GPS and DGPS for field surveying	Apply

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	3	-	1	-	-	-	1	2	2	-	-
CO2	1	3	2	3	3	3	3	-	2	2	2	2	2	-	-
CO3	1	3	2	3	2	-	1	-	1	1	1	2	2	-	-
CO4	1	3	3	3	2	1	1	-	2	2	1	3	2	-	-
CO5	1	3	3	3	2	1	1	-	2	2	1	3	2	-	-
Avg	1	2.6	2.4	2.8	2.4	1	1.4	-	1.4	1.4	1.2	2.4	2	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE18	TRAFFIC ENGINEERING AND MANAGEMENT		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Transportation Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To give an overview of Traffic engineering
2	To study the various traffic surveys and to the traffic characteristics and related problems
3	To provide knowledge of traffic control devices and its techniques in transportation interaction
4	To understand the basics in the design of intersections
5	To develop a strong knowledge base of traffic planning and its management in any transportation area

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Significance and scope, Characteristics of Vehicles and Road Users, Skid Resistance and Braking Efficiency, Components of Traffic Engineering- Road, Traffic and Land Use Characteristics					
Unit II	**TRAFFIC SURVEYS**	**9**	**0**	**0**	**9**
Surveys and Analysis – Volume, Capacity, Speed and Delays, Origin and Destination, Parking, Pedestrian Studies, Accident Studies and Safety Level of Services.					
Unit III	**TRAFFIC CONTROL**	**9**	**0**	**0**	**9**
Traffic signs, Road markings, Design of Traffic signals and Signal coordination, Traffic control aids and Street furniture, Street Lighting, Computer applications in Signal design					
Unit IV	**GEOMETRIC DESIGN OF INTERSECTIONS**	**9**	**0**	**0**	**9**
Conflicts at Intersections, Classification of Intersections at Grade, - Channelized and Unchannelized Intersection – Grade Separators (Concepts only), Principles of Intersection Design, Elements of Intersection Design, Channelization and Rotary design, Grade Separators.					
Unit V	**TRAFFIC MANAGEMENT**	**9**	**0**	**0**	**9**
Traffic Management- Traffic System Management (TSM) and Travel Demand Management (TDM), Traffic Forecasting techniques, Restrictions on turning movements, One-way Streets, Traffic Segregation, Traffic Calming, Tidal flow operations, Exclusive Bus Lanes – Introduction to Intelligence Transport System (ITS)					
					Total= 45 Periods

Text Books:	
1	Kadiyali. L.R.,“Traffic Engineering and Transport Planning”, Khanna Publishers, Delhi,2015.
2	Khanna .K, Justo C.E.G. and VeeraragavanA.,“Highway Engineering”, Nem Chand & Bros., Roorkee, Revised 10th Edition, 2019

Reference Books:	
1	Sharma S.K., Principles Practice and Design of Highway Engineering, S.Chand& Co Ltd. New Delhi, 2014.
2	Guidelines of Ministry of Road Transport and Highways, Government of India.
3	Saxena S.C. Highway & Traffic Engineering, 2020.
4	IRC:93-1985 Guidelines on Design and Installation of Road Traffic Signals
5	IRC: SP 041-1994 Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the principles and standards adopted in planning and design of traffic system	Understand
CO2	Apply the knowledge of science and engineering fundamentals in conducting traffic surveys	Apply
CO3	Understand the various control measures to design a safe traffic system.	Understand
CO4	Design various types of regulatory measures to meet an efficient traffic network.	Create
CO5	Understand various traffic management measures in addressing the demand and ITS applications	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	1	-	-	-	-	-	3	-	-
CO2	2	2	1	3	2	2	1	-	2	-	-	-	3	-	-
CO3	2	2	3	1	3	3	2	-	-	-	-	-	3	-	-
CO4	2	2	3	1	3	2	2	-	-	-	-	-	3	-	-
CO5	2	2	1	1	2	3	-	-	-	-	2	-	3	-	-
Avg	2.2	2	1.8	1.25	2.2	2.4	1.5	-	2	-	2	-	3	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE19	SOIL STRUCTURE INTERACTION				Semester		
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
Soil Mechanics and Foundation Engineering		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	The student is expected to understand the importance and significance of soil structure interaction
2	To learn the various techniques soil models
3	To study the details about plate on elastic medium
4	To understand about the elastic analysis of pile
5	To learn about the laterally loaded pile

Unit I	SOIL-FOUNDATION INTERACTION	9	0	0	9

Introduction to Soil-foundation interaction problems – Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, Soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior and Time dependent behavior.

Unit II	BEAM ON ELASTIC FOUNDATION – SOIL MODELS	9	0	0	9

Infinite beam, two parameters, Isotropic elastic half-space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

Unit III	PLATE ON ELASTIC MEDIUM	9	0	0	9

Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, Rectangular and Circular plates, Numerical analysis of finite plates, Simple solutions.

Unit IV	ELASTIC ANALYSIS OF PILE	9	0	0	9

Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Unit V	LATERALLY LOADED PILE	9	0	0	9

Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile raft system, Solutions through influence charts.

Total= 45 Periods

Text Books:

1	Sadhu Singh, “Experimental Stress Analysis” Khanna Publishers, New Delhi, 2009.
2	Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier, 1979.
3	Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980.

Reference Books:

1	Scott R.F., Foundation Analysis, Prentice Hall, 1981.
2	Structure-Soil Interaction – State of Art Report”, Institution of Structural Engineers, 1978.
3	ACI 336, Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute, Delhi, 1988.

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand various applications to soil structure interaction	Understand
CO2	Analyse the beam on Elastic Foundation	Analyse
CO3	Analyse the plate on Elastic Foundation	Analyse
CO4	Elastic analysis of pile group	Analyse
CO5	Analyse the laterally loaded pile	Analyse

COURSE ARTICULATION MATRIX

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

22CEPE20	RIVER ENGINEERING			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
Applied Hydraulic Engineering		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	To acquire a wide knowledge on rivers required to make an integrated river basin management plan based on natural & social sciences and engineering & technology.
2	To know the relation to river systems, long term environmental changes of rivers and their factors, river flows and river channel processes, river, and lake ecological systems.
3	To study the recent characteristics of flood disasters, integrated river basin planning including flood control
4	To understand the sustainable reservoir management, nature restoration, and sediment transport management
5	To develop the abilities to design the protection works.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction, classification of Rivers, Mechanics of alluvial rivers including channel and flood plain features, Sediment transport and budgets, River morphology and various classification schemes.

Unit II	**BEHAVIOUR OF RIVER**	**9**	**0**	**0**	**9**

Behaviour of Rivers: Introduction, River Channel patterns, Straight River channels, causes, characteristics and shapes of meanders and control, cutoff, Braided Rivers, Bed forms, Instability of rivers, Hydraulic geometry, Delta formation and control

Unit III	**MECHANICS OF RIVER**	**9**	**0**	**0**	**9**

Mechanics of Alluvial Rivers, Rivers and restoration structures, Socio-cultural influences and ethics of stream restoration

Unit IV	**ANALYSIS AND DESIGN OF RIVER**	**9**	**0**	**0**	**9**

Bio-engineering Techniques, Classification review, Natural Channel Design Analysis, Time Series, Analysis of flow, Sediment and channel geometry data.

Unit V	**RIVER TRAINING AND PROTECTION WORKS**	**9**	**0**	**0**	**9**

River Training and Protection Works: Introduction, Classification of River Training, Types of River training works, Protection for Bridges with reduced waterway, Design of Guide Band, embankment and spurs/dampeners and other river/ flood protection works.

Total= 45 Periods

Text Books:

1	Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008.
2	Murthy, V.V.N., Land and Water Management, Khalyani Publishers, 2009.

Reference Books:

1	Murthy, J. V. S., Watershed Management, New Age International Publishers, 1998.
2	Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the various channel systems	Understand
CO2	Understand the behaviour of river	Understand
CO3	Identify various types of reservoirs and their design aspects	Apply
CO4	Understand the Bio-engineering Techniques	Evaluate
CO5	Design the protection works	Create

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

<table>
<tr><td>22CEPE21</td><td colspan="4">DESIGN OF COMPOSITE STRUCTURES</td><td colspan="2">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To impart knowledge about the composite structures</td></tr>
<tr><td>2</td><td colspan="7">To impart knowledge to Design composite beams, columns and trusses</td></tr>
<tr><td>3</td><td colspan="7">To impart knowledge to Design connections in composite structures</td></tr>
<tr><td>4</td><td colspan="7">To impart knowledge to Design box-girder bridges including the related connections</td></tr>
<tr><td>5</td><td colspan="7">To make students do case studies related to steel-concrete constructions of buildings.</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 to steel - concrete composite construction – Codes – Composite action –Serviceability and Construction issues in design.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">DESIGN OF COMPOSITE MEMBERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Design of composite beams, slabs, columns, beam – columns - Design of composite trusses.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">DESIGN OF CONNECTIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Shear connectors – Types – Design of connections in composite structures – Design of shear connectors – Partial shear interaction.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">COMPOSITE BOX GIRDER BRIDGES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Introduction - behaviour of box girder bridges - design concepts.</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">Case studies on steel - concrete composite construction in buildings - seismic behaviour of composite structures.</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Johnson R.P., “Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings”, Vol.I, Blackwell Scientific Publications, 2004.</td></tr>
<tr><td>2</td><td>Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford, 1995.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1</td><td>Owens.G.W and Knowles.P, ”Steel Designers Manual”, Steel Concrete Institute(UK), Oxford Blackwell Scientific Publications, 1992.</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain knowledge about the composite structures	Remember
CO2	Design composite beams, columns and trusses	Create
CO3	Design connections in composite structures	Create
CO4	Design box-girder bridges including the related connections	Create
CO5	Get exposure on case studies related to steel-concrete constructions of buildings.	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	-	2	1	1	2	-	-	-	1	3	2	-
CO2	3	2	3	-	2	1	1	2	-	-	-	1	3	2	-
CO3	3	2	3	-	2	1	1	2	-	-	-	1	3	2	-
CO4	3	2	3	-	2	1	1	2	-	-	-	1	3	2	-
CO5	-	-	-	2	2	2	1	-	-	3	-	2	2	-	-
Avg	3	2	3	2	2	1.2	1	2	-	3	-	1.2	2.8	2	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEPE22</td><td colspan="5">STORAGE STRUCTURES</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="4">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="4" rowspan="2">DESIGN OF STEEL STRUCTURES & PRESTRESSED CONCRETE STRUCTURES</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="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To introduce the student to basic theory and concepts of design of storage structures like steel water tanks.</td></tr>
<tr><td>2</td><td colspan="8">Design of Concrete Water Tanks</td></tr>
<tr><td>3</td><td colspan="8">Design of Steel Bunkers and Silos.</td></tr>
<tr><td>4</td><td colspan="8">Design of Concrete Bunkers and Silos</td></tr>
<tr><td>5</td><td colspan="8">Design of Prestressed Concrete Water Tanks</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="3">STEEL WATER TANKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Design of rectangular riveted steel water tank – Tee covers – Plates – Stays – Longitudinal and transverse beams – Design of staging – Base plates – Foundation and anchor bolts – Design of Prestressed steel water tank – Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder – Design of staging and foundation.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="3">CONCRETE WATER TANKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Design of Circular tanks – Hinged and fixed at the base – IS method of calculating shear forces and moments – Hoop tension – Design of Intze tank – Dome – Ring girders – Conical dome – Staging – Bracings – Raft foundation – Design of rectangular tanks – Approximate methods and IS methods – Design of underground tanks – Design of base slab and side wall – Check for uplift.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="3">STEEL BUNKERS AND SILOS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Design of square bunker – Jansen’s and Airy’s theories – IS Codal provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams – Design of cylindrical silo – Side plates – Ring girder –stiffeners</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="3">CONCRETE BUNKERS AND SILOS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Design of square bunker – Side Walls – Hopper bottom – Top and bottom edge beams – Design of cylindrical silo – Wall portion – Design of conical hopper – Ring beam at junction</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="3">PRESTRESSED CONCRETE WATER TANKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Principles of circular prestressing – Design of Prestressed concrete circular water tanks.</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Rajagopalan K., "Storage Structures", Tata McGraw Hill, New Delhi, 1998.</td></tr>
<tr><td>2</td><td>Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, New Delhi, 1998.</td></tr>
</table>

Reference Books:	
1	Punmia B.C, Ashok Kumar Jain, Arun K.Jain, "R.C.C. Designs Reinforced Concrete Structures", Laxmi Publications Pvt. Ltd., New Delhi, 2006.
2	Gambhir. M.L., "Design of Reinforced Concrete Structures", Prentice Hall of India Private Limited, 2012.
3	Lin T.Y., Ned H. Burns., Design of Prestressed concrete Structures, A John Wiley & Sons, INC., Publication, Third Edition,1981
4	V. Natarajan., Fundamentals of Prestressed concrete, B.I., Publication, Second Edition,1983
5	IS 3370-1 (2009) Code of Practice Concrete Structures for the storage of liquids
E-References:	
1	You tube – Technical Civil – Design of Water Tanks(different types) - Part 1 to Part 9

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the basic theory and concepts of designing the steel storage structures like Water tank	Create
CO2	Design of Steel and Reinforced Concrete Water tanks	Create
CO3	Designing the Steel Bunkers and Silo	Create
CO4	Design of Steel and Reinforced Concrete Bunkers and Silos	Create
CO5	Design of Prestressed Concrete Water tank	Create

COURSE ARTICULATION MATRIX

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

22CEPE23	SUSTAINABLE AND GREEN BUILDING TECHNOLOGY		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Construction Materials and Technology, Environmental Science and Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To Know various aspects of green buildings
2	To Use different steps involved in measuring environmental impact assessment.
3	To Relate the construction of green buildings 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 AND DESIGN FEATURES**	**9**	**0**	**0**	**9**

Definition of Green Building, Benefits of Green Building, Components/ features of Green Building, Site selection, Energy Efficiency, Water efficiency, Material Efficiency, Indoor Air Quality.

Site selection strategies, Landscaping, building form, orientation, building envelope and fenestration, material and construction techniques, roofs, walls, fenestration and shaded finishes, advanced passive heating and cooling techniques, waste reduction during construction.

Unit II	**ENERGY AUDIT AND ENVIRONMENTAL IMPACT ASSESSMENT**	**9**	**0**	**0**	**9**

Meaning, Necessity, Procedures, Types, Energy Management Programs.

Introduction, EIA regulations, Steps in environmental impact assessment process, Benefits of EIA, Limitations of EIA, Environmental clearance for civil engineering projects.

Unit III	**ENERGY AND ENERGY CONSERVATION**	**9**	**0**	**0**	**9**

Renewable Energy Resources: Solar Energy, Wind Energy, Ocean Energy, Hydro Energy, Biomass Energy.

Non-renewable Energy Resources: Coal, Petroleum, Natural Gas, Nuclear Energy, Chemical Sources of Energy, Fuel Cells, Hydrogen, Biofuels.

Introduction, Specific objectives, present scenario, Need of energy conservation, LEED India Rating System and Energy Efficiency.

Energy-saving houses, Green House, Passive house, Passive house construction, Low-energy house, Zero-energy house, Energy consulting, Energy efficiency.

Unit IV	**PRINCIPLES AND PLANNING OF GREEN BUILDING**	**9**	**0**	**0**	**9**

Features: Salient features of Green Building, Environmental design (ED) strategies for building construction.

Process: Improvement in environmental quality in civil structure Materials: Green building materials and products- Bamboo, Rice husk ash concrete, plastic bricks, Bagasse particle board, Insulated concrete forms. reuse of waste material-Plastic, rubber, Newspaper wood, Non Toxic paint, green roofing.

Housing modernization and management (building and construction safety, energy efficiency in housing, Property Refurbishment / Upgrade / Modernization / Renovation - Modular kitchens, bathrooms

Unit V	**RATING SYSTEM**	**9**	**0**	**0**	**9**

Introduction to (LEED) criteria, Indian Green Building council (IGBC) Green rating, Green Rating for Integrated Habitat Assessment. (GRIHA) criteria Heating Ventilation Air Conditioning (HVAC) unit in green Building Functions of

Government organization working for Energy conservation and Audit(ECA) - National Productivity council (NPC) Ministry of New and Renewable Energy (MNRE) Bureau of Energy efficiency (BEE) -BER (Building Energy Rating) - Certificates – Plumbing and Electrical to heating efficiency
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, New Delhi
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 and its Design Features.	Understand
CO2	Assess Environmental Impacts.	Evaluate
CO3	Explain the concept of Energy and Energy Conservation.	Understand
CO4	Discuss the Principles and Planning of Green Building.	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	1	2	3	-	-	1	2	1	2	-	-
CO2	-	1	1	2	-	-	-	1	-	2	-	-	1	3	-
CO3	-	-	3	-	3	-	-	-	-	2	2	-	-	-	-
CO4	1	-	-	-	3	-	-	-	-	2	2	-	-	-	-
CO5	1	1	2	3	3	-	-	-	-	3	2	-	-	3	-
Avg	1	1	2	2	2.5	2	3	1	-	2	2	1	1.5	3	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEPE24</td><td colspan="2">FORMWORK FOR CONCRETE STRUCTURES</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">Concrete Technology, Construction Practices</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To acquire knowledge on formwork requirements and formwork materials</td></tr>
<tr><td>2</td><td colspan="6">To understand the construction of formworks for structural elements</td></tr>
<tr><td>3</td><td colspan="6">To impart knowledge in formwork for special structures</td></tr>
<tr><td>4</td><td colspan="6">To improve the proficiency in slipform and scaffolds</td></tr>
<tr><td>5</td><td colspan="6">To acquire knowledge on scaffold materials and formwork failures</td></tr>
<tr><td>Unit I</td><td colspan="2">FORMWORK MATERIALS AND ACCESSORIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Different types of temporary structures –Requirements for formwork –Selection criteria of formwork– Traditional Classification of formwork – Formwork materials – Timber, plywood, steel, aluminium, plastic formworks with requirements and permissible stresses.</td></tr>
<tr><td>Unit II</td><td colspan="2">FORMWORK FOR STRUCTURAL ELEMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Formwork for isolated, wall, steeped and raft footings – Formwork for walls - climbing formwork –Conventional column formwork –Traditional slab and beam formwork- achieving economy in column formwork, slab and beam formwork</td></tr>
<tr><td>Unit III</td><td colspan="2">FORMWORK FOR SPECIAL STRUCTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Formwork for shells, Formwork for domes–Formwork for cast in situ folded plates – Formwork for precast folded plates – Formwork for tunnels – Formwork for Lift shafts- Formwork for caissons – Formwork for piers – Formwork for bridge railings – Formwork for Tunnels</td></tr>
<tr><td>Unit IV</td><td colspan="2">FLYING FORMWORK AND SLIPFORM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Flying Formwork cycles – Advantages and disadvantages of Flying Forms –Vertical Slipform – Horizontal Slipform – Types of Slipform– Components of Slipform, Assembly, Sliding and Dismantling of Slipform – Safety operations during Slipform erections.</td></tr>
<tr><td>Unit V</td><td colspan="2">SCAFFOLD AND FORMWORK FAILURE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Classification of Scaffolds- Timber, Metal, Galvanized, Scaffolds. –Scaffolds for High clearance Structures –Possible collapses in Scaffolds –Causes of Formwork failure – Precautions for avoiding Formwork failures.</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Robert L. Peurifoy, GaroldD. Oberlender, Formwork for Concrete Structures, McGraw Hill Education., 2010.</td></tr>
<tr><td>2</td><td>Kumar NeerajJha, Formwork for Concrete Structures, McGraw Hill Publications Education., 2019</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1</td><td>Hanna, A.S, Concrete Formwork systems, CRC, 2009</td></tr>
<tr><td>2</td><td>Hurst, M.P, Formwork for Concrete, American Concrete Institute, 2005.</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select the types of formwork materials for different requirements	Understand
CO2	Know about the building of formwork for various structural elements	Understand
CO3	Explaining the formwork requirements for special structures	Understand
CO4	Justifying the requirements of slipform and its advantages	Analysis
CO5	Planning the safety requirements in Formwork construction	Apply

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	-	3	-	-	-	-	-	-	3	-	-
CO2	1	1	3	1	-	3	-	-	-	-	-	-	3	-	-
CO3	1	2	3	1	-	3	-	-	-	-	-	-	3	-	-
CO4	2	2	3	2	-	3	-	-	-	-	-	-	3	-	-
CO5	2	1	3	2	-	3	-	-	-	-	-	-	3	-	-
Avg	1.4	1.4	3	1.4	-	3	-	-	-	-	-	-	3	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE25	MARINE POLLUTION MONITORING AND CONTROL			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives

1	This subject educated the students about Coastal and Marine environment, ocean dynamics, sources of marine pollution and methods for monitoring, modeling and control.
2	The subject deals with the method for monitoring the marine pollution
3	The subject cover modelling and controlling methods of marine pollution
4	The subject deals with evaluate the marine pollution using GIS and RS technologies
5	This subject educated the students about various pollution controlling factors on marine

Unit I	MARINE ENVIRONMENT	9	0	0	9

Seas and oceans, Continental area, Coastal zone, Properties of seawater, Principles of Marine Geology, coastal features – Beaches, Estuaries, Lagoons– The oceans and climate

Unit II	OCEAN HYDRODYNAMICS	9	0	0	9

Wave Theory, Waves in shallow waters –Refraction, Diffraction and Shoaling, Approximations for deep and shallow water conditions –Tidal Classification- General circulation of ocean waters-Ocean currents -Coastal sediment transport - Onshore offshore sediment transport -Beach formation and coastal processes -Tsunamis, storm surge, El Nino effect.

Unit III	MARINE POLLUTION SOURCES AND EFFECTS	9	0	0	9

Sources of Marine Pollution –Point and non-point sources, Pollution caused by Oil Exploration, Dredging, Offshore Structures, Agriculture Impacts of pollution on water quality and coastal ecosystems –Marine discharges and effluent standards

Unit IV	MONITORING OF MARINE POLLUTION	9	0	0	9

Basic measurements -Sounding boat, lead lines, echo sounders –current meters -tide gauge -use of GPS –Measurement of coastal water characteristics –seabed sampling –Modeling of Pollutant transport and dispersion -Oil Spill Models -Ocean Monitoring satellites – Applications of Remote Sensing and GIS in monitoring marine pollution

Unit V	MARINE POLLUTION CONTROL AND ICZM	9	0	0	9

Design of out falls -Pollution Control strategies –Selection of optimal Outfall locations -National and International Treaties, Coastal Zone Regulation–Total Maximum Daily Load applications –Protocols in Marine Pollution – ICZM and Sustainable Development

Total= 45 Periods

Text Books:

1	Marine Pollution (5thEdition) R.B. Clark, C. Frid and M Atttrill Oxford Science Publications, 2001
2	Marine pollution Dr.P.C.Sinha ,Anmol Publications Pvt. Ltd, 1998

Reference Books:

1	Problems of Marine Pollution : India and Canada, Raghavan, Sudha , Eastern Book Corporation,Delhi, India,
2	Laws, E.A., Aquatic pollution, an introductory text. John Wiley and Sons, Inc., New York, 2000

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Ability to know about marine environment	Understand
CO2	learnt the physical concepts lying behind the oceanic currents and natural processes of various activities happening over the marine environment	Understand
CO3	Acquired knowledge on the marine pollution and the effect of the same on the ecology	Remember
CO4	Gain the knowledge on remote sensing and various other techniques for measuring and monitoring oceanic environment parameters	Apply
CO5	Acquired knowledge on control of marine pollution and sustainable development	Remember

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	-	-	2	2	2	2	1	-	2
CO2	3	1	-	2	2	-	1	1	1	2	2	2	1	-	2
CO3	2	2	2	1	1	2	-	-	2	3	2	1	1	-	2
CO4	-	3	2	2	2	2	2	-	3	3	2	3	3	1	3
CO5	1	2	2	1	2	1	2	1	2	3	2	2	2	-	2
Avg	1.6	2.0	1.6	1.4	1.4	1.2	1.0	0.4	2.0	2.6	2.0	2.0	1.6	0.2	2.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE26	OPEN CHANNEL FLOW			Semester			
PREREQUISITES		Category	PE	Credit		3	
Mechanics of Fluids, Applied Hydraulics Engineering		Hours/Week	L	T	P	TH	
			3	0	0	3	

Course Learning Objectives	
1	To introduce Open Channel Flow, types of open channel, application
2	To impart knowledge about Hydraulic Slope, Hydraulic Curve
3	To impart knowledge about Critical depth, velocity, Hydraulic jumps
4	To apply fundamental concepts and techniques of hydraulics, hydrology in the analysis
5	To analyses flow characteristics in open channel, design hydraulic machines

Unit I	INTRODUCTION	9	0	0	9

Basic concepts of free surface flows, velocity and pressure distribution, Mass, energy and momentum principle for prismatic and non-prismatic channels, Review of Uniform flow: Standard equations, hydraulically efficient channel sections, compound sections. Energy-depth relations: Concept of specific energy, specific force, critical flow, critical depth, hydraulic exponents, and channel transitions

Unit II	GRADUALLY VARIED FLOW (GVF)	9	0	0	9

Equation of gradually varied flow and its limitation, flow classification and surface profiles, Control sections. Computation methods and analysis: integration of varied flow equations by analytical, graphical and advanced numerical methods, Transitions of subcritical and supercritical flow, flow in curved channels.

Unit III	RAPIDLY VARIED FLOW (RVF)	9	0	0	9

Characteristics of rapidly varied flow, Classical hydraulic jump, Evaluation of the jump elements in rectangular and non-rectangular channels on horizontal and sloping beds, Hydraulic jump in gradually and suddenly expanding channels, submerged hydraulic jump, rolling and sky jump, use of jump as an energy dissipator

Rapidly varied unsteady flow: Equation of motion for unsteady flow, "Celerity" of the gravity wave, deep and shallow water waves, open channel positive and negative surge.

Unit IV	SPATIALLY VARIED FLOW (SVF)	9	0	0	9

Basic principles, Differential SVF equations for increasing and decreasing discharge, Classifications and solutions, Numerical methods for profile computation, Flow over side

Unit V	FLOW MEASUREMENT	9	0	0	9

Flow measurement by sharp crested and broad crested weirs, critical depth flumes, sluice gate, Free overfall Flumes – Parshall flume, Venturi Flume, Cut throat flume

Total= 45 Periods

Text Books:	
1	Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008.
2	Murthy, V.V.N., Land and Water Management, Khalyani Publishers, 2009

Reference Books:	
1	Murthy, J. V. S., Watershed Management, New Age International Publishers, 1998.
2	Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Knowledge of types of open channel flow	Remember
CO2	Analysis the various of gradually varied flow	Analyse
CO3	Analysis the various types of hydraulic jump	Analyse
CO4	Understand the spatially varied flow	Understand
CO5	Knowledge of flow measurement	Remember

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	-	-	-	-	-	-	-	-	3	-
CO2	3	3	2	1	1	-	-	-	-	-	-	-	-	3	-
CO3	3	2	1	2	1	-	-	-	-	-	-	-	-	2	-
CO4	2	2	1	1	1	-	-	-	-	-	-	-	-	2	-
CO5	3	2	3	2	1	-	-	-	-	-	-	-	-	2	-
Avg	2.8	2.4	2	1.4	1	-	-	-	-	-	-	-	-	2.4	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE27	GROUND IMPROVEMENT TECHNIQUES			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
Mechanics of Soils & Foundation Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives	
1	The student is expected to identify basic deficiencies of various soil deposits
2	To learn the various techniques of drainage and dewatering
3	To know about various in-situ treatment of soil samples
4	To study the details about earth reinforcement
5	To understand about the grouting techniques

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Role of ground improvement in foundation engineering – methods of ground improvement – Geotechnical problems in alluvial, laterite and black cotton soils-Selection of suitable ground improvement techniques based on soil condition.

Unit II	**DRAINAGE AND DEWATERING**	**9**	**0**	**0**	**9**

Drainage techniques – Well points – Vacuum and electro-osmotic methods – Seepage analysis for two dimensional flow-fully and partially penetrating slots in homogeneous deposits (Simple cases only).

Unit III	**IN SITU TREATMENT OF COHESIONLESS AND COHESIVE SOILS**	**9**	**0**	**0**	**9**

In-situ densification of cohesionless and consolidation of cohesive soils –Dynamic compaction and consolidation – Vibro-flotation – Sand pile compaction – Preloading with sand drains and fabric drains – Stone columns – Lime piles – Installation techniques only – relative merits of various methods and their limitations.

Unit IV	**EARTH REINFORCEMENT**	**9**	**0**	**0**	**9**

Concept of reinforcement – Types of reinforcement material – Applications of reinforced earth – use of Geotextiles for filtration, drainage and separation in road and otherworks.

Unit V	**GROUT TECHNIQUES**	**9**	**0**	**0**	**9**

Types of grouts – Grouting equipment and machinery – Injection methods – Grout monitoring – Stabilisation with cement, lime and chemicals – Stabilisation of expansive soils.

Total= 45 Periods

Text Books:	
1	Purushothama Raj P., Ground Improvement Techniques, Tata McGraw- Hill Publishing Company, New Delhi, 1995
2	Koerner R.M., Construction and Geotechnical Methods in Foundation Engineering, McGraw-Hill, 1994.
3	Moseley M.P., Ground Improvement , Blackie Academic and Professional, Chapman and Hall, Glasgow, 1993
Reference Books:	
1	Jones J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1995
2	Koerner R.M., Design with Geosynthetics, (3rdEdition) Prentice Hall, New Jersey

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the various ground improvement techniques	Understand
CO2	Understand drainage and dewatering techniques	Understand
CO3	Carry out in situ treatment of cohesionless and cohesive soils	Understand
CO4	Apply the geotextile material in practice	Apply
CO5	Know the grouting equipment and monitoring	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**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO2	**1**	**-**	**2**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO3	**1**	**-**	**2**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO4	**1**	**-**	**2**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO5	**1**	**-**	**2**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
Avg	**1**	**-**	**2**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE28	RAILWAY ENGINEERING			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
Surveying and Transportation Engineering		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives	
1	To introduce the students about Railways planning
2	To know about the basics and design of various components of railway Engineering
3	To study about the types and functions of track, junctions and railway stations.
4	To understand about construction procedure for railways
5	To impart knowledge about metro, mano and seaport

Unit I	**RAILWAY PLANNING AND ALIGNMENT**	**9**	**0**	**0**	**9**
Elements of permanent way – Rails, Sleepers, Ballast, rail fixtures and fastenings, Selection of gauges, Track Stress, coning of wheels, creep in rails, defects in rails – Route alignment surveys, conventional and modern methods					
Unit II	**CURVATURE OF TRACK**	**9**	**0**	**0**	**9**
Designation of curve – Types of curves and degree of curve –Transition curve –Geometric design of railway gradient, super elevation, widening of gauge on curves- Level Crossings.					
Unit III	**RAILWAY CONSTRUCTION AND MAINTENANCE**	**9**	**0**	**0**	**9**
Earthwork – Stabilization of track on poor soil – Track drainage – Calculation of Materials required for track laying – Construction and maintenance of tracks					
Unit IV	**RAILWAY OPERATION AND CONTROL**	**9**	**0**	**0**	**9**
Points and crossings and their design – Track junctions – simple track layouts – Railway Station and yards and passenger amenities-Signaling and interlocking – Train movement control systems					
Unit V	**URBAN INFRASTRUCTURE FOR METRO**	**9**	**0**	**0**	**9**
Infrastructure for Metro-Introduction to metros, Planning of Metros, Alignment/ Span configuration and overview of superstructure construction, Mono and underground railways.					
					Total= 45 Periods

Text Books:	
1	A Text Book of Railway Engineering | S. C. Saxena S. P. Arora | Dhanpat Rai Publications
2	Railway Engineering by Rangwala 2017,27th Edition
3	Railway Track Engineering by J S Mundrey Fifth Edition 2017
Reference Books:	
1	Satish Chandra And M. M. Agarwal's Railway Engineering – Second Edition, Published By Oxford University Press 2013
2	Railway Planning, Management, And Engineering 5th Edition By V.Profillidis
3	Railway Transport Planning and Management – Stefano De Luca June 22 ,2022
4	Modern Railway Engineering By Ali G. Hessami March 27th 2017

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Carry out the surveys for railways	Apply
CO2	Understand the design elements in Railway Constructions	Understand
CO3	Understand the Construction techniques and Maintenance of Track laying and Railway stations.	Understand
CO4	Implement the railway operation	Apply
CO5	Apply the construction of metro infrastructure	Apply

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	-	-	-	-	2	-	2
CO2	3	3	3	-	3	-	-	1	-	-	-	-	1	-	3
CO3	-	-	-	2	3	1	-	-	-	-	-	2	1	-	1
CO4	1	1	-	-	2	-	-	-	-	-	-	2	1	-	3
CO5	-	-	-	2	2	2	-	2	-	-	-	2	2	-	3
Avg	2.3	2.3	2.7	2	2.4	1.5	-	1.3	-	-	-	2	1.4	-	2.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE29	URBAN PLANNING & DEVELOPMENT		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Surveying and Architecture		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To know the basic requirements for urbanization and industrialization
2	To enable students to understand the trend of urbanization at different level
3	To enable students to have the knowledge on urban planning and development process
4	To introduce about the regulations and laws related to Urban design
5	To understand the act of legislation and management for management of urban system

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Basic requirements – current scenario of metropolitan and other cities –Need of urbanisation and industrialization- Definition of Human settlement, Urban area, Town, City, Urbanisation, Suburbanisation, Urban sprawl.

Unit II	**BASIC ISSUES**	**9**	**0**	**0**	**9**

Peri-urban areas, Central Business District (CBD), Classification of urban areas – Trend of Urbanization at International, National, Regional and State level.

Unit III	**PLANNING PROCESS**	**9**	**0**	**0**	**9**

Principles of Planning – Types and Level of Plan, Stages in Planning Process – Goals, Objectives, Delineation of Planning Areas, Surveys and Questionnaire Design.

Unit IV	**DEVELOPMENT PLANS, PLAN FORMULATION AND EVALUATION**	**9**	**0**	**0**	**9**

Scope and Content of Regional Plan, Master Plan, Detailed Development Plan, Development Control Rules, Transfer of Development Rights, Special Economic Zones- Development of small town and smart cities-case studies- CMDA Approval – benefits of approval

Unit V	**LEGISLATION, DEVELOPMENT AND MANAGEMENT OF URBAN SYSTEM**	**9**	**0**	**0**	**9**

Town and Country Planning Act, Land Acquisition and Resettlement Act etc., Urban Planning Standards and Regulations, Involvement of Public, Private, NGO, CBO and Beneficiaries.

Total= 45 Periods

Text Books:

1	Goel, S.L Urban Development and Management, Deep and Deep publications, New Delhi 2003
2	George Chadwick, A Systems view of planning, https://www.scribd.com/user/301453208/Elsevier-Science, 2016
3	Singh V.B, Revitalised Urban Administration in India, Kalpaz publication, Delhi, 2002
4	Edwin S.Mills and Charles M.Becker, Studies in Urban development, A World Bank publication, 1986

Reference Books:	
1	Tamil Nadu Town and Country Planning Act 1971, Government of Tamil Nadu, Chennai
2	Goel S.L., Urban Development and Management, Deep and Deep Publications, New Delhi, 2002
3	Thooyavan, K.R., Human Settlements – A Planning Guide to Beginners, M.A Publications, Chennai, 2005
4	CMDA, Second Master Plan for Chennai, Chennai 2008

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe basic issues in urban planning	Understand
CO2	Formulate plans for urban and rural development	Create
CO3	Plan and analyses socio economic aspects of urban and rural planning	Analyse
CO4	Design the urban development projects	Analyse
CO5	Manage the urban development projects.	Analyse

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	1	-	-	-	-	-	1	-	-
CO2	1	3	2	1	1	1	1	-	-	-	-	-	2	-	-
CO3	1	1	2	2	2	1	1	-	-	-	-	-	2	-	-
CO4	1	1	3	2	1	1	1	-	-	-	-	-	1	-	-
CO5	1	1	3	2	1	1	1	-	-	-	-	-	1	-	-
Avg	1	1.4	2.2	1.6	1.2	1	1	-	-	-	-	-	1.4	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEPE30	FERROCEMENT TECHNOLOGY				Semester		
PREREQUISITES		Category		PE	Credit		3
NIL		Hours/Week		L	T	P	TH
				3	0	0	3

Course Learning Objectives

1	To give a good insight about the ferrocement technology
2	To impart knowledge about the mechanical properties of ferrocement
3	To give an understanding of construction methods of ferrocement
4	To impart knowledge about the design of ferrocement structures
5	To impart knowledge about the hydraulic structures and soil retaining structures

Unit I	INTRODUCTION	9	0	0	9

Definition, historical background, Constituent materials-cement mortar, skeletal steel, mesh reinforcement-Types of meshes, distinct characteristics of ferrocement versus reinforced concrete, Similarities between ferrocement and reinforced concrete applications.

Unit II	MECHANICAL PROPERTIES	9	0	0	9

Behaviour of ferrocement in tension, cracking and multiple cracking behavior, maximum elongation at failure, stress at first cracking, elastic modulus in tension, behaviour of ferrocement in bending-load versus deflection response, impact strength, leakage, fire resistance, durability.

Unit III	PRACTICAL DESIGN GUIDELINES	9	0	0	9

Allowable stresses under maximum service load, maximum crack width, fatigue life, durability and corrosion, deflection limitation. Practical design parameters for ferrocement - cover, thickness and mesh opening, skeletal reinforcement depth, minimum volume fraction of reinforcement, minimum volume fraction in water retaining structures, fibers, number of mesh layers, bending members – hybrid fiber reinforcement, wire diameter, fineness of matrix. Guidelines for good construction.

Unit IV	FERROCEMENT IN BUILDING CONSTRUCTION	9	0	0	9

Construction methods-Skeletal Armature method, Closed mould method, Integral Mould method, Open mould method-ferrocement precast walls, hollow floors, hollow beams, roofing units, earthquake resistant structures, cost comparision with conventional construction.

Unit V	HYDRAULIC AND SOIL RETAINING STRUCTURES IN FERROCEMENT	9	0	0	9

Water retaining structures- Design and method of fabrication and casting, storage tanks of various types, foot bridges-canal lining. Soil retaining structure - Ferrocement counterfort retaining wall, Ferrocement containers for storing granular materials, Method of precasting

Total= 45 Periods

Text Books:

1	B R Paul and R P Pama. Published by International Ferrocement Information Centre. A.I.T.Bangkok, Thailand
2	State-of-the-art report and guide for Design,Construction and Repairs of Ferrocement; ACI committee Report. No ACI549R- 88 and ACI 549.1R.88. Published by American Concrete Institute, Detroit, USA

Reference Books:	
1	Ferrocement and laminated cementitious composites A E Naaman Publisher: Techno-press, Ann Arbor, Michigan, USA
2	Ferrocement- Materials and applications; Publication SP 61, A C I Detroit. U S A

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know about the ferrocement technology	Remember
CO2	Acquire knowledge about the mechanical properties of ferrocement	Remember
CO3	Understand of construction methods of ferrocement	Understand
CO4	Design the ferrocement structures	Create
CO5	Understand the hydraulic structures and soil retaining structures	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	3	-	-	-	-	-	3	-	-
CO2	-	-	-	-	-	2	3	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	2	3	-	-	-	-	-	3	-	-
CO4	3	2	2	-	2	2	2	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	2	3	-	-	-	-	-	3	-	-
Avg	3	2	2	-	2	2	2.8	-	-	-	-	-	3	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEPE31</td><td colspan="2">EARTH RETAINING STRUCTURES</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">Soil Mechanics and Foundation Engineering</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 impart knowledge on students about various theories in Earth Pressure</td></tr>
<tr><td>2</td><td colspan="6">To impart knowledge on students to Analyse the Stability of retaining structure</td></tr>
<tr><td>3</td><td colspan="6">To acquire knowledge in the Analysis and design of sheet pile walls and anchor systems</td></tr>
<tr><td>4</td><td colspan="6">To get a idea about the lateral pressure during supported excavation</td></tr>
<tr><td>5</td><td colspan="6">To understand the concepts in analysis and design of slurry supported trenches and deep cuts.</td></tr>
<tr><td>Unit I</td><td colspan="2">EARTH PRESSURE THEORIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Introduction – State of stress in retained soil mass – Earth pressure theories – Classical and graphical techniques – Active and passive cases – Earth pressure due to external loads, empirical methods. Wall movement and complex geometry.</td></tr>
<tr><td>Unit II</td><td colspan="2">COMPACTION, DRAINAGE AND STABILITY OF RETAINING STRUCTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Retaining structure – Selection of soil parameters – Lateral pressure due to compaction, strain softening, wall flexibility, drainage arrangements and its influence. – Stability analysis of retaining structure both for regular and earthquake forces.</td></tr>
<tr><td>Unit III</td><td colspan="2">SHEET PILE WALLS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Types of sheet piles – Analysis and design of cantilever and anchored sheet pile walls – free earth support method – fixed earth support method. Design of anchor systems – isolated and continuous.</td></tr>
<tr><td>Unit IV</td><td colspan="2">SUPPORTED EXCAVATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving. Earth pressure around tunnel lining, shaft and silos – Soil anchors – Soil pinning –Basic design concepts.</td></tr>
<tr><td>Unit V</td><td colspan="2">SLURRY SUPPORTED TRENCHES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Basic principles – Slurry characteristics – Specifications – Diaphragm and bored pile walls – stability Analysis and design.</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Clayton, C.R.I., Militisky, J. And Woods, R.I. Woods, Earth pressure and Earth-Retaining structures,3rd Edition, CRC Press, 2014.
2	Muni Budhu “Foundations and Earth Retaining Structures”, John Wiley & Sons,2008.
Reference Books:	
1	Das, B.M., “Principles of Geotechnical Engineering”, 4th Edition, The PWS series in Civil Engineering, 1998.
2	Das, B.M., “Principles of Geotechnical Engineering”, 4th Edition, The PWS series in Civil Engineering, 1998.
3	Rowe, R.K., “Geotechnical and Geoenvironmental Engineering Handbook”, Kluwer Academic Publishers, 2001.
4	Koerner, R.M., “Design with Geosynthetics”, 3rd Edition, Prentice Hall, 1997.

5	Day, R.W., "Geotechnical and Foundation Engineering: Design and Construction", McGraw Hill, 1999.
6	Mandal, J.N., "Reinforced Soil and Geotextiles", Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1993.
7	McCarthy, D.F., "Essentials of Soil Mechanics and Foundations: Basic Geotechnics", 6th Edition, Prentice Hall, 2002
8	Hajnal, I., Marton, J. and Regele, Z., Construction of diaphragm walls, A Wiley – Interscience Publication, 1984.
9	Petros P. Xanthakos., Slurry walls as structural systems, 1993

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand various Earth Pressure theories	Understand
CO2	Analysis the Stability of retaining structure	Analyse
CO3	Analysis, design of sheet pile walls and anchor systems	Analyse
CO4	Estimate the lateral pressure during supported excavation.	Apply
CO5	Analysis, design of slurry supported trenches	Analyse

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**2**	**2**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
CO2	**3**	**3**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
CO3	**3**	**3**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
CO4	**3**	**3**	**1**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
CO5	**3**	**3**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
Avg	**2.8**	**2.8**	**2.8**	**2**	**-**	**-**	**2.8**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

OPEN ELECTIVE COURSES

22MAOE01	SAMPLING THEORY AND NUMERICAL METHODS				
PREREQUISTIES	**CATEGORY**	**L**	**T**	**P**	**C**
Basic 12^{th} 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)”, 4^{th} 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, 11^{th} 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)**															

<table>
<tr><td>22CEOE02</td><td colspan="2">DISASTER MITIGATION AND MANAGEMENT</td><td colspan="3">Semester</td><td>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">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">To provide students an exposure to disasters, their significance and types</td></tr>
<tr><td>2</td><td colspan="6">To ensure that students begin to understand the relationship between vulnerability disasters, disaster prevention and risk reduction</td></tr>
<tr><td>3</td><td colspan="6">To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)</td></tr>
<tr><td>4</td><td colspan="6">To enhance the institutional processes in the country</td></tr>
<tr><td>5</td><td colspan="6">To evaluate the various case studies in disaster management</td></tr>
<tr><td>Unit I</td><td colspan="2">INTRODUCTION TO DISASTERS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit II</td><td colspan="2">APPROACHES TO DISASTER RISK REDUCTION (DRR)</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit III</td><td colspan="2">INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit IV</td><td colspan="2">DISASTER RISK MANAGEMENT IN INDIA</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit V</td><td colspan="2">DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

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)**															

<table>
<tr><td>22CEOE04</td><td colspan="2">MECHANICS OF DEFORMABLE BODIES</td><td colspan="3">Semester</td><td>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">Mechanics of Solids and Strength of Materials</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 the fundamental concepts of stress, strain and their relations based on linear elasticity with applications to bars and beams.
2	Analyze the bending of various types of beams under static loading conditions and compute the shear-moment diagrams of a beam and find the Maximum moment/shear and their locations for different cross sections of beams.
3	Understand the basic concept of theory of flexure and torsion, springs and strain energy.
4	To learn the principles of mechanics applied to different materials under static conditions and to develop problem solving skills through application of these principles to basic engineering problems.
5	To learn the principles of mechanical behavior of engineering materials, various tests under dynamics conditions and parametric studies.

Unit I	**SIMPLE STRESSES, BEHAVIOUR OF COMPOSITE SECTIONS, THERMAL STRESSES**	**9**	**0**	**0**	**9**
Mechanical properties of solids –Hooke's law, principle of superposition, Bars of varying sections –Elastic constants – composite sections – determination of stress, strain , deformation –Temperature stress ,strain					
Unit II	**BENDING AND SHEAR**	**9**	**0**	**0**	**9**
Types of beams – shear force and bending moment. Theory of simple bending - Analysis of stress-load carrying capacity. Shear stress distribution of simple beams of different cross sections					
Unit III	**TORSION AND SPRINGS**	**9**	**0**	**0**	**9**
Torsion of circular shaft – Hollow and solid circular section, torsional rigidity-stepped shaft-Twist and torsional stiffness-compound shaft-shafts springs-Stiffness and deflection of helical springs, leaf spring					
Unit IV	**MECHANICAL BEHAVIOUR OF MATERIALS UNDER STATIC LOADS**	**9**	**0**	**0**	**9**
Tension tests – stress – strain diagram, Elastic and plastic regions – True stress – strain properties in tension – fracture under tensile loads – compression and Torsion tests – stress concentration –Residual stresses					
Unit V	**MECHANICAL BEHAVIOUR OF MATERIALS UNDER DYNAMIC LOADS**	**9**	**0**	**0**	**9**
Fatigue loading and Fatigue fracture – Fatigue tests – Empirical relations between variable stress and mean stress – Fatigue stress concentration Factors – Cumulative Damage – Endurance limit –Impact – notched – Bar Impact tests, Charpy Impact tests – Izod Impact tests – Elevated temperature – Creep tests – Isochronous curves – stress Relaxation – Parametric methods					
					Total= 45 Periods

Text Books:	
1	James M.Gere, Mechanics of Materials, Brooke/Cole Thomson Learning, 5 Ed., 2001.
2	Dr.R.Vaithiyanathan, Dr. P. Perumal &Lingeswari", Mechanics of Solids and StructuresVolume-I" Sci- tech publications, India(Pvt) Chennai-17.
3	Srinath L.S; - Strength of materials – Macmillan India Limited – New Delhi,2017

Reference Books:	
1	Popov.E.P., “Engineering Mechanics of solids”, Prentice- Hall of India, New Delhi
2	Beer F.P and Johnston R, “Mechanics of Materials”, McGraw- Hill book Co, Third Edition
3	Timoshenko S.P., “Elements of Strength of Materials”, Tata McGraw- Hill, New Delhi
4	Nash W.A., “Theory and Problems in Strength of Materials”, Schuam outline Series, McGraw- Hill Book Co., New York.
5	Rajput. R.K., “Strength of Materials”, S. Chand & Co, Delhi, Third Edition, 2003.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	To acquire basic knowledge of stress strain and deformation of structures of varying cross sections of bars.	Knowledge
CO2	To draw Shear Force and Bending Moment Diagram for transverse loading under various types of loadings and beams.	Analyse
CO3	To solve problems of Torsional shear stress for shaft and stiffness and deflection of springs	Apply
CO4	Describe the mechanical behaviour of engineering materials subjected to various types of stresses	Understand
CO5	Understand the concept of mechanical behaviour under dynamic loading of various tests to find the stresses induced in the materials.	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	2	-	-	1	-	-	-	-	1	-	-	-
CO2	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	1	1	-	1	-	-	-	-	-	-	-	1	-	-	-
CO4	1	1	-	1	-	-	-	-	-	-	1	1	-	-	-
CO5	1	1	-	1	-	-	-	-	-	-	1	1	-	-	-
Avg	1	1	-	1.25	-	-	1	-	-	-	1	1	-	-	-

22CSOE01	OBJECT ORIENTED PROGRAMMING USING CONCEPTS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
Problem Solving and C Programming		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1. To understand object oriented programming concept
2. To apply object oriented concept for problem solving
3. To design solutions to the real world problems using object oriented concept.

UNIT I	INTRODUCTION	9	0	0	9

Procedure oriented programming paradigm - Object oriented programming paradigm - Basic concepts of object oriented programming, benefits of OOP, application of OOP - C++ fundamentals –structure of C++ program, tokens, data types - Operators and expressions - Control structures - Functions.

UNIT II	CLASSES AND OBJECTS	9	0	0	9

Classes and objects - friend functions- constructors and destructors- Operator overloading – binary and unary operator overloading using member function and friend function - Type conversions.

UNIT III	INHERITANCE AND VIRTUAL FUNCTIONS	9	0	0	9

Inheritance – defining derived classes, types, virtual base classes, abstract classes, constructor in derived classes - Pointers- pointers to objects, this pointer, pointer to derived classes - Virtual functions.

UNIT IV	TEMPLATES AND EXCEPTION HANDLING	9	0	0	9

Generic Classes – class template, class templates with multiple parameters - Generic Functions - function templates, function templates with multiple parameters, member function templates - Exception handling – basics, exception handling mechanism, rethrowing an exception .

UNIT V	CONSOLE I/O AND FILE HANDLING	9	0	0	9

C++ Stream Classes – unformatted I/O operations, formatted console I/O operations, manipulators - Files-classes for file operation, opening and closing a file, detecting end of file, files modes, sequential file operations, random file operations.

Total (45 L) =45 Periods

Text Books:

1. E. Balagurusamy “Object Oriented Programming with C++”, Eighth Edition, Tata McGraw-Hill, 2020.

Reference Books:

1. Herbert Schildt, "The Complete Reference C++", Fifth Edition, Tata McGraw Hill, 2015.
2. Bjarne Stroustrup, “The C++ programming language”, Fourth Edition Addison Wesley, 2013.
3. K.R.Venugopal, Rajkumar Buyya, T.Ravishankar , Mastering in C++, Second Edition, Tata McGraw Hill,2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Familiarize the object oriented programming concepts, Generic Programming and handling exceptions.	Understand
CO2	Build Object Oriented Programming concepts for problem solving.	Apply
CO3	Develop solutions to real world problems using Object Oriented Concepts.	Apply

22CSOE02	OPERATING SYSTEMS PRINCIPLES					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand the structure and functions of Operating systems
2.	To understand the process concepts and scheduling algorithms
3.	To understand the concept of process synchronization and deadlocks
4.	To learn various memory management schemes
5.	To illustrate various file systems and disk management strategies

UNIT I	INTRODUCTION AND OPERATING SYSTEM STRUCTURES	9	0	0	9

Main frame Systems, Desktop Systems, Multiprocessor Systems, Distributed Systems, Clustered Systems, Real Time systems, Hand held Systems; Operating Systems Structures - System Components, Operating System Services, System calls, System Programs, System Design and Implementation.

UNIT II	PROCESS MANAGEMENT	9	0	0	9

Processes-Process Concepts, Process Scheduling, Operation on Processes, Co-Operating Processes, InterProcess Communication; Threads- Multithreading Models, Threading Issues; CPU Scheduling-Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

UNIT III	PROCESS SYNCHRONIZATION AND DEADLOCKS	9	0	0	9

Process Synchronization- The Critical Section Problem, Semaphores, Classical Problem of Synchronization, Monitors; Deadlocks- Deadlock Characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance ,Deadlock Detection, Recovery from Deadlock.

UNIT IV	MEMORY MANAGEMENT AND VIRTUAL MEMORY	9	0	0	9

Memory Management- Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging; Virtual Memory - Demand paging, Page Replacement, Thrashing.

UNIT V	FILE SYSTEM AND MASS-STORAGE STRUCTURE	9	0	0	9

File System Interface - File Concepts, Access methods, Directory Structure, File Sharing, File Protection; File System Implementation - File System Structure and Implementation, Directory Implementation, Allocation Methods, Free Space Management; Mass-Storage Structure - Disk Structure, Disk scheduling, Disk Management, RAID Structure.

Total (45 L) =45 Periods

Text Books:

1.	Abraham Silberschatz, P.B.Galvin, G.Gagne —Operating System Concepts 6th edition, John Wiley & Sons, 2003.

Reference Books:

1.	Andrew S. Tanenbaum, —Modern Operating Systems, PHI , 2nd edition, 2001
2.	D.M.Dhamdhere, "Systems Programming and Operating Systems ", 2nd edition, Tata McGraw Hill Company, 1999.
3.	Maurice J. Bach, —The Design of the Unix Operating System, 1st edition, PHI, 2004.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the components and functionalities of the operating system	Understand
CO2	Apply various services and concepts of operating system to real time applications	Apply
CO3	Analyze the issues related to operating system and provide suitable solutions.	Analyze

22CSOE03	COMPUTER COMMUNICATIONS AND NETWORKS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To study the concepts of data communications and functions of different ISO/OSI reference architecture
2.	To understand the error detection and correction methods and also the types of LAN
3.	To study the concepts of subnetting and routing mechanisms
4.	To understand the different types of protocols and congestion control
5.	To study the application protocols and network security

UNIT I	**DATA COMMUNICATIONS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**

Data Communication; Networks- Physical Structures (Types of Connections, Physical Topology),Categories of Networks, Interconnection of Networks: Internetwork; Protocols and Standards; Network Models-The OSI Model, Layers in the OSI Model, Addressing; Transmission media-Guided Media, Unguided Media.

UNIT II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**

Introduction-Types of errors, Redundancy, Detection versus Correction; Block Coding-Error Detection and Correction (VRC, LRC, CRC, Checksum, Hamming Code);Data link Control- Flow Control (Stop- and-Wait, Sliding Window),Error Control (Automatic Repeat Request, Stop-and-wait ARQ, Sliding Window ARQ), HDLC; Local Area Networks- Ethernet, Token Bus, Token Ring.

UNIT III	**NETWORK LAYER**	**9**	**0**	**0**	**9**

Network Layer services-Packet Switching-Network Layer Performance-IPv4 addresses-IPv6 addressing- Subnetting-Bridges-Gateways- Routers-Routing Algorithm-Distance Vector Routing, Link State Routing.

UNIT IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**

Duties of the Transport layer-User Datagram Protocol-Transmission Control Protocol- Congestion Control and Quality of Service-Congestion, Congestion Control, Quality of Service, Techniques to improve QoS.

UNIT V	**APPLICATION LAYER**	**9**	**0**	**0**	**9**

Domain Name System - Domain Name Space, DNS in the Internet; Electronic Mail-FTP- HTTP- World Wide Web.

Total (45 L) =45 Periods

Text Book:

1.	Behrouz A. Ferouzan, “Data Communications and Networking”, 4th Edition, Tata McGraw-Hill, 2007.

Reference Books:

1.	Andrew S. Tanenbaum, “Computer networks “PHI, 4^{th} edition 2008
2.	William Stallings,” Data and computer communications”, 10^{th} edition,PHI, 2012
3.	Douglas E. comer,” Internetworking with TCP/IP-Volume-I”, 6^{th} edition,PHI, 2008

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Understand the fundamental concepts of networking and working principles of various communication protocols.	Understand
CO2	Apply the various functionalities of OSI layers in real time applications	Apply
CO3	Analyze the various network issues in different layers and provide suitable solutions.	Analyze

22CSOE04	PYTHON PROGRAMMING					
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To Learn the basic concepts of python programming.
2	To write simple programs using python programming concepts.
3	To build simple real world applications using python.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Introduction - Features- The Basics - Numbers, Sequence: Strings, Lists, Tuples, Mapping and set types. Variables- Operators- Expressions- Precedence of operators – Comments - Input and output functions - Formatting numbers and strings- Implicit/explicit type conversion.					
UNIT II	**CONDITIONS,CONTROL STRUCTURES AND FILES**	**9**	**0**	**0**	**9**
Conditionals and loops-if statement-else statement – elif-Conditional Expressions-while statement-for statement – break-continue –pass; Files and Input/ Output.					
UNIT III	**PYTHON EXCEPTIONS, MODULES AND PACKAGES**	**9**	**0**	**0**	**9**
Errors and Exceptions – Introduction-Detecting and handling Exceptions- Raising Exceptions – Assertions-Standard Exceptions – Modules: user defined modules, random and o s modules - Packages.					
UNIT IV	**FUNCTIONS**	**9**	**0**	**0**	**9**
Functions-Calling functions-Creating functions-Passing Functions-Formal Arguments-Variable length arguments- Variable scope – Recursion- Map, Filter, Reduce and List Comprehensions-Iterators -Generator Expressions.					
UNIT V	**OBJECT ORIENTED PROGRAMMING AND REGULAR EXPRESSION**	**9**	**0**	**0**	**9**
Introduction – Classes- Class Attributes – Instances-Instances attributes-Building and Method Invocation-Static methods and Class Methods – Inheritance-Operator overloading-Regular Expression.					
					Total (45 L) =45 Periods

Text Books:

1.	Wesley J.Chun-“Core Python Programming” –Prentice Hall, Third Edition, 2012.

Reference Books:

1.	Swaroop C N, “ A Byte of Python “, ebshelf Inc., 1st Edition, 2013
2.	“A Practical Introduction to python programming”, Brian Heinold,MountSt.Mary’s University,2012
3.	Learning to Program with Python,” Richard L. Halterman”., Southern Adventist University

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	To understand the basic concepts of python programming.	Understand
CO2	To design simple programs using python programming concepts.	Apply
CO3	To apply python programming concepts in the real world application.	Analyze

22CSOE05	INTRODUTION TO PROGRAMMING IN JAVA					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
C Programming		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To familiarize and apply the Object Oriented concepts and java features
2.	To write the standalone applications and applet applications
3.	To build simple chart application and Database Connectivity

UNIT I	**INTRODUCTION TO JAVA**	**9**	**0**	**0**	**9**

Fundamentals of object oriented programming- java features, comparing JAVA with C and C++, JAVA environment; Overview of java language - java program structure, java tokens, java statements, implementing java program, java virtual machine, command line arguments; constants, variables and data types - Operators and expressions - Decision making – branching and looping.

UNIT II	**JAVA FEATURES**	**9**	**0**	**0**	**9**

Classes, objects methods – arrays, Strings and Vectors– Interfaces – Packages - Multithreaded programming- Exception handling.

UNIT III	**APPLET**	**9**	**0**	**0**	**9**

Applet programming- build applet code, applet life cycle, creating executable applet, designing a web page, applet tag, running the applet ,passing parameters to Applet; Graphics programming – graphics class, lines, rectangles, circles, ellipses, arcs and polygons

UNIT IV	**AWT CONTROLS**	**9**	**0**	**0**	**9**

Event handling – event handling Mechanisms, delegation event model, event classes, sources of events, event listener interfaces; AWT - AWT controls, Layout Managers, Menu Bars and Menus, Dialog Boxes, FileDialogs;

UNIT V	**I/O FILES AND JDBC**	**9**	**0**	**0**	**9**

I/O Files- concepts of stream, stream classes, byte stream classes, character stream classes, file classes, creation of files, reading and writing characters and bytes; Design of JDBC - JDBC drivers; JDBC programming concepts - Database concepts, making connection, executing SQL commands, managing connections, statements, and result sets; Query execution - Prepared Statements.

Total(45L)=45Periods

Text Books:

1.	E. Balaguruswamy, “Programming with java”, Sixth, TMH 2019 (Unit- I-III)
2.	Patrick Naughton , Herbert Schildt, “The Complete Reference Java 2” , Twelfth edition Tata McGraw Hills , 2021 (Unit IV - V)

Reference Books:

1.	Cay S. Horstmann, Gary Cornell “ Core Java 2” Eighth Edition, Pearson Education, 2008
2.	Graham Hamilton , Rick Cattell, Maydene Fisher ,”JDBC Database access with java”.1997
3.	PaulDeitel and Harvey Deitel, “Java How to Program”, Eleventh Edition, Pearson Prentice Hall 2017.

COURSEOUTCOMES: Upon completion of the course ,the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Familiarize the Object Oriented concepts and java features	Understand
CO2	Build the simple standalone applications and web applications	Create
CO3	Develop simple application using files and Database	Create

22CSOE06	COMPUTER ORGANIZATION					SEMESTER VI
PREREQUISITES		CATEGORY	OE	Credit		3
Digital Principles and System Design		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:	
1.	To understand the basic structure and operations of digital computer and to learn the working of different arithmetic operations.
2.	To expose different types of processor control and the concept of pipelining and to familiarize hierarchical memory system including cache memory and virtual memory
3.	To expose the different ways of communicating with I/O devices and standard I/O interfaces

UNIT I	INTRODUCTION	9	0	0	9
Functional units ,Basic Operational Concepts, Bus Structure ,Memory Locations and Addresses, MemoryOperations, Instruction and Instruction Sequencing, Addressing modes.					
UNIT II	**ARITHMETIC UNIT**	**9**	**0**	**0**	**9**
Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, BoothAlgorithm, Fast Multiplication, Integer Division, Floating point number operations.					
UNIT III	**PROCESSOR UNIT AND PIPELINING**	**9**	**0**	**0**	**9**
Fundamental Concepts, Execution of Instruction, Multi Bus Organization, Hardwired control, Micro programmed control, Basic Concepts of pipelining, Data Hazards, Instruction Hazards, Data path & Control Considerations.					
UNIT IV	**MEMORY SYSTEMS**	**9**	**0**	**0**	**9**
Basic Concepts, Semiconductor RAM, ROM, Cache memory, Improving Cache Performance, Virtual memory, Memory Management requirements, Secondary Storage Device.					
UNIT V	**INPUT AND OUTPUT ORGANIZATION**	**9**	**0**	**0**	**9**
Accessing I/O devices, Programmed I/O, Interrupts, Direct Memory Access, Interface circuits, Standard I/OInterfaces (PCI, SCSI, USB).					
					Total (45 L)= 45 Periods

Text Books:	
1.	Carl Hamacher V.,Zvonko G.Vranesic, Safwat G. Zaky, " Computer organization ", Tata McGraw Hill,5th Edition, 2008.
Reference Books:	
1.	Patterson and Hennessey, “Computer Organization and Design ". The Hardware/Software interface,Harcourt Asia Morgan Kaufmann, 3rd Edition, 2007
2.	Hayes, “Computer Architecture and Organization ", 3rd edition,Tata McGraw Hill, 2006
3.	Heuring V.P., Jordan H.F., " Computer System Design and Architecture ", 6th edition ,Addison Wesley,2008

COURSE OUTCOMES Upon completion of the course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	Understand the working principles of computer components	Understand
CO2	Design the arithmetic and processing units	Create
CO3	Analyze the various computer components	Analyze

22CSOE07	DATA STRUCTURES USING C++			SEMESTER VI			
PREREQUISITES			**Category**	**OE**	**Credit**		**3**
C Programming			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives	
1	To comprehend the fundamentals of object oriend programming, particularly in C++
2	To design linear and non linear data structure using object programming concepts
3	To apply various sorting and searching alogorithims.

UNIT I	**DATA ABSTRACTION & OVERLOADING**	**9**	**0**	**0**	**9**
Overview of C++ – Structures – Class Scope and Accessing Class Members – Reference Variables – Initialization – Constructors – Destructors – Member Functions and Classes – Friend Function – Dynamic Memory Allocation – Static Class Members – Container Classes and Integrators – Overloading: Function overloading and Operator Overloading.					
UNIT II	**INHERITANCE AND POLYMORPHISM**	**9**	**0**	**0**	**9**
Base Classes and Derived Classes – Protected Members – Casting Class pointers and Member Functions – Overriding – Public, Protected and Private Inheritance – Constructors and Destructors in derived Classes – Implicit Derived – Class Object to Base – Class Object Conversion – Virtual functions – this Pointer – Abstract Base Classes and Concrete Classes – Virtual Destructors – Dynamic Binding.					
UNIT III	**LINEAR DATA STRUCTURES**	**9**	**0**	**0**	**9**
Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation –Singly Linked lists –Polynomial Manipulation – Stack ADT – Queue ADT – Evaluating arithmetic expressions.					
UNIT IV	**NON-LINEAR DATA STRUCTURES**	**9**	**0**	**0**	**9**
Trees – Binary Trees – Binary tree representation and traversals – Application of trees – Binary Search Tree - Heaps - Operations of Heaps - Binary Heap - Max Heap - Min Heap - Graph and its representations – Graph Traversals – Representation of Graphs – Breadth-first search – Depth-first search.					
UNIT V	**SORTING AND SEARCHING**	**9**	**0**	**0**	**9**
Sorting algorithms: Insertion sort – Quick sort – Merge sort – Searching: Linear search –Binary Search					
Total (45 L) =45 Periods					

Text Books:	
1	Deitel and Deitel, "C++, How To Program", Tenth Edition, Pearson Education, 2017.
2	Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Fourth Edition, Addison Wesley, Copyright 2014.
Reference Books:	
1	Bhushan Trivedi, "Programming with ANSI C++, A Step-By-Step approach", Oxford University Press,2010.
2	Goodrich, Michael T., Roberto Tamassia, David Mount, "Data Structures and Algorithms in C++", 7thEdition, Wiley. 2004.
3	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Second Edition, Mc Graw Hill, 2002.
4	Bjarne Stroustrup, "The C++ programming language", Fourth Edition Addison Wesley, 2013.
5	Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, "Fundamentals of Data Structures in C++", Galgotia Publications, 2007.

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Level
CO1	Understand the concepts of Object oriented programming	Understand
CO2	Design linear and non-linear data structure using object oriented programming concepts	Apply
CO3	Apply various sorting and searching Alogarithms.	Analyze

22CSOE08	CLOUD COMPUTING FUNDAMENTALS					
PREREQUISITES:		**CATEGORY**	**OE**	**Credit**		**3**
Computer Networks		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the broad perceptive of Parallel Computing, Distributed Computing and Cloud Computing.
2.	To understand the concept of Virtualization, Cloud Architecture and Storage.
3.	To understand the Cloud Platforms in Industry and Software Environments.
4.	To understand the concept of Cloud Security and Applications.

UNIT I	INTRODUCTION	9	0	0	9

The vision of Cloud Computing – Defining a Cloud – The Cloud Computing reference model –Characteristics and Benefits; Historical developments: Distributed systems – Virtualization - Web 2.0 - Service-oriented computing - Utility-oriented computing.
Principles of Parallel and Distributed Computing: Parallel vs. distributed computing - Elements of parallel and distributed computing - Technologies for distributed computing.

UNIT II	VIRTUALIZATION	9	0	0	9

Introduction - Characteristics of Virtualized environments - Virtualization techniques: Machine Reference Model – Hardware Level Virtualization - Programming Language Level Virtualization –Application Level Virtualization - Other types of Virtualization - Pros and cons of Virtualization.

UNIT III	CLOUD ARCHITECTURE AND STORAGE	9	0	0	9

The cloud reference model: IaaS, PaaS, SaaS; Types of clouds: Public clouds – Private clouds – Hybrid clouds – Community clouds ;Architectural design challenges.
Cloud Storage: Storage as a Service – Advantages of cloud storage – Cloud Storage Provider: Amazon Simple Storage Service (S3).

UNIT IV	CLOUD INDUSTRIAL PLATFORMS AND SOFTWARE ENVIRONMENTS	9	0	0	9

Cloud Platforms in Industry: Amazon Web Service - Google App Engine - Microsoft Azure; Cloud Software Environments -Hadoop –Map Reduce -Eucalyptus – Open Nebula;

UNIT V	CLOUD SECURITY AND APPLICATIONS	9	0	0	9

Security in the cloud: Cloud Security challenges – Software as a Service Security: Security Management – Security governance – Security Architecture Design -Virtual Machine Security – Identity Access Management.
Cloud Scientific Applications: Healthcare: ECG analysis in the cloud- Geo science: Satellite Image Processing.

Total (45 L)=45 Periods

Text Books:

1.	Rajkumar Buyya, Christian Vecchiola, S.TamaraiSelvi, 'Mastering Cloud Computing-Foundations and Applications Programming", TMGH,2013.
2.	Rittinghouse, John W., and James F. Ransome – Cloud Computing: Implementation, Management and Security. CRC Press, 2017.

Reference Books:

1.	Kai Hwang.GeoffreyC.Fox.JackJ.Dongarra, " Distributed and Cloud Computing ,From Parallel Processing to The Internet of Things", 2012 Elsevier
2.	Barrie Sosinsky, "Cloud Computing Bible", Wiley Publisher, 2011

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the main concepts and architecture of Parallel computing, Distributed Computing and Cloud Computing.	Understand
CO2	Analyze the concept of Virtualization, Cloud Architecture and Storage.	Analyze
CO3	Analyze the Cloud Platforms in Industry and Software Environments.	Analyze
CO4	Identify the security issues in scientific and real time applications.	Apply

22CSOE09	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING				
PREREQUISITES:	**CATEGORY**	**OE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1. To learn the various characteristics of Intelligent agents, different search strategies and represent knowledge in solving AI problems
2. To understand the need for machine learning for various problem solving
3. To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning

UNIT I	INTRODUCTION	9	0	0	9

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II	PROBLEM SOLVING METHODS	9	0	0	9

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems – Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning.

UNIT III	KNOWLEDGE REPRESENTATION	9	0	0	9

First Order Predicate Logic – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.

UNIT IV	LEARNING PROBLEMS	9	0	0	9

Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.

UNIT V	NEURAL NETWORKS AND GENETIC ALGORITHMS	9	0	0	9

Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evaluation and Learning.

Total (45 L)=45 Periods

Text Books:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009
2. I. Bratko, ―Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011
3. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

Reference Books:

1. M. Tim Jones, ―Artificial Intelligence: A Systems Approach(Computer Science)‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J. Nilsson, ―The Quest for Artificial Intelligence‖, Cambridge University Press, 2009
3. William F. Clocksin and Christopher S. Mellish,‖ Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003

E-References:	
1.	https://builtin.com/artificial-intelligence
2.	https://science.howstuffworks.com/robot6.htm
3.	https://onlinecourses.nptel.ac.in/noc18_cs40/preview, (Prof. Sudeshna Sarkar,IIT KHARAGPUR)
4.	Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning From Theory to Algorithms, Cambridge University Press, 2014
5.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use appropriate search algorithms for any AI problem	Apply
CO2	Represent a problem using first order and predicate logic	Understand
CO3	Differentiate between supervised, unsupervised, semi-supervised machine learning approaches	Analyze
CO4	Discuss the decision tree algorithm and identity and overcome the problem of over fitting	Apply

22ECOE01	FUNDAMENTALS OF ELECTRON DEVICES					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

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

Unit I	**SEMICONDUCTOR DIODE**	**9**	**0**	**0**	**9**

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diode.

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	Analysing
CO3	Analyze the knowledge of various types of FET.	Analysing
CO4	Gain a knowledge on special semiconductor devices	Understanding
CO5	Understand the knowledge on Power and Display devices.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	3	1	2	-	-	-	-	-	-	-	-	2	-	-
CO3	2	3	1	3	-	-	-	-	-	-	-	-	3	-	-
CO4	1	2	1	-	-	-	1	-	-	-	1	3	3	-	1
CO5	1	3	1	1	1	-	1	-	-	-	2	3	3	1	2
Avg	1.6	2.8	1	2	2	-	2	-	-	-	1.5	3	2.4	1	1.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE02	PRINCIPLES OF MODERN COMMUNICATION SYSTEMS				OPEN ELECTIVE	
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To have the knowledge of the basic concepts of AM, FM and PM.
2.	To gain knowledge about different pulse modulation and digital modulation techniques.
3.	To gain knowledge about technical information on satellite communication and wireless communication

Unit	Title	L	T	P	TH
Unit I	**FUNDAMENTALS OF ANALOG COMMUNICATION**	**9**	**0**	**0**	**9**

Modulation: Introduction - Amplitude modulation: Modulator and demodulator with waveforms - Angle Modulation: Frequency modulation: Modulator and demodulator with waveforms - Phase modulation - Equivalence between PM and FM - FM transmitters and receivers (Block diagram approach only) - Comparison of various Analog Communication System (AM – FM – PM).

Unit	Title	L	T	P	TH
Unit II	**BASICS OF DIGITAL COMMUNICATION AND PULSE MODULATION**	**9**	**0**	**0**	**9**

Pulse Amplitude Modulation (PAM) – Pulse Width Modulation (PWM) – Pulse code Modulation (PCM)–Differential Pulse Code Modulation - Pulse Position modulation: Generation and detection - Comparison of various Pulse Communication System (PAM – PWM – PCM - PPM).

Unit	Title	L	T	P	TH
Unit III	**DIGITAL MODULATION TECHNIQUES**	**9**	**0**	**0**	**9**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) - Minimum Shift Keying (MSK) –Binary Phase Shift Keying (BPSK) – QPSK –M- ary PSK- Comparison of various Digital Communication System (ASK – FSK – PSK).

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

History of Satellites- Kepler's laws - Satellite Orbits-Geo synchrous Satellites - Satellite Classification - Footprints - Satellite system link models: Uplink model and down link model - Multiple Access Techniques: TDMA - FDMA-CDMA-SDMA - Comparison of Multiple Access Schemes - various satellite services.

Unit	Title	L	T	P	TH
Unit V	**CELLULAR MOBILE COMMUNICATION**	**9**	**0**	**0**	**9**

Cellular concept - Frequency reuse-Channel Assignment Strategy - Hand off mechanism - Basic propagation models: Reflection - diffraction and scattering - Bluetooth-WLAN-Global System for Mobile Communications (GSM) –GPRS.

Total (45L)= 45 Periods

Text Books:

1.	Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007
2.	Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2010

Reference Books:

1.	Dennis Roddy, John Coolen, "Electronic Communications", Prentice Hall of India, 4th Edition.,2016
2.	H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007.
3.	B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007.
4.	AnokhSingh , "Principles of Communication Engineering" ,S.CHAND Publication, 2002

E-References:

1.	http://www.nptelvideos.in/2012/11/communication-engineering.html
2.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-973-communication-system-design-spring-2006/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the need for modulation and how analog modulation takes place	Understanding
CO2	Understand the features of digital communication and pulse modulation.	Understanding
CO3	Analyse various digital modulation schemes.	Analysing
CO4	Have the knowledge about satellite communication.	Remembering
CO5	Have the basics of wireless and mobile communication.	Remembering

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	-	-	-	-	-	-	-	3	2	2
CO2	2	2	1	1	1	-	-	-	-	-	-	-	2	1	2
CO3	1	3	2	2	1	-	-	-	-	-	-	-	3	1	2
CO4	2	2	1	1	1	-	-	-	-	-	-	-	3	2	2
CO5	1	2	2	1	1	-	-	-	-	-	-	-	3	2	2
Avg	1.6	2.2	1.4	1.4	1	-	-	-	-	-	-	-	2.8	1.6	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE03	MICROCONTROLLERS AND ITS APPLICATIONS				OPEN ELECTIVE		
PREREQUISITES			**CATEGORY**	**OE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To learn microcontroller basics and get exposure to 8051 architectures
2.	To embed and program with 8051 microcontrollers
3.	To introduce the advanced features in microcontrollers and its applications

Unit I	INTRODUCTION TO 8051 MICROCONTROLLER	9	0	0	9

Introduction to the concepts of microprocessors, microcontrollers, RISC, CISC, Harvard and Von Neumann architectures. Selection of microcontrollers, variants of MCS-51 family and their features. Applications of microcontrollers. 8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization.

Unit II	ASSEMBLY LANGUAGE PROGRAMMING	9	0	0	9

Features of machine language, assembly language, middle-level and high-level languages. 8051 Addressing modes. Instruction set: Classification, syntax and function of instructions, example programs.

Unit III	I/O PORT AND INTERRUPTS PROGRAMMING	9	0	0	9

Features of I/O ports. Byte size I/O, bit addressability and configuring I/O ports, interface I/O devices such as LED, buzzer, push-button switch, relay, example programs with assembly. Polling & interrupt methods, executing an interrupt, different types, IE and IP registers, enabling, disabling and priority setting, example programs in assembly.

Unit IV	PIC MICROCONTROLLERS	9	0	0	9

Main characteristics of PIC microcontrollers – PIC microcontroller families-12-bit instruction word-14-bit instruction word-16-bit instruction word-Inside a PIC microcontroller.

Unit V	APPLICATIONS	9	0	0	9

Multiplexed seven-segment display, LCD module, ADC 0804, wave form generation using DAC 0808, DC motor-PWM for speed control, Stepper motor, appropriate program.

Total (45L)= 45 Periods

Text Books:

1.	A.Mazidi , J.C. Mazidi&R.D.McKinlay,” The 8051 Microcontroller & Embedded systems using assembly and C” (2ndEdition)
2.	Lucio Di Jasio et.al., “PIC Microcontrollers: Know It All”, Elsevier Science,2007

Reference Books:

1.	Microcontrollers & applications, Ramani Kalpathi, & Ganesh Raja
2.	Embedded C - Michael .J.Pont - Pearson Education -2002
3.	I. Scott MacKenzie, Raphael C.-W. Phan “The 8051 Microcontroller” , Pearson/Prentice Hall Publishers, 2008.
4.	M. Mahalakshmi, “8051 Microcontroller Architecture, Programming and Application”, Laxmi Publications , 2008.

E-References:

1.	https://nptel.ac.in/courses/108105102
2.	https://www.youtube.com/playlist?list=PLm_MSClsnwm9hEIDpFfDnOEu-6kVnF4ug
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basics of microcontroller and 8051 architectures.	Understanding
CO2	Develop programs for control applications using assembly language	Applying
CO3	Illustrate the use of interrupts service routines	Applying
CO4	Understand the PIC microcontroller architecture.	Understanding
CO5	Design microcontroller based simple real-world applications	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	-	2	-	2	-	-	-	-	-	-	3	-	2
CO2	1	2	-	-	-	2	-	-	-	-	-	-	-	-	1
CO3	2	2	-	3	-	1	-	-	-	-	-	-	2	-	3
CO4	1	3	-	2	-	2	-	-	-	-	-	-	2	-	1
CO5	2	3	-	1	-	2	-	-	-	-	-	-	2	-	2
Avg	1.4	2.4	-	2	-	1.8	-	-	-	-	-	-	2.25	-	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE04	COMPUTER NETWORKS			OPEN ELECTIVE			
PREREQUISITES			CATEGORY	OE	Credit		3
			Hours/Week	L	T	P	TH
				3	0	0	3

Course Objectives:

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

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

Text Books:	
1.	Behrouz A. Foruzan, "Data communication and Networking", TMH, 4th edition, 2014.
2.	James. F. Kurouse& W. Ross, "Computer Networking: A Top down Approach Featuring", Pearson, 2020.
Reference Books:	
1.	LarryL.Peterson&PeterS.Davie,"ComputerNetworks",HarcourtAsiaPvt.Ltd.,SecondEdition.
2.	AndrewS.Tanenbaum,"ComputerNetworks",PHI,FourthEdition,2003.
3.	An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education
4.	AjitPal,"DataCommunicationandComputerNetworks",PHI,2014.
E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://www.mbit.edu.in/wp-content/uploads/2020/05/Computer-Networks-5th-Edition.pdf
3.	https://www.tutorialspoint.com/data_communication_computer_network/index.htm

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

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

22ECOE05	BASICS OF EMBEDDED SYSTEMS					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

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

Unit I	**BASICS OF EMBEDDED SYSTEMS**	**9**	**0**	**0**	**9**
Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Examples - Programming Languages - Recent Trends in Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning - Development Environment.					
Unit II	**MEMORY MANAGEMENT AND INTERRUPTS**	**9**	**0**	**0**	**9**
Memory Access Procedure - Types of Memory - Memory Management Methods - DMA – Memory Interfacing - Polling Vs Interrupts - Types of Interrupts - Interrupt Latency - Interrupt Priority – Programmable Interrupt Controllers - Interrupt Service Routines.					
Unit III	**COMMUNICATION INTERFACES**	**9**	**0**	**0**	**9**
Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth					
Unit IV	**REAL TIME OPERATING SYSTEMS**	**9**	**0**	**0**	**9**
Real-Time Concepts - Task Management - Task Scheduling - Classification of Scheduling Algorithms - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing - Priority Inheritance Protocol - Priority Ceiling Protocol - Inter Task Communication - Mutex - Semaphores - Message Queues - Timers - Commercial RTOS.					
Unit V	**VALIDATION AND DEBUGGING**	**9**	**0**	**0**	**9**
Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer – Background Debug Mode - InCircuit Emulator CASE STUDY: RFID Systems - GPS Navigation System – Development of Protocol Converter.					
Total (45L)= 45 Periods					

Text Books:

1.	Sriram VIyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2.	Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.

Reference Books:

1.	Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003
2.	Heath, "Embedded Systems Design‖", Newnes an Imprint of Elsevier, Massachusetts, 2003.
3.	Tammy Noergaard, "Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4.	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013

E-References:

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

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Outline the concepts of embedded systems	Remembering
CO2	Understand the concept of memory management system and interrupts.	Understanding
CO3	Know the importance of interfaces.	Understanding
CO4	Understand real time operating system concepts.	Understanding
CO5	To realize the applications of validation and debugging.	Applying

COURSE ARTICULATION MATRIX

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

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

22ECOE06	BASICS OF INTERNET OF THINGS					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

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

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

Text Books:

1.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2.	Arshdeep Bahga, Vijay Madisetti, “Internet of Things-A hands-on approach”, Universities Press, 2015

Reference Books:

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

E-References:

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

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

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

22ECOE07	BASICS OF ARTIFICIAL INTELLIGENCE					OPEN ELECTIVE
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	Study about uninformed and Heuristic search techniques.
2.	To Learn techniques for reasoning under uncertainty
3.	Introduce Machine Learning and supervised learning algorithms
4.	Study about ensemble and unsupervised learning algorithms.
5.	Learn the basics of deep learning using neural networks.

Unit I	**PROBLEM SOLVING**	**9**	**0**	**0**	**9**
Introduction to AI - AI applications – problem solving agents – search algorithms – Uninformed search strategies – Heuristic search strategies – local search and optimization problems –adversarial search – constraing satisfaction problems(CSP) .					
Unit II	**PROBABILISTIC REASONING**	**9**	**0**	**0**	**9**
Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.					
Unit III	**SUPERVISED LEARNING**	**9**	**0**	**0**	**9**
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree.					
Unit IV	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**	**9**	**0**	**0**	**9**
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN					
Unit V	**NEURAL NETWORKS**	**9**	**0**	**0**	**9**
Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) –batch normalization, regularization, dropout.					
					Total (45L)= 45 Periods

Text Books:	
1.	Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021
2.	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006
Reference Books:	
1.	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
2.	Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3.	Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4.	Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.
E-References:	
1.	https://machinelearningmastery.com/
2.	https://ai.google/education/
3.	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	Use appropriate search algorithms for problem solving	Understanding
CO2	Apply reasoning under uncertainty	Applying
CO3	Build supervised learning models	Applying
CO4	Build ensembling and unsupervised models	Applying
CO5	Build deep learning neural network models	Applying

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

22EEOE01	RENEWABLE ENERGY SOURCES			SEMESTER			VI / VII
PREREQUISITES			**CATEGORY**	**OE**	**Credit**		**3**
Basic Electrical and Electronics Engineering			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1. To impart knowledge on the different renewable energy sources and technologies.

UNIT 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**	**PSO1**	**PSO2**	**PSO3**
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="5">DESIGN OF MACHINE ELEMENTS AND MACHINING</td><td colspan="4">SEMESTER VI/VIII</td></tr>
<tr><td colspan="5" 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.

UNIT I	**STRESSES IN MACHINE ELEMENTS**	**9**	**0**	**0**	**9**
Stress in simple machine members- axial, bending, torsional, bearing stress, Hertz contact stress; combined stresses, principle stresses, Theories of failure, factor of safety, stress concentration, preferred numbers.					
UNIT II	**DESIGN OF SHAFTS AND WELDED JOINTS**	**9**	**0**	**0**	**9**
Design of shaft members subjected to simple and combined stresses - Welded joints- Types of welding symbols, design of welded joints subjected to various load -Design of Riveted joints					
UNIT III	**DESIGN OF MACHINE ELEMENTS**	**9**	**0**	**0**	**9**
Springs: Design of helical springs- stresses and deflection - design procedure. Bearings: Need for bearing, Types, sliding and rolling contact bearings, hydro- dynamic and hydro static bearings- Life of bearings – Selection of bearings-Problems.					
UNIT IV	**METAL CUTTING**	**9**	**0**	**0**	**9**
Theory of metal cutting: Introduction, mechanics of metal cutting, orthogonal and oblique cutting, merchants' equation, chip formation, heat generation, cutting fluids, cutting tool life, recent developments and applications (Dry machining and high-speed machining)					
UNIT V	**MACHINE TOOLS AND SURFACE FINISHING PROCESSES**	**9**	**0**	**0**	**9**
Tools and machine tools: Cutting tool materials, cutting tool nomenclature, introduction to machine tools, lathe, shaper, planning, milling, drilling and boring machines, working principle, operations, work holding devices. Surface finishing processes: Introduction to Grinding honing, lapping processes and machines. Introduction to CAD/CAM/CIM.					
Total(45L) = 45Periods					

REFERENCE BOOKS:	
1	Rao P N, "Manufacturing Technology" Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2006
2	HMT, "Production Technology" Tata McGraw-Hill Co., New Delhi, 1998
3	Milton C Shaw, "Metal Cutting Principles", Clarendon Press, Oxford, 1999.
4	James Brown, "Advanced Machining Technology Handbook", McGraw- Hill Book Company, New York, 1988.
5	Robert L Mott, "Machine Elements in Mechanical Design", Macmillan Publishing Co., London. UK, 1992.
6	Shighley and Mische, "Mechanical Engineering Design" McGraw Hill, 1992.
7	Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.
E-REFERENCES:	
1.	https://nptel.ac.in/courses/112105124
2.	Design of Machine Elements - V. B. Bhandari - Google Books
3.	"A Textbook of Machine Design" by R.S.Khurmi and J.K.Gupta

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		Bloom Taxonomy Mapped
CO1	Analyze the stresses induced in a machine element.	Analyze
CO2	Familiarize the design concept of joints under various loading.	Remember
CO3	Familiarize the design of various types of bearings and Spring.	Remember
CO4	Identify the process parameters associated with various machining processes.	Apply
CO5	Familiarize the cutting tools materials and surface finishing processes.	Remember

COURSE ARTICULATION MATRIX

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

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

22MEOE02	INDUSTRIAL ENGINEERING					SEMESTER VI / VIII		
			CATEGORY	OE	Credit			3
			Hours/Week	L	T	P		TH
				3	0	0		3

COURSE OBJECTIVES	
1	Assume technical and managerial roles in the industries.
2	Apply engineering principles to the working environment.
3	Use quality tools to foresee and solve issues in the industrial situations.
4	Work collaboratively.
5	To know the importance of EBQ.

UNIT I	FORECASTING	9	0	0	9
Characteristics and Principles - Qualitative Methods, Delphi Technique, Market Research -Time Series Methods- Moving Average, Exponential Smoothing- Box Jenkins Method – Auto Regressive Moving Average (ARMA) or Auto Regressive Integrated Moving Average (ARIMA) models – Fitting Regression Models - Measurement of Forecast Errors, Coefficient of Correlation - Problem solving.					
UNIT II	**FACILITIES PLANNING AND WORK STUDY**	**9**	**0**	**0**	**9**
Factors affecting Site Location Decisions - Principles and Types of Layout - Layout Planning -Layout Tools and Computerised Layout Techniques - Design of Group Technology Layout – Line Balancing - Line Balancing Methods- Objectives of Work Study -Method Study Procedure, Recording Techniques - Motion Study - Principles of Motion Economy - Techniques of Work measurement - Time Study - Synthesis Method - Analytical Estimating - Predetermined Motion Time System (PMTS) - Work Sampling Techniques.					
UNIT III	**LEAN MANUFACTURING**	**9**	**0**	**0**	**9**
Elements of Just In Time (JIT) - Pull and Push System, Kanban System- Optimized ProductionTechnology and Synchronous Manufacturing – Implementation of Six Sigma - Single Minute Exchange of Die (SMED) 5S concept - Concurrent Engineering- Cellular Manufacturing – Enablersof Agile Manufacturing – Rapid Manufacturing - Business Process Re-engineering (BPR) - Basics of Supply Chain Management, Supply chain and “Keiretsu” – Enterprises Resources Planning (ERP) - Role of KAIZEN, Quality Circles and POKA YOKE in Modern Manufacturing – Seven wastes in Lean Manufacturing.					
UNIT IV	**AGGREGATE PRODUCTION PLANNING**	**9**	**0**	**0**	**9**
Objectives of Aggregate Planning - Capacity Requirement Planning (CRP) Process - Types of Capacity Planning - Strategies for Aggregate Capacity Planning - Master Production Scheduling - Procedure for Developing MPS – Materials Requirements Planning (MRP-I), Issues in MRP, Designing and Managing the MRP System, Evaluation of MRP - Manufacturing Resources Planning (MRP-II).					
UNIT V	**SCHEDULING OF OPERATIONS**	**9**	**0**	**0**	**9**
Operations Planning and Scheduling - Scheduling Techniques - Stages in Scheduling – Loading, Dispatching, Expediting - Finite Loading and Infinite Loading - Load Charts and Machine Loading Charts - Priority Sequencing -Dynamic Sequencing Rules - Batch Scheduling – Economic Batch Quantity (EBQ) or Economic Run Length (ERL) – Scheduling in Repetitive, Batch and Job Shop Manufacturing – Allocation of units for a single resource, allocation of multiple resources – Resource balancing - Flexible Manufacturing System.					
					Total (45L) = 45 Periods

REFERENCE BOOKS:	
1	R.Panneerselvam, “Production & Operations Management”, 3rd Edition, PHI LearningPrivate Limited, New Delhi, 2012
2	Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production/Operation Management”, 8thEdition, John Wiley & Sons, 2000
3	Dilworth B.James, “Operations Management Design, Planning and Control forManufacturing and Services”, Mcgraw Hill Inc., New York, 1992

4	Vollman T.E, “Manufacturing Planning and Control Systems”, Galgotia Publications, 2002.
E-REFERENCES:	
1.	https://www.newtondesk.com/industrial-engineering-study-notes-hand-written
2.	https://en.wikipedia.org/wiki/Lean_manufacturing
3.	https://www.planettogether.com/blog/types-of-scheduling-in-production-planning-and-control

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Apply the knowledge of engineering and sciences to improve the productivity of industries.	Apply
CO2	Design a system to meet the desired needs within realistic constraints.	Create
CO3	Function in multidisciplinary teams.	Apply
CO4	Use the techniques, skills, and modern engineering tools in manufacturing practice.	Understand
CO5	Perform as an effective industrial engineer integrating high and low levels of management	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3			2	2									3
CO2			3											2
CO3						3	2		3	2	3	2	3	
CO4	3	3		2	3	3						2		3
CO5						3	2	3					3	
Avg	**3**	**3**	**3**	**2**	**2.5**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2.6**

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

22MEOE03	INDUSTRIAL ROBOTICS			SEMESTER VI/VII			
		CATEGORY	OE	Credit		3	
		Hours/Week	L	T	P	TH	
			3	0	0	3	

COURSE OBJECTIVES

1	To explore concepts of robot technologies that is playing vital role in manufacture.
2	Describe various robot technology applications.
3	Develop an understanding of robot Kinematics and dynamics.
4	Explain and summarize robot end effectors and Sensors.
5	Explore conceptual understanding of Robot programming.

UNITI	INTRODUCTION	9	0	0	9

Robot - definition - robot anatomy - co-ordinate systems - work envelope - types and classification - specifications – joint notations – types of joints - speed of motion - pay load - robot parts and their functions - need for robots in Indian scenario.

UNIT II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9	0	0	9

Drives - hydraulic, pneumatic, mechanical and electrical - servo motors - stepper motors - salient features, application – end effectors – types: tools - grippers - mechanical grippers - pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, multiple grippers.

UNIT III	SENSORS AND MACHINE VISION	9	0	0	9

Requirements of sensors – principles, types and applications of following types of sensors proximity (inductive, Hall effect, capacitive, ultrasonic and optical) – range (Triangulation, structured light approach, laser range) – speed, position (resolvers, optical encoders, pneumatic) – force – torque – touch sensors (binary, analog sensor) - Introduction to machine vision -functions - image processing and analysis.

UNIT IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9	0	0	9

Forward kinematics and reverse kinematics of manipulators - two, three degrees of freedom (in 2 dimensional) – homogeneous transformation matrix - simple problems - lead through programming, robot programming languages - VAL programming –motion commands - sensor commands - end effecter commands - simple programs for loading, unloading and palletizing operations.

UNIT V	APPLICATIONS, IMPLEMENTATION AND ROBOT ECONOMICS	9	0	0	9

Robot cell design – types - Application of robots in processing - assembly - inspection - material handling - loading - unloading - automobile - implementation of robots in industries - safety considerations for robot operations – economic analysis of robots - pay back method and rate of return method.

Total (45L) = 45Periods

REFERENCE BOOKS:

1	Mikell. P. Groover, ‘Industrial Robotics Technology’, Programming and Applications, McGraw Hill Co, 1995.
2	Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
3	Richard D.Klafter, Thomas A.Chmielewski and MichealNegin, “Robotic engineering –An Integrated Approach”, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 2005.
4	Janakiraman.P.A. “Robotics and Image Processing”, Tata McGraw-Hill, 1995.
5	YoramKoren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992.
6	A.K.Gupta and S.K.Arora, “Industrial Automation and Robotics”, Laxmi Publications Pvt ltd, 2007.
7	Fu. K. S., Gonzalez. R. C. & Lee C.S.G., ‘Robotics control, sensing, vision and intelligence’, McGraw Hill Book co, 1987.
8	Craig. J. J. ‘Introduction to Robotics mechanics and control’,Addison- Wesley, 1999

9	Ray Asfahl. C., 'Robots and Manufacturing Automation', John Wiley & Sons Inc., 1985.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the basic concepts, parts of robots and types of robots.	Understand
CO2	Understand the potential applications of robots in industries as part of automation tool.	Understand
CO3	Familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots.	Remember
CO4	Discuss about the various applications of robots, justification, implementation and safety of robot	Analyze
CO5	Select an appropriate robot for a particular application.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1			1							1	1
CO2			1		1	1							1	1
CO3		1	0										1	1
CO4			1			3								1
CO5		2											1	2
Avg	**3**	**1.7**	**1**		**1**	**1.7**							**1**	**1.2**

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

22MEOE04	POWER PLANT ENGINEERING					SEMESTER VI/VII		
PREREQUISITES			CATEGORY	OE		Credit		3
1. Having sufficient knowledge on basics of power plant			Hours/Week	L	T		P	TH
2. Basic unit calculation for consumption of power				3	0		0	3

COURSE OBJECTIVES:

1.	Understanding of thermal power plant operations and its components.
2.	Location of hydro power plant and its components to generate power.
3.	Complete knowledge about diesel and gas power plant.
4.	Basic knowledge of nuclear reaction and types of nuclear power plant.
5.	Basic knowledge of power plant economics and various tariff methods.

UNIT I	**STEAM POWER PLANT**	**9**	**0**	**0**	**9**
Layout of steam power plant – boilers - Modern high pressure and supercritical boilers - Preparation and handling of coal - Pulverizer - Dust collector - Ash removal; Stokers - Different types - Pulverized fuel burning; Draught - Different types - Chimney design - Selection of blowers, Cooling towers - Different types - Waste heat recovery, Fluidised Bed and Circulated Fluidised Bed boilers					
UNIT II	**HYDRO ELECTRIC POWER PLANT**	**9**	**0**	**0**	**9**
Layout of hydel power plant- classification –working – components – layout of pumped storage power plant - Plant equipment for Pumped Store Schemes.					
UNIT III	**DIESEL AND GAS POWER PLANT**	**9**	**0**	**0**	**9**
Layout of Diesel power plant- Important components – performance analysis – Layout of gas power plant – classification of gas turbine cycles – components – relative thermal efficiencies of different cycles.					
UNIT IV	**NUCLEAR, MHD POWER GENERATION**	**9**	**0**	**0**	**9**
Elementary treatment - nuclear fission, chain reaction - Pressurized water reactors, boiling water reactors, gas cooled reactors - Fast breeder reactors, Magneto Hydro Dynamic power- open cycle and closed cycle system.					
UNIT V	**ECONOMICS AND SAFETY**	**9**	**0**	**0**	**9**
Economics and safety - Actual load curves - Fixed and operating costs - Tariff methods for electrical energy - Peak load and variable load operations - Selection of generation type and general equipment. Introduction to safety aspects in power plants - Environmental impacts - assessment for thermal power plant.					
	Total(45L) = 45 Periods				

TEXT BOOKS:

1.	S. Domkundwar, A.V. Domkundwar, S.C. Arora.A Course in Power Plant Engineering, Dhanpat Rai Publications. 2013
2.	P.K. Nag, Power Plant Engineering, Tata McGraw Hill, Laxmi Publications Pvt.Ltd New Delhi, 5th Edition, 2014.

REFERENCES:

1	R.K. Rajput. A Text of Power Plant Engineering, Laxmi publications, New Delhi 5th Edition, 2016.
2	G.R. Nagpal, Power Plant Engineering, Khanna Publications 1998.
3	Bernhardt G. Askrotzki and William A. Vopat, “Power Station Engineering and Economy”, Tata McGraw Hill Publishing Co. Ltd., 1972.
4	Frederick T. Mores, “Power Plant Engineering”, Affiliated East-West Press Private Ltd., 1953.
5	Joel Weisman and Roy Eckart, “Modern Power Plant Engineering”, Prentice Hall International Inc., 1985.

E-REFERENCES:	
1.	https://en.wikipedia.org/wiki/Power_plant_engineering
2.	https://onlinecourses.nptel.ac.in/noc21_me86/preview

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		Bloom Taxonomy Mapped
CO1	Ample knowledge on thermal power plant operation and its merits and demerits.	Analyze
CO2	Potential Power of water to convert into useful energy by hydropower.	Remember
CO3	Augment with diesel and gas power plant operation and its components.	Understand
CO4	Able to cope with recent developments on nuclear power plant.	Understand
CO5	Understanding of various economics to construct power plant and to measure the consumption of power by different tariff.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	1		1	1	2		2	2	2	1	2
CO2	1	2	3	2	1		1	1	2		2	2	2	1	2
CO3	1	2	3	2	1		1	1	2		2	2	2	1	2
CO4	1	2	3	2	1		1	1	2		2	2	2	1	2
CO5	2		1	2				2	2	1	1	1	2		
Avg	**1.2**	**2**	**2.6**	**2.0**	**1**		**1**	**1.2**	**2.0**	**1**	**1.8**	**1.8**	**2.0**	**1**	**2**

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

22MEOE05	PRINCIPLES OF MANAGEMENT					SEMESTER VI/VIII
		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES

1.	To understand the management basic features of management.
2.	Principles usages in all walks of life and industrial growth.
3.	Able to have a clear understanding of the managerial functions like planning, organizing, staffing, leading and controlling.
4.	To gain some basic knowledge in international aspect of management.

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)

22MEOE07	RENEWABLE SOURCES OF ENERGY					SEMESTER VI/VIII
PRE-REQUISITE: 1. Basic idea about solar radiation and other renewable energy that exists. 2. Understanding about various chemical reactions occur in the energy conversion process		CATEGORY	OE	Credit		3
		Horus/Week	L	T	P	TH
			3	0	1	4

COURSE OBJECTIVES	
1.	To recognize the consciousness of energy conservation in scholars
2.	To identify the employ of renewable energy sources for electrical power generation
3.	To collect different energy storage methods
4.	To detect about environmental effects of energy conversion

UNIT I	**SOLAR RADIATION AND ITS MEASUREMENTS**	**9**	**0**	**0**	**9**
Alternative energy sources, Global and Indian energy scenario. Solar Energy: Introduction – Solar Radiation Measurement and Instruments – Data and estimation.					
UNIT II	**SOLAR ENERGY COLLECTORS, SOLAR ENERGY STORAGE AND APPLICATIONS OF SOLAR ENERGY**	**9**	**0**	**0**	**9**
Flat Plate and Concentrating Collectors –Solar direct Thermal Applications – Solar thermal Power Generation – Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation –Solar Energy Storage: Thermal energy, Chemical Energy and Electromagnetic energy storage; Solar PV Applications: Solar water heating, Space heating and cooling, Solar distillation, Solar pumping, Solar furnace, Solar cooking.					
UNIT III	**BIOMASS AND ITS CONVERSION TECHNOLOGIES**	**9**	**0**	**0**	**9**
Bio-mass conversion Techniques: Direct combustion (incineration); Thermo-chemical conversion-Gasification and its types; Wet Process- Classification of biogas plant- types of Anaerobic digestion (Khadi and Village Industries type, Pragati design, Gasnesh biogas plant and Ferro-cement digester biogas plant) – Fermentation process;					
UNIT IV	**WIND, GEOTHERMAL AND TIDAL ENERGY**	**9**	**0**	**0**	**9**
Basic principle of wind energy conversion, types of wind energy conversion; Geothermal sources – hydrothermal geothermal resources, geopressurised resources, hot dry rock resources of petrothermal systems, Magma resources – Comparison of flashed steam and total flow concept. Basic principle of tidal power, components of tidal power plants, operation methods of utilization of tidal power.					
UNIT V	**CHEMICAL ENERGY, HYDROGEN ENERGY AND MAGNETO HYDRO DYNAMIC**	**9**	**0**	**0**	**9**
Design and principle operation of a Fuel cells, classification of fuel cells, types of fuel cells, Advantages, disadvantages and applications of fuel cells. Basic principle of Magneto Hydro Dynamic – Open cycle and closed cycle system.					
Total (45L) = 45Periods					

REFERENCE BOOKS:	
1	G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
2	Suhas P. Sukhatme, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., 2007.
3	Khan, B.H., "Non-Conventional Energy Resources", The McGraw Hill Companies, 2009.
4	Twidell, J.W. & Weir, A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2005.
5	Solanki: Renewable Energy Technologies: Practical Guide for Beginners, PHI Learning Pvt.Ltd., 2008
6	D. Mukherjee: Fundamentals of Renewable Energy Systems, New Age International publishers, 2007.
7	Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.
E-REFERENCES:	
1.	https://en.wikipedia.org/wiki/Renewable_energy

2.	Ellabban, Omar; Abu-Rub, Haitham; Blaabjerg, Frede (2014). "Renewable energy resources: Current status, future prospects and their enabling technology". Renewable and Sustainable Energy Reviews. 39: 748–764 [749]

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the principles of solar radiation and its measuring devices	Understand
CO2	Comprehend the ideology of solar energy collectors, solar photovoltaic power generationsolar energy storage and applications of solar energy	Analyze
CO3	Acquire awareness about biomass sources of energy technologies	Understand
CO4	Design various renewable energy gadgets such as wind and tidal plant	Create
CO5	Learn about extracting energy from chemical methods	Understand

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

2MEOE08	ROBOTIC PROCESS AUTOMATION					SEMESTER VI/VIII
Pre-requisite:		**CATEGORY**	**OE**	**Credit**		**3**
Basics in kinematics and dynamics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

COURSEOBJECTIVES

1.	To study the various parts of robots and fields of robotics.
2.	To study the various kinematics and inverse kinematics of robots.
3.	To study the Euler, Lagrangian formulation of Robot dynamics.
4.	To study the trajectory planning for robot.
5.	To study the control of robots for some specific applications

UNIT I	**BASIC CONCEPTS**	**9**	**0**	**0**	**9**
Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov‟s laws of robotics – dynamic stabilization of robots.					
UNIT II	**POWER SOURCES AND SENSORS**	**9**	**0**	**0**	**9**
Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors					
UNIT III	**MANIPULATORS, ACTUATORS AND GRIPPERS**	**9**	**0**	**0**	**9**
Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.					
UNIT IV	**KINEMATICS AND PATH PLANNING**	**9**	**0**	**0**	**9**
Solution of inverse kinematics problem – multiple solution jacobian work envelop – Hill Climbing Techniques – robot programming languages					
UNIT V	**CASE STUDIES**	**9**	**0**	**0**	**9**
Multiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.					
					Total (45L) = 45 Periods

REFERENCE BOOKS:

1	Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., “Industrial Robotics”, Mc Graw-Hill Singapore, 1996.
2	Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
3	Deb. S.R., “Robotics Technology and flexible Automation”, John Wiley, USA 1992.
4	Klafter R.D., Chimielewski T.A., Negin M., “Robotic Engineering – An integrated approach”, Prentice Hall of India, New Delhi, 1994.
5	Barry Leatham – Jones, “Elements of industrial Robotics” PITMAN Publishing, 1987.
6	Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, “Industrial Robotics Technology, Programming and Applications “, McGraw Hill Book Company 1986.
7	Fu K.S. Gonzaleaz R.C. and Lee C.S.G., “Robotics Control Sensing, Vision and Intelligence” McGraw Hill International Editions, 1987.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Explain the basic concepts of working of robot.	Understand
CO2	Analyze the function of sensors in the robot.	Analyze
CO3	Analyze the working of manipulates, actuators and grippers.	Analyze
CO4	Write program to use a robot for a typical application.	Create
CO5	Use robots in different applications.	Apply

COURSE ARTICULATION MATRIX														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2		2					1		2	2	2
CO2	1	3	2	1	1							2	1	3
CO3		2	2	1	1							2	1	3
CO4		1	1	2	3			1	3	2	1	2		
CO5		1	2	2	2	1	2	2	3	2	1	2		
Avg	**1**	**1.6**	**1.8**	**1.5**	**2**	**1**	**2**	**1.5**	**3**	**1.7**	**1**	**2**	**1.3**	**2.7**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)														

22MEOE09	TOTAL QUALITY MANAGEMENT			SEMESTER VI/VIII			
		CATEGORY		OE	Credit		3
		Hours/Week		L	T	P	TH
				3	0	0	3

COURSE OBJECTIVES	
1.	Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
2.	Explain the TQM Principles for application.
3.	Define the basics of six sigma and apply traditional tools, new tools, Benchmarking and FMEA.
4.	Describe Taguchi's Quality Loss Function, Performance measures and apply techniques like QFD, TPM, COQ and BPR.
5.	Illustrate and apply QMS and EMS in any organization.

UNIT I	INTRODUCTION	9	0	0	9
Definition of Quality - Dimensions of Quality - Quality planning - Quality costs, Analysis techniques for quality costs- Basic concepts of total quality management (TQM) - Historical review - Principles of TQM – Leadership - Role of senior management - Quality council, Quality statements - Strategic planning- Deming philosophy - Barriers to TQM implementation					
UNIT II	**TQM PRINCIPLES**	**9**	**0**	**0**	**9**
Customer satisfaction - Customer perception of quality, Customer complaints, Service quality, Customer Retention, Employee involvement - Motivation, Empowerment, Teams, Recognition and reward, Performance appraisal - Continuous process improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen - Supplier Partnership, Sourcing, Supplier selection, Supplier rating, Relationship development - Performance measures, Basic concepts, Strategy					
UNIT III	**STATISTICAL PROCESS CONTROL (SPC)**	**9**	**0**	**0**	**9**
The seven tools of quality, Statistical fundamentals – Measures of central tendency and dispersion, Population and sample, Normal curve - Control charts for variables and attributes, Process capability - Concept of six sigma, New Seven Management Tools.					
UNIT IV	**TQM TOOLS**	**9**	**0**	**0**	**9**
Benchmarking – Reasons to benchmark, Benchmarking process, Quality function deployment (QFD) process – House of quality, Benefits - Taguchi quality loss function - Total productive maintenance (TPM) concept, Improvement needs - FMEA – Stages of FMEA.					
UNIT V	**QUALITY MANAGEMENT SYSTEMS**	**9**	**0**	**0**	**9**
Need for ISO 9000 and other quality systems, benefits of ISO registration, ISO 9001:2008 quality system – Elements, Implementation of quality system, Documentation, Quality auditing, AS 9100,TS 16949:2002 and TL 9000					
Total (45L) = 45Periods					

REFERENCE BOOKS:	
1	Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2	Feigenbaum.A.V. “Total Quality Management”, McGraw Hill, 1991.
3	Joel.E. Ross, “Total Quality Management – Text and Cases”, Routledge. 2017.
4	Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
5	Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
6	Suganthi.L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006

7	Narayana V and Sreenivasan, N.S, “Quality Management – Concepts and Tasks”, New Age International, 1996.
E-REFERENCES:	
1.	https://www.oreilly.com/library/view/total-quality-management/9780815330486/xhtml/Reference1.xhtml
2.	https://www.sanfoundry.com/best-reference-books-total-quality-management/
3.	https://www.routledge.com/Total-Quality-Management-TQM-Principles-Methods-and-Applications/Luthra-Garg-Agarwal-Mangla/p/book/9780367512835

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Ability to apply TQM concepts in a selected enterprise.	Apply
CO2	Ability to apply TQM principles in a selected enterprise.	Apply
CO3	Ability to understand Six Sigma and apply Traditional tools, new tools, Benchmarking and FMEA.	Understand
CO4	Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.	Understand
CO5	Ability to apply QMS and EMS in any organization.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3			2		1		2			2	1	2
CO2	1	2							2			2		
CO3	1	2	2		1			1				2	1	
CO4	1	2			2	3		2		3		2	2	2
CO5	1	2	2		2	2	1	2	2	3		2	2	2
Avg	**1**	**2.2**	**2**		**1.75**	**2.5**	**1**	**1.7**	**2**	**3**		**2**	**1.5**	**2**

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

22MTOE01	FOUNDRY AND WELDING TECHNOLOGY				
PREREQUISITES: **Manufacturing Technology**		**Category**	**OE**	**Credit**	**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To know the basic concepts of metal casting technology and to apply them to produce of new materials.
2.	To know the concepts of different materials joining technology and emphasis on underlying science and engineering principle of every processes.

UNIT I	**MOULDING MATERIALS AND PATTERNS**	**9**	**0**	**0**	**9**
Introduction to foundry operations, patterns - functions, types, allowances, selection of pattern materials, colourcodes, core boxes, moulding practice, ingredients of moulding sand and core sand, Testing of Moulding sands. Sand preparation, Sand reclamation in foundries.					
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 alloysand 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 andlaser beam welding processes. Friction, friction stir welding, ultrasonic explosive and diffusion welding.					
					Total (45+0) = 45 Hours

Text Books:

1.	Heine R W., Loper, C.R.Rosenthal, P.C.,"Principles of Metal Casting",Tata-McGraw Hill PublishingCo Ltd, New Delhi, 2008.
2.	Srinivasan N K.,"Foundry Engineering", Khanna Tech Publications, New Delhi, 2005.
3.	Parmar, R.S., –Welding Processes and Technology‖, 2nd edn. Khanna Publishers, New Delhi, 2001
4.	Srinivasan N K ,"Welding Technology", Khanna Publications, Delhi, 2000

Reference Books:

1.	Beeley P R., "Foundry Technology", Butterworths, London, 1982.
2.	Howard B. Cary, "Modern Welding Technology", Prentice Hall, New Jersey, USA, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the alloying element effect on the steels and mention the precaution to be taken in mouldingand melting of steels.	L2: Understanding
CO2	:	Distinguish different moulding and casting techniques.	L3:Applying
CO3	:	Apply the melting procedure for the various alloys like steels, stainless steels,discuss the slag-metal reactions	L3:Applying
CO4	:	Illustrate the conventional welding processes and allied joining processes.	L2: Understanding
CO5	:	Compare the various special welding processes.	L3:Applying

<u>COURSE ARTICULATION MATRIX</u>

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	Title	L	T	P	TH
UNIT I	**TRIBOLOGY AND PLATING PROCESSES**	**9**	**0**	**0**	**9**

Introduction to tribology, Wear: Types of wear - adhesive, abrasive, oxidative, corrosive, erosive and trotting wear, roles of friction and lubrication and wear testing. Plating Processes: Fundamentals of electrode position, plating of nickel, chromium, tin and copper, pulsed plating, hydrogen embrittlement, plating adhesion, electrolessplating, electrochemical conversion coating, selective plating for repair, plating properties, hard anodizing.

UNIT	Title	L	T	P	TH
UNIT II	**HARD FACING PROCESSES**	**9**	**0**	**0**	**9**

SMAW, GTAW, GMAW, FCAW, SAW, PAW, Oxy-Acetylene Welding, Furnace fusing, Thermal-spray, Flamespray processes - HVOF, Detonation gun and Jet kote processes, Hard facing consumables.

UNIT	Title	L	T	P	TH
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	Title	L	T	P	TH
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	Title	L	T	P	TH
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, computer aided selection, structural index; Case studies: table legs, flywheel, springs, pressure vessels, bearings, heat exchangers, airframes, ship structures, automobile structures.					
UNIT IV	**PROCESSES AND PROCESS SELECTION**	**9**	**0**	**0**	**9**
The processes: shaping, joining and finishing, Process selection, ranking processes, cost, computer based process selection, Case studies: fan, pressure vessel, optical table, economical casting.					
UNIT V	**MULTIPLE CONSTRAINTS AND OBJECTIVES**	**9**	**0**	**0**	**9**
Selection under multiple constraints, conflicting objectives, penalty-functions, exchange constants, Case studies: connecting rods for high performance engines, windings of high field magnets.					
					Total (L+T) = 45 Hours

Text Books:	
1.	Michael F. Ashby, Materials Selection in Mechanical Design, third edition, Butterworth-Heinemann,2005
2.	J. Charles, F.A.A. Crane, J. A.G. Furness, Selection and Use of Engineering Materials, third edition,Butterworth-Heinemann, 2006
Reference Books:	
1.	ASM Metals Handbook, Vol.20: Materials Selection and Design, ASM International,1997
2.	Myer Kutz, Handbook of Materials Selection, John Wiley & Sons, Inc., New York, 2002

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the design process and design flow chart tools for the materials selection criterion.	L2: Understanding
CO2	:	Apply the materials for corrosion and wear resistance processes.	L3:Applying
CO3	:	Apply the materials for auto and aero industry.	L3:Applying
CO4	:	Classify the process selection criterion for high temperature materials.	L2: Understanding
CO5	:	Suggest the process selection criterion for high performance materials..	L3:Applying

COURSE ARTICULATION MATRIX																
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1		1	
CO2	2	1	1			1	1							2		
CO3	1	1		1	1								1	1		
CO4	2	1	1		1									2		
CO5	1	1		1	1											1
Avg.	1.4	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.7	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

22MTOE04	NANOSCIENCE AND TECHNOLOGY					
PREREQUISITES: **Engineering material and metallurgy**	**Category**	**OE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1. To study about nanomaterials and its application

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

Definition, Length scales, surface area/volume ratio of micron to nanoscale materials, Importance of Nanoscale and Technology, Top down and bottom up approaches, Classification of nanomaterials, Properties of selected nanomaterials including carbon nanotubes (CNT), graphene, metal nanoparticles, clays, nanowires, quantum dots (QDs), effect of size on thermal, mechanical and electrical properties of nanomaterials.

UNIT II	**SYNTHESIS OF NANOMATERIALS**	**9**	**0**	**0**	**9**

Fabrication of Nanomaterials: Top-down approaches-lithography, Mechanical alloying milling, Severe PlasticDeformation, Bottom-up approaches-chemical vapour deposition, physical vapour deposition, atomic layer deposition (ALD), and Sol-gel method, Synthesis and purification of CNT, synthesis of expanded graphite (EG) orgraphene.

UNIT III	**NANOCOMPOSITES**	**9**	**0**	**0**	**9**

Fabrication of nanocomposites: Fabrication of Clay-rubber, Clay-polymer, CNT-polymer, EG-polymer, magnetic particle-polymer, CNT-metal, trade off between the composites and nanocomposites etc. Consolidation of nanomaterials.

UNIT IV	**CHARACTERIZATION OF NANOMATERIALS**	**9**	**0**	**0**	**9**

Characterization of Nanomaterials:, X-ray diffraction (XRD), Dynamic Light Scattering, Scanning electron microscope (SEM), Transmission Electron Microscope (TEM), UV-Visible spectroscopy, Scanning probe microscopy- Atomic force microscope (AFM) and scanning tunneling microscope (STM). Nanoindentation.

UNIT V	**APPLICATIONS OF NANOMATERIALS**	**9**	**0**	**0**	**9**

Applications of nanomaterials: Electronics, structural, biomedical, sensors nanofluids, optical, magnetic, biomedicalfields, solar cells, LED, LCD, electrically conducting polymers, batteries, fuel cells, SMART Materials. Environmental and health issues related to nanomaterials.

Total (L+T) = 45 Hours

Text Books:

1.	B.S. Murty, P. Shankar, Baldev Raj, B BRath, James Murday, Textbook of Nanoscience and Nanotechnology,University Press (I) Pvt. Ltd., 2013.
2.	Bharat Bhushan (Ed), Springer Handbook of Nanotechnology, Springer-Verlag Berlin Heidelberg, 2004

Reference Books:

1.	Charles P Poole and Frank J Owens, –Introduction to Nanotechnology‖, John Wiley and Sons, New York, 2003.
2.	Michael Wilson, KamaliKannagara and Geoff Smith, ―Nanotechnology: Basic Science and Emerging Technology‖, Chapman and Hall, New York, 2002.
3.	Pradeep T, –Nano: The Essentials‖, Tata McGraw Hill, New Delhi, 2007.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Define and differentiate engineering materials on the basis of structure and properties for engineeringapplications.	L2: Understanding
CO2	:	Explain the various applications of nanomaterials.	L3:Applying
CO3	:	Discuss the fabrications of composites and nano composites.	L2: Understanding
CO4	:	Describe the charactrization of nanomaterials using SEM & TEM.	L4: Analyzing
CO5	:	Apply the applications of nanomaterials.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
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

PROFESSIONAL ELECTIVE COURSES - VERTICALS FOR HONOURS

<table>
<tr><td>22CEH101</td><td colspan="4">BRIDGE ENGINEERING
(Use of IS 1893 (part 1) 2016,IRC6(2014); IRC 7(2017); IRCS(2015) & IRC 112</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td colspan="2">3</td></tr>
<tr><td colspan="3" rowspan="2">Basic Structural Analysis, Foundation Engineering

Transportation Engineering</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">3</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To impart knowledge about loads on bridges and selection of type of bridge for the site condition.</td></tr>
<tr><td>2</td><td colspan="8">To impart knowledge about the super structure by various methods.</td></tr>
<tr><td>3</td><td colspan="8">To impart knowledge about the trussed bridge and plate girder bridges.</td></tr>
<tr><td>4</td><td colspan="8">To impart knowledge about reinforced concrete slab and T beam bridges and prestressed concrete bridges.</td></tr>
<tr><td>5</td><td colspan="8">To impart knowledge about the appropriate sub structural systems, bearings and expansion joints for the bridges.</td></tr>
<tr><td>Unit I</td><td colspan="3">INTRODUCTION</td><td>9</td><td>0</td><td>0</td><td colspan="2">9</td></tr>
<tr><td colspan="9">History of bridges - Components of a bridge - Classification of road bridges - Selection of site and initial decision process - Survey and alignment; Geotechnical investigations and interpretations. River Bridge: Selection of Bridge site and planning - Collection of bridge design data - Hydrological calculation Road Bridges - IRC codes - Standard Loading for Bridge Design - Influence lines for statically determinate and indeterminate structures - Transverse distribution of Live loads among deck longitudinal - Load combinations for different working state and limit state designs Railway Bridges: Loadings for Railway Bridges; Railroad data. Pre-design considerations - Railroad versus Highway bridges.</td></tr>
<tr><td>Unit II</td><td colspan="3">SUPERSTRUCTURES</td><td>9</td><td>0</td><td>0</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Bridge decks – Structural forms and behavior – Choices of superstructure types – Behavior and modeling of bridge decks – Simple beam model – Plate model – Grillage method – Finite Element method - Different types of superstructures (RCC and PSC); Longitudinal Analysis of Bridge. - Transverse Analysis of Bridge - Temperature Analysis - Distortional Analysis - Effects of Differential settlement of supports - Reinforced earth structures</td></tr>
<tr><td>Unit III</td><td colspan="3">DESIGN OF STEEL BRIDGES</td><td>9</td><td>0</td><td>0</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Design of Truss Bridges – Design of Plate girder bridges.</td></tr>
<tr><td>Unit IV</td><td colspan="3">DESIGN OF RC AND PSC BRIDGES</td><td>9</td><td>0</td><td>0</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Design of slab bridges – T beam bridges – PSC bridges.</td></tr>
<tr><td>Unit V</td><td colspan="3">SUBSTRUCTURE, BEARINGS AND EXPANSION JOINTS, PARAPETS AND RAILINGS</td><td>9</td><td>0</td><td>0</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Substructure - Pier; Abutment - Wing walls- Importance of Soil-Structure Interaction - Types of foundations - Open foundation- Pile foundation- Well foundation- Simply supported bridge- Continuous Bridge - Bearings and Expansion Joints - Different types of bridge bearings and expansion joints - Parapets and Railings for Highway Bridges</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Ponnuswamy, S., Bridge Engineering, Tata McGraw – Hill, New Delhi, 1997.
2	Victor, D. J., Essentials of Bridge Engineering, Oxford and IBH Publishers Co., New Delhi, 1980.
3	Jagadeesh. T. R. And Jayaram. M. A., Design of Bridge Structures, Prentice Hall of India Pvt. Ltd., 2004
4	Raina. V. K., Concrete Bridge Practice, Tata McGraw Hill Publishing Company, New Delhi, 1991.
Reference Books:	
1	N. Rajagopalan, Bridge Superstructure, Narosa Publishing House, New Delhi, 2006.
2	Phatak D.R., "Bridge Engineering", Satya Prakashan, New Delhi, 1990.
3	IRC:6-2000 Standard specifications and code of practice for road bridges.
4	IS 1893(part 1) 2016: criteria for Earthqurake resistant design of structures
5	IRC.6 (2014) Standard specifications and code of practice for road bridges
6	IRC 7(2017) Recommended practice for sumbering culverts, bridges and tunnels
7	IRC 5(2015) Standard specifications and code of practice for road bridges.
8	IRC 112: code of practice for concrete road bridge.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify loads on bridges and selection of type of bridge for the site condition.	Remember
CO2	Analyze the super structure by various methods.	Understand
CO3	Design the trussed bridge and plate girder bridges.	Create
CO4	Design reinforced concrete slab and T beam bridges and prestressed concrete bridges.	Create
CO5	Decide the appropriate sub structural systems, bearings and expansion joints for the bridges.	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	-	2	2	3	-	-	-	-	-	3	-	-
CO2	1	1	3	-	2	2	1	-	-	-	-	-	1	-	-
CO3	3	1	3	-	2	2	2	-	-	-	-	-	3	-	-
CO4	3	1	3	-	2	2	2	-	-	-	-	-	3	-	-
CO5	3	1	3	-	2	2	3	-	-	-	-	-	2	-	-
Avg	2.6	1	3	-	2	2	2.2	-	-	-	-	-	2.4	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH102	REPAIR AND REHABILITATION OF STRUCTURES				Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
Construction Materials and Technology, Concrete Technology		**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- NDTtest – Introduction to nonlinear NDT test

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)**															

22CEH103	INDUSTRIAL STRUCTURES (Use of Is6533 (Part 1 and Part 2) IS 1343:2012 &IS 4998 :2015)			Semester			
PREREQUISITES		**Category**		**PE**	**Credit**		**3**
Design of Steel Structural Elements Advanced Steel Structures Prestressed Concrete Structures		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the requirements and planning of industrial structures
2	To understand functional requirements of structures
3	To analyze and design the steel industrial structures
4	To analyze and design R.C industrial structures
5	To know the concepts of prefabrication

Unit I	**PLANNING**	**9**	**0**	**0**	**9**
Classification of Industries and Industrial structures – General requirements for industries like cement, chemical and steel plants – types of frames – bracings – crane girders and columns – workshop sheds - -Planning and layout of buildings and components					
Unit II	**FUNCTIONAL REQUIREMENTS**	**9**	**0**	**0**	**9**
Lighting – Ventilation – Accounts – Fire safety – Guidelines from factories act.					
Unit III	**DESIGN OF STEEL STRUCTURES**	**9**	**0**	**0**	**9**
Industrial roofs – Crane girders – Mill buildings – Design of bunkers and silos					
Unit IV	**DESIGN OF R.C. STRUCTURES**	**9**	**0**	**0**	**9**
Concrete Silos and bunkers – Chimneys – Principles of folded plates and shell roofs – Machine foundations					
Unit V	**PREFABRICATION**	**9**	**0**	**0**	**9**
Principles of prefabrication – Prestressed precast roof trusses- Functional requirements for Precast concrete units					
					Total= 45 Periods

Text Books:

1	Duggal S.K., Limit State Design of Steel Structures, Tata McGraw-Hill Publishing Company, New Delhi, 2019.
2	Subramanian N., Design of Steel Structures, First edition, OXFORD university press, 2022
3	Purushothaman.P, Reinforced Concrete Structural Elements: Behaviour, Analysis and Design, Tata McGraw-Hill Publishing Company, 1984.

Reference Books:	
1	Henn W. Buildings for Industry, VolI and II, London Hill Books, 1995
2	Handbook on Functional Requirements of Industrial buildings, SP32 – 1986, Bureau of Indian Standards, New Delhi 1990
3	Course Notes on Modern Developments in the Design and Construction of Industrial Structures, Structural Engineering Research Centre, Madras, 1982
4	IS 6533 (part 1 and part2) 1989 code of practice for design and construction of steel chimneys
5	Is 1343:2012 Indian standard prestessed concrete code of practice
6	IS 4998:2015 Criteria for design of reinforced concrete chimneys
7	Is 8091: 2008 Indian Standard Industrial plant layout -code of safe practice

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge on planning of industrial structures.	Remember
CO2	Describe the functional requirements of structures	Understand
CO3	Analyze and Design steel industrial structures	Analyze
CO4	Analyze and Design R.C. industrial structures	Create
CO5	Explain the concepts of Prefabrication	Understand

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	1	2	-	-
CO3	3	2	3	2	-	-	-	-	-	-	-	2	2	-	-
CO4	3	2	3	2	-	-	-	-	-	-	-	2	2	-	-
CO5	-	1	1	-	-	-	-	-	-	-	-	1	2	-	-
Avg	3	2	2.25	2	-	-	-	-	-	-	-	1.6	2	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH104	PREFABRICATED STRUCTURES			Semester			
PREREQUISITES		**Category**	**PE**	**Credit**			**3**
Construction Materials, Design of Reinforced Concrete Elements		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives

1	To impart knowledge to students on modular construction,
2	To know about construction of different prefabricated elements
3	To acquire knowledge in different manufacturing methods.
4	To know about techniques for erection of prefabricated elements
5	To learn about various applications of prefabricated structures

Unit I	**GENERAL PRINCIPLES OF FABRICATION**	**9**	**0**	**0**	**9**

Comparison with monolithic construction – Types of prefabrication – site and plant prefabrication – Economy of prefabrication – Modular coordination – Standardization – Planning for Components of prefabricated structures – Disuniting of structures – Design of simple rectangular beams and I beams – Handling and erection stresses – Elimination of erection stresses – Beams, columns - Symmetrical frames.

Unit II	**PREFABRICATED ELEMENTS**	**9**	**0**	**0**	**9**

Roof and floor panels – Ribbed floor panel, Hollow core, concrete roof, massive slab floors – Pros and Cons – Wall panels – Footings – Joints for different structural connections – Effective sealing of joints for water proofing – Provisions for non-structural fastenings – Expansion joints in pre-cast construction.

Unit III	**PRODUCTION TECHNOLOGY**	**9**	**0**	**0**	**9**

Choice of production setup – Manufacturing methods – Support system – Conveyor system – Aggregate system – Fabrication process – Main, Secondary and Subsidiary process – Stationary and mobile production – Planning of production setup– Storage of precast elements – Dimensional tolerances – Acceleration of concrete hardening.

Unit IV	**HOISTING TECHNOLOGY**	**9**	**0**	**0**	**9**

Equipment for hoisting and erection – Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads – Design consideration – Risk identification and control – Control methods – Advantages and Disadvantages of using hoisting technology.

Unit V	**APPLICATIONS**	**9**	**0**	**0**	**9**

Designing and detailing of precast unit for factory structures – Purlins, Principal rafters, roof trusses, lattice girders, gable frames – Single span single storeyed frames – Single storeyed buildings – slabs, beams and columns – Precast concrete frame, wall and floor construction process and benefits.

Total= 45 Periods

Text Books:

1	Hubert Bachmann, Alfred Steinle, Precast Concrete Structures, 2nd Edition,2019
2	S.ElliottKim.Precast Concrete Structures, 2nd Edition,2017
3	L.Mokk, "Prefabricated Concrete for Industrial and Public Structures", Publishing House of the Hungarian Academy of Sciences, Budapest,1st Edition,1964.
4	I. T. Koncz, "Manual of Precast Concrete Construction", Vol. I, II, III & IV, Berlin,1st Edition,1971

Reference Books:	
1	CBRI, “Building materials and components”, India, 1990.
2	C.Z. Gerostiza, C HendriksonandD.R.Rehat., Knowledge based process planning for construction And manufacturing, Academic Press Inc., 2012.
3	Structural Design Manual, “Precast Concrete Connection Details”, Society for the Studies in the use of Precast Concrete, Netherland Betor Verlag, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Discuss the knowledge on the basics of prefabricated structure design principles.	Understand
CO2	Analyse the behaviour of various prefabricated structural members, floors, stairs, roofs and walls	Analyse
CO3	Summarize the Production and Storage of Precast elements	Understand
CO4	Summarize the hoisting methods of different structural elements	Understand
CO5	Explain the applications of various prefabricated units	Understand

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	1	-	1	-	-	-	-	-	1	-	-
CO2	3	1	1	1	1	-	1	-	-	-	2	-	1	1	-
CO3	3	1	1	-	1	-	1	-	2	-	2	-	-	-	1
CO4	3	1	1	-	1	-	1	-	2	-	2	-	-	-	1
CO5	3	1	3	2	1	-	1	-	-	-	-	1	-	2	-
Avg	3	1	1.4	1.3	1	-	1	-	2	-	2	1	1	1.5	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEH105</td><td colspan="4">FINITE ELEMENT ANALYSIS</td><td colspan="2">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">Strength of Materials, Advanced Structural Analysis</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To acquire knowledge about the basis of Finite Element theory, computer implementation of this theory and its practical applications.</td></tr>
<tr><td>2</td><td colspan="6">To understand various basic energy and weighted residual methods</td></tr>
<tr><td>3</td><td colspan="6">To Familiarize with principles of structural mechanics</td></tr>
<tr><td>4</td><td colspan="6">To impart knowledge on isoparametric and axisymmetric elements</td></tr>
<tr><td>5</td><td colspan="6">To study about the shape functions for linear and quadric models</td></tr>
<tr><td>Unit I</td><td colspan="2">ELEMENTS OF ELASTICITY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Basic principles of structural mechanics – Equations of equilibrium – Strain displacement relations –Stress strain relations–Plane stress and plane strain cases–Principles of Virtual work and minimum potential energy.</td></tr>
<tr><td>Unit II</td><td colspan="2">DIRECT STIFFNESS METHOD</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Steps in direct method of FEA – Element stiffness matrix – Global stiffness matrix – Boundary conditions – Problems on simple beams and Trusses.</td></tr>
<tr><td>Unit III</td><td colspan="2">ANALYSIS OF 2D/3D ELEMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Discretization - Basic element shapes - Element properties – Node numbering procedure – Convergence requirements – Generalised co-ordinates – Natural co-ordinates – Shape functions for linear & quadratic models – Stiffness matrix – Nodal load vector 2D or 3 D– Static condensation – Simple problems.</td></tr>
<tr><td>Unit IV</td><td colspan="2">INTRODUCTION TO ISOPARAMETRIC ELEMENTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Concept of sub, iso, super parametric elements – Gauss quadrature – Examples in one- and two-dimensional elements</td></tr>
<tr><td>Unit V</td><td colspan="2">SOLUTION TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Different solvers – Variational approach – Weighted mean residual methods like Collocation method, Sub domain method, Galerkin method and Least square method – Simple problems only.</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Tirupathi R. Chandrupatla and Ashok D. Belugundu , “Introduction to Finite Elements in Engineering”, Third Edition, Prentice Hall India Pvt Ltd, 2011</td></tr>
<tr><td>2</td><td>P.Seshu, “Textbook of Finite Element Analysis”, Prentice Hall India Pvt Ltd, 2008.</td></tr>
</table>

Reference Books:	
1	Rajasekaran.S., “Finite Element Analysis in Engineering Design”, Wheeler Publishing,2000.
2	S.S.Rao, “The Finite Element Method in Engineering”, Buttersworth-Heinemann publishing, 2000
3	Desai C S

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Understand the basic concepts involved in FEM theory	Understand
CO2	Apply the concepts on simple structural elements	Apply
CO3	Determine linear, quadratic and cubic shape functions for interpolation (for 1D, 2D and 3D Problems).	Analyze
CO4	Familiarise the formation of isoparametric elements	Analyze
CO5	Analyse elements subjected to axisymmetric	Analyze

COURSE ARTICULATION MATRIX

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

22CEH106	EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION			Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To learn analytical experimental methods using sophisticated instruments and interpretation of experimental data
2	To impart knowledge about the fundamental concepts of vibration measurement and signal acquisition.
3	To learn about the fundamental theory and use a device to measure a physical phenomenon.
4	To impart knowledge about the distress measurements
5	Understand the advanced non-destructive testing instruments used in construction industry

Unit I	FORCE AND STRAIN MEASUREMENTS	9	0	0	9

Strain gauges, Principle, Types, Performance and Uses-Photo elasticity, Principle and applications – Hydraulic jack and pressure gauges – Electronic load cell – Proving rings – Calibration of testing machines

Unit II	VIBRATION MEASUREMENTS	9	0	0	9

Characteristics of structural vibrations – Linear Variable Differential Transducer (LVDT) – Transducers for velocity and acceleration measurements – Vibration meter – Seismographs – Vibration analyzer – Electro dynamic exciters – Display and recording of signals – Cathode Ray Oscilloscope – XY plotters – Chart plotters – Digital and Acquisition systems - Principles and Applications.

Unit III	ACOUSTICS AND WIND FLOW MEASUREMENTS	9	0	0	9

Principles of pressure and flow measurements – Pressure transducer – Sound level meter – Venturi Meter and Flow meters – Wind tunnel and its use in structural analysis – structural modeling - Direct and indirect model analysis

Unit IV	DISTRESS MEASUREMENTS	9	0	0	9

Diagnosis of distress in structures- Crack observation and measurement – Corrosion of reinforcement in concrete– Half cell, construction and use – damage assessment – Controlled blasting for demolition

Unit V	NON-DESTRUCTIVE TESTING METHODS	9	0	0	9

Load testing of structures, buildings, bridges and towers – Rebound hammer – Ultrasonic testing, principle and applications – Moiré fringes – brittle coatings – Holography – Use of lasers for structural testing.

Total= 45 Periods

Text Books:

1	Sadhu Singh, “Experimental Stress Analysis” Khanna Publishers, New Delhi, 2009.
2	Karthick and Balaji S, “Applications and Techniques for Experimental Stress Analysis”, 2019.
3	Srinath L.S., et al, Experimental Stress Analysis, Tata McGraw Hill Co., New Delhi, 1984.

Reference Books:

1	Dalley.J.WandRiley.W.F., “Experimental Stress Analysis”, Tata McGraw Hill Book Co.
2	Sironi R.S and Radha Krishna H.C.,Mechanical Measurements, New Age International (P) Ltd.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize with various types of force and strain measuring devices	Understand
CO2	Select a measuring device for a vibration measurement	Remember
CO3	Conduct experiments to measure acoustics and wind flow	Apply
CO4	Measure the distress on structures.	Apply
CO5	Apply non destructive testing techniques on 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**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**
CO2	**1**	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**
CO3	**1**	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**
CO4	**1**	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**
CO5	**1**	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**
Avg	**1**	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEH107</td><td colspan="4">ADVANCED CONCRETE TECHNOLOGY
(Use of IS 456:2000; IS 10262 2019 (pg: 1 to 15) and ACI 211.1.91 pg: 1 to 13 21 to 23)</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td colspan="2">Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Construction materials and Construction Technology</td><td colspan="2" rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">Have a good knowledge about constituent materials in concrete.</td></tr>
<tr><td>2</td><td colspan="8">Understand the concept and procedure for concrete mix design as per IS code standards.</td></tr>
<tr><td>3</td><td colspan="8">Get awareness about the properties of fresh and hardened concrete.</td></tr>
<tr><td>4</td><td colspan="8">Understand about the durability properties and NDT on concrete.</td></tr>
<tr><td>5</td><td colspan="8">Know about the types of special concrete.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="3">CONCRETE MATERIALS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Cement -Review of manufacturing process- chemical composition, Bogue’s compounds, mechanism of hydration-heat of hydration-Aggregate-Review of types, sampling and testing, artificial aggregates - Chemical Admixtures- types, uses, mechanism of action - effects on properties of concrete - Mineral admixtures- types, chemical composition – physical characteristics - effects on properties of concrete - Rheology – basic concepts – Bingham model.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="3">MIX PROPORTIONING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Mix design - nominal mix- design mix – concept of mix design - variables of proportioning -general considerations - factors considered in the design of concrete mix- various methods ofmix design - design of concrete mix as per IS 10262-2019 - Statistical quality control of concrete – mean strength – standard deviation – coefficient of variation – sampling - testing - acceptance criteria.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="3">PROPERTIES OF CONCRETE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Properties of fresh concrete- workability-factors affecting workability - slump test compaction factor test- Vee Bee consistometer test- Properties of hardened concrete -modulus of elasticity, compressive strength, split tensile strength, flexural strength- effect of water cement ratio – maturity concept- Creep - factors affecting creep - effect of creep-Shrinkage- factors affecting shrinkage - plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="3">DURABILITY & NDT OF CONCRETE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Durability of concrete- Factors affecting durability - permeability- cracking-reinforcement corrosion; carbonation, chloride penetration, sulphate attack, acid attack, fire resistance; frost damage, alkali silica reaction, concrete in sea water -.

Non-destructive testing of concrete surface hardness test- ultrasonic pulse velocity method - penetration resistance- pull-out test core cutting - measuring reinforcement cover.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="3">SPECIAL TOPICS IN CONCRETE TECHNOLOGY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="9">Special concretes - lightweight concrete-heavy weight concrete - high strength concrete –high performance concrete - self compacting concrete -roller compacted concrete– fibre reinforced concrete - polymer concrete-pumped concrete - ready mix concrete – green concrete. Special processes and technology - sprayed concrete; underwater concrete, mass concrete; slip form construction, prefabrication technology- 3D concrete printing. Light Emitting concrete, ,Glasscrete, Hempcrete, Bio concrete, Self-healing concrete smart concrete, coconut shell aggregate concrete, geopolymer concrete, concrete with agricultural waste, ferrocement</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2016.
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.
Reference Books:	
1	Indian Standard Recommended Guide lines for Concrete Mix Design, IS:10262 – 2019, Bureau of Indian Standards, New Delhi.
2	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete IS:383-1970 R2011, Bureau of Indian Standards, New Delhi.
3	Gambhir. M.LConcrete technology, Volume I &II , Tata McGraw-Hill Book Company, Third print, 2003.
4	Krishna Raju N. Design of Concrete Mixes, CBS publishers. New Delhi, 2002.
5	IS 456:2000 Indian standard plain and rein forced concrete-code of practice
6	ACI 211.1.91 standard practice for selecting proportions for normal, Heavy weight and mass concrete.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To recall the properties and testing procedure of concrete materials as per IS code	Remember
CO2	To design concrete mix using IS Code Methods.	Apply
CO3	To describe the procedure of determining the properties of fresh and hardened concrete	Remember
CO4	To explain nondestructive testing of concrete	Remember
CO5	To describe the various special types of concretes	Remember

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	-	-	-	2	-	2
CO2	-	-	2	3	3	1	2	-	2	2	-	2	2	-	2
CO3	-	-	-	-	2	1	-	-	-	-	-	-	2	-	2
CO4	-	-	2	-	3	-	-	2	2	-	-	-	2	-	2
CO5	-	-	1	-	1	-	-	2	1	-	-	-	2	-	2
Avg	-	-	1.5	3	2	1	2	2	1.5	2	-	2	2	-	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

VERTICAL II – ENVIRONMENTAL ENGINEERING

<table>
<tr><td>22CEH201</td><td colspan="2">INDUSTRIAL WASTEWATER TREATMENT</td><td colspan="2">Semester</td><td></td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>PE</td><td>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">To identify the sources and types of industrial wastewater</td></tr>
<tr><td>2</td><td colspan="6">To assess the waste minimization techniques</td></tr>
<tr><td>3</td><td colspan="6">To evaluate and design industrial wastewater treatment technologies</td></tr>
<tr><td>4</td><td colspan="6">To plan common effluent treatment plants for treatment of industrial wastewater and disposal of sludge</td></tr>
<tr><td>5</td><td colspan="6">To determine the appropriate treatment methods for wastewater of various industries.</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">Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry –Sources and types of industrial wastewater – Nature and Origin of Pollutants – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling - generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.</td></tr>
<tr><td>Unit II</td><td colspan="2">INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Prevention & Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimisation Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period –Implementing & Promoting Pollution Prevention Programs in Industries.</td></tr>
<tr><td>Unit III</td><td colspan="2">INDUSTRIAL WASTEWATER TREATMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Flow and Load Equalisation – Solids Separation – Removal of Fats, Oil & Grease- Neutralisation – Removal of Inorganic Constituents – Precipitation, Heavy metal removal, Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Electrodialysis & Evaporation – Removal of Organic Constituents – Biological treatment Processes, Chemical Oxidation Processes, Advanced Oxidation processes – Treatability Studies.</td></tr>
<tr><td>Unit IV</td><td colspan="2">WASTEWATER REUSE AND RESIDUAL MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.</td></tr>
<tr><td>Unit V</td><td colspan="2">VARIOUS INDUSTRIAL WASTEWATER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining–Pharmaceuticals–Sugar and Distilleries- sugar and diary textiles</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Eckenfelder, W.W., “Industrial Water Pollution Control”, Mc-Graw Hill Publishers, 2000.
2	LawranceK.Wang, Yung Tse Hung, Howard H.Lo and Constantine Yapijakis “Handbook of Industrial and Hazardous waste Treatment”, Second Edition, 2004.
Reference Books:	
1	Metcalf & Eddy/ AECOM, "Water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies, 2007
2	Nelson Leonard Nemerow, “Industrial waste Treatment”, Elsevier, 2007.
3	Waste water Treatment for pollution control and reuse by Soli. J. Arceivala, Shyam. R. Asolekar, Tata Mcgraw Hill, 2007

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Identify the sources and types of wastewaters and its nature	Identify
CO2	Gain knowledge of Prevention & Control of Industrial Pollution	Remember
CO3	Suggest the suitable treatment technologies for the treatment of wastewater.	Evaluate
CO4	Know about CETP and reuse of treated wastewater.	Analyze
CO5	Assess the characteristics and treatment systems for wastewater from various industries	Evaluate

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	2
CO2	-	-	2	1	-	2	1	1	1	1	-	-	2	1	1
CO3	-	-	3	1	-	1	-	-	-	-	-	-	1	-	1
CO4	-	1	3	2	2	3	2	1	2	2	2	1	3	1	2
CO5	2	-	2	3	1	1	3	1	2	2	3	2	1	1	3
Avg	1.5	1	2.2	1.8	1.5	1.8	2	1	1.7	1.7	2.5	1.3	1.6	1.0	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH202	ENVIRONMENTAL IMPACT AND RISK ASSESSMENT			Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Environmental Law and Legislations in India		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To expose the students to the need and usefulness of EIA and ERA in environmental management and to develop the skill to prepare environmental management plan.
2	To illustrate the methodology, documentation of EIA and to know about the various impacts of development projects on environment.
3	To identify, predict and evaluate the economic, environmental and social impact of development activities and to know about the various impacts of development projects on environment and the mitigating measures.
4	To develop the skills to prepare environmental management plan using modern tools
5	To provide knowledge related to the broad field of environmental risk assessment and tools that can be used in predicting and managing human health risks

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Environmental Impact Assessment (EIA): Objectives, Principles of Process, Screening of projects- Legal provisions on EIA. Environmental risk assessment framework-Hazard identification.

Unit II	**METHODOLOGIES**	**9**	**0**	**0**	**9**

Methods of EIA –Check lists and Documentation – Matrices – Networks – Cost-benefit analysis – Analysis of alternatives – Case studies- Multi-storey Buildings, Bridges, Highways, Dam and Water supply projects

Unit III	**PREDICTION AND ASSESSMENT**	**9**	**0**	**0**	**9**

Prediction Methodologies-Assessment of Impact on land, water and air, noise, social, cultural flora and fauna- Mathematical models- public participation – Limitation of EIA- Case studies Multi-storey Buildings, Bridges, Highways, Dam and Water supply projects

Unit IV	**ENVIRONMENTAL MANAGEMENT PLAN**	**9**	**0**	**0**	**9**

Environment Protection Acts in India: Air, Water, Lake and River action programmes; Coastal zone management; pollution control boards, Management plans using GIS and RS tools

Unit V	**ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT**	**9**	**0**	**0**	**9**

Environmental hazards and risks- Tools for Environmental Risk Assessment-Risk Perception and Communication-Risk assessment methodologies- Exposure Assessment and Dose Response Analysis-Emergency Preparedness Plans -Case studies- practical applications

Total= 45 Periods

Text Books:

1	Canter, R.L., Environmental Impact Assessment, McGraw-Hill Inc., New Delhi, 1996.
2	Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
3	“ENVIRONMENTAL IMPACT ASSESSMENT” for Department of Technical education, Govt of Uttarakhand

Reference Books:	
1	Shukla, S.K. and Srivastava, P.R., Concepts in Environmental Impact Analysis, Common Wealth Publishers, New Delhi, 1992.
2	John G. Rau and David C Hooten (Ed)., Environmental Impact Analysis Handbook, McGraw-Hill Book Company, 1990
3	Judith Petts, Handbook of Environmental Impact Assessment Vol. I & II, Blackwell Science, 1999.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the importance of EIA and ERA in project development	Understand
CO2	Apply the mathematical modeling for EIA	Apply
CO3	Analyze different environmental attributes and selecting the environmental parameters affecting project	Analyze
CO4	Prepare the environmental management plan including the preparation, implementation and mitigation aspects	Create
CO5	Evaluate and predict the human health risks	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	2	1	1	1	1	1	1	-	2
CO2	3	2	1	2	3	3	2	-	1	1	2	2	2	-	2
CO3	3	2	1	3	3	3	2	-	1	1	2	2	2	-	2
CO4	-	2	1	-	1	2	2	1	3	1	2	2	3	-	3
CO5	-	1	-	1	-	1	2	1	2	1	1	1	1	-	2
Avg	1.2	1.4	0.6	1.2	1.4	2.4	2	0.6	1.6	1	1.6	1.6	1.8	-	2.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEH203</td><td colspan="4">ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td colspan="2">Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Environmental Impact and Risk Assessment
Environmental Law and Legislations in India</td><td colspan="2" rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To study the variable natures of our environmental resources and to understand their importance associated with our societal life.</td></tr>
<tr><td>2</td><td colspan="8">To study the variable categories of pollutants and their controlling measures</td></tr>
<tr><td>3</td><td colspan="8">To impart an understanding of systems approach to Environmental Management as per ISO 14000 and to evaluate the management plan using GIS tools</td></tr>
<tr><td>4</td><td colspan="8">To impart skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.</td></tr>
<tr><td>5</td><td colspan="8">To impart skills for the managing the usage of our natural resources without disrupting balance and stability of the natural system.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="3">ENVIRONMENTAL RESOURCES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="3">ENVIRONMENTAL POLLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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, flyash, thermal stations, nuclear power plants</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="3">ENVIRONMENTAL MANAGEMENT SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="3">ENVIRONMENTAL LAW AND POLICY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="3">ENERGY-ENVIRONMENT AND SUSTAINABLE DEVELOPMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
</table>

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	-	-
CO2	-	1	3	-	-	3	1	1	1	-	1	3	3	-	-
CO3	1	1	1	2	2	3	1	-	2	2	3	2	3	-	-
CO4	-	1	1	-	-	3	1	1	2	2	1	2	1	-	-
CO5	1	1	3	2	1	3	3	-	2	-	3	3	3	-	-
Avg	0.4	1	2	0.8	0.6	3	1.4	0.6	2	0.8	1.8	2.6	2.6	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEH204</td><td colspan="2">ENVIRONMENTAL LEGISLATIONS IN INDIA</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">Water Supply Engineering, Waste Water Engineering</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 pollution control acts for water pollution.</td></tr>
<tr><td>2</td><td colspan="6">To know the pollution control acts forair pollution</td></tr>
<tr><td>3</td><td colspan="6">To impart knowledge of National and international Environmental Policies and gain knowledge about decision making on environmental policies</td></tr>
<tr><td>4</td><td colspan="6">To impart knowledge of the management and handling of Industrial solid waste.</td></tr>
<tr><td>5</td><td colspan="6">To impart knowledge of the management and handling of E- waste.</td></tr>
<tr><td>Unit I</td><td colspan="2">THE WATER (PREVENTION & CONTROL OF POLLUTION) ACT, 1974</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Definitions-Salient features-Powers & functions of Regulatory agencies–Responsibilities of occupier, provisions relating to prevention & control-procedures to obtain consent-Monitoring and compliance mechanisms-legal provision for violation of Water(P&CP) Act-Case studies on water polluting industries-Textile dyeing, Paper Mills-Electroplating, Starch industries-inventorisation of new water polluting industry and its management-field visits.</td></tr>
<tr><td>Unit II</td><td colspan="2">THE AIR (PREVENTION & CONTROL OF POLLUTION) ACT, 1981</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Definition-Salient features- Powers & functions of Regulatory agencies -National ambient Air quality standards-Emission standards for industries specific- Responsibilities of occupier, provisions relating to prevention & control-procedures to obtain consent Monitoring and compliance mechanisms- legal provision for violation of Air(P&CP)Act- Case studies on Air polluting industries-Foundries, Cement, Thermal power plants- inventorisation of new Air polluting industry and its management - field visits</td></tr>
<tr><td>Unit III</td><td colspan="2">THE ENVIRONMENT (PROTECTION) ACT, 1986</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Genesis of the Act-Salient features-Role of Central Government-various notifications and rules – prohibition on import of genetically modified organisms-chemicals-hazardous wastes- Batteries management-Restriction on Ozone depleting substances-EIA notification-Sitting of industries-State level EIA Authorities-eco-mark-Control on noise pollution-coastal regulations- Monitoring and compliance mechanisms-Role of National Green Tribunals(NGT),Environmental courts & Public interest litigation -Case studies</td></tr>
<tr><td>Unit IV</td><td colspan="2">REGULATIONS ON INDUSTRIAL SOLID WASTE MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Restriction on Hazardous waste-Bio-medical wastes-Recycled plastic wastes - Municipal solid wastes e-waste-Salient features-Responsibilities of occupier/generator/local bodies/PCBs- Monitoring and compliance mechanisms-consent clearance, Authorization, Registration procedures for industry specific-Issues & Challenges-Best practices-Case studies on lead refining, engineering units, hospitals, plastic units, Municipal landfills -field visits</td></tr>
<tr><td>Unit V</td><td colspan="2">ELECTRONIC WASTE (MANAGEMENT AND HANDLING) RULES 201</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Definition-Environmental & Occupational Health hazards of e-waste-Salient features of E-waste Rules-Extended producers' responsibility-issues and challenges –Compliance and Consent Clearance mechanisms-Best practices of E-waste management-Case studies on E-waste recycling units, Bulk consumers, Collection Centers-field visits.</td></tr>
<tr><td colspan="7" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	P.Leelakrishnan., “Environmental Law in India”, Lexis Nexis 4th edition 2016.
2	Stuart Bell and Donald., “Environmental Law”, McGillinary sixth edition 2005
3	Shyam Divan and Armin Roseneranz, “Environmental law and policy in India”, Oxford University Press, New Delhi, 2017.
4	K.R.Gupta. “Environmental legislation in India”, Atlantic 2006.
5	E WASTE MANAGEMENT IN INDIA (2009), Electronics for you, www. efymag.com
Reference Books:	
1	Hilary Theisen and Samuel A, Vigil, George Tchobanoglous, “Integrated Solid Waste Management”, McGraw- Hill, New York, 1993
2	CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000
3	Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans, “Environmental Resources Management, Hazardous waste Management”, Mc-Graw Hill International edition, New York, 2001.
4	Vesilind P.A., Worrell W and Reinhart, “Solid waste Engineering”, Thomson Learning Inc., Singapore, 2002
5	David ong., “Source book on environmental Law”, 2001
6	www.envfor.nic.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Summarize the pollution control acts for water pollution	Understand
CO2	Summarize the pollution control acts for air pollution	Understand
CO3	Understand the National and international Environmental Policies and Apply the knowledge in Planning and decision making of Environmental policies	Apply
CO4	Understand the management and handling of Industrial solid waste and E- waste	Understand
CO5	Understand the management and handling of E- waste	Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	2	-	-	-	1	1	-	-	-
CO2	1	1	2	-	-	1	3	1	-	-	-	1	1	-	-
CO3	-	1	-	-	-	2	3	2	-	-	1	1	-	-	-
CO4	2	3	-	2	-	-	2	1	-	1	2	1	2	-	1
CO5	-	2	1	3	-	1	1	1	-	1	-	1	-	-	-
Avg	**0.6**	**1.4**	**0.6**	**1**	**-**	**0.8**	**2.2**	**1**	**-**	**0.4**	**0.8**	**1**	**0.6**	**-**	**0.2**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH205	ENVIRONMENTAL MICROBIOLOGY		Semester			
PREREQUISITES		Category	PE	Credit		3
NIL		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the basics of microbiology relevant to environmental engineering for students with little prior knowledge of the subject
2	To study the morphology, behavior and biochemistry of bacteria, fungi, protozoa, viruses, and algae and their role in nutrient cycle.
3	To understood the role microbial metabolism in a waste water treatment plant.
4	To know the role of microorganisms in contaminated water and the diseases caused.
5	To gain knowledge to conduct and test the toxicity due to various natural and synthetic products in the environment

Unit I	CLASSIFICATION AND CHARACTERISTICS	9	0	0	9

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology

Unit II	MICROBES AND NUTRIENT CYCLES	9	0	0	9

Distribution of microorganisms – Distribution / diversity of Microorganisms – fresh and marine, terrestrial – microbes in surface soil, Air – outdoor and Indoor, aerosols, bio safety in Laboratory – Extreme Environment – archae bacteria – Significance in water supplies – problems and control. Transmissible diseases. Biogeochemical cycles-Hydrological - Nitrogen, Carbon, Phosphorus, Sulphur, Cycle – Role of Microorganism in nutrient cycle.

Unit III	METABOLISM OF MICRO ORGANISMS	9	0	0	9

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics

Unit IV	PATHOGENS IN WASTEWATER	9	0	0	9

Introduction to Water Borne pathogens and Parasites and their effects on Human, Animal and Plant health, Transmission of pathogens – Bacterial, Viral, Protozoan, and Helminths, Indicator organisms of water – Coli forms - total coli forms, E-coli, Streptococcus, Clostridium, Concentration and detection of virus. Control of microorganisms; Microbiology of biological treatment processes – aerobic and anaerobic, □ -oxidation, β-oxidation, nitrification and denitrification, eutrophication. Nutrients Removal – BOD, Nitrogen, Phosphate. Microbiology of Sewage Sludge.

Unit V	TOXICOLOGY	9	0	0	9

Ecotoxicology – toxicants and toxicity, Factors influencing toxicity. Effects – acute, chronic, Test organisms – toxicity testing, Bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring, bioleaching

Total= 45 Periods

Text Books:	
1	Hurst, C.J. Manual of "Environmental Microbiology". 3rd Edition. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199- X.2007
2	Grerard J. Tortora, Berdell R. Funke, Christine and L. Case. Microbiology: An Introduction. Benjamin Cummings, U.S.A. 2004
3	StanleyE. Manahan, "Environmental Science andTechnology", Lewis Publishers.2000
Reference Books:	
1	Frank C. Lu and Sam Kacew, LU"s Basic Toxicology, Taylor & Francis, London 5th Ed, 2003
2	Prescott, L.M., Harley, J.P. and Klein, D.A. Microbiology. McGraw Hill, New York 2006
3	SVS. Rana, "Essentials of Ecology and Environmental Science", 3rd revised Edition, Prentice Hall of India Private Limited, 2007
4	Bajwa, G.S. "Practical Handbook on Public Health Engineering", Deep Publishers, Shimla, 2003

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understood the basics of microbiology and their diversity and on the genetic material in the living cell.	Understand
CO2	Understood and Describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem	Understand
CO3	Understood the role of microbial metabolism in a wastewater treatment plant.	Understand
CO4	Understood the role of microorganisms in a contaminated water and the diseases caused.	Understand
CO5	Evaluate test on toxicity due to various natural and synthetic products in the environment	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	1	1	-	-	3	3	-	-	1	-	1	1	-	-
CO2	-	-	-	-	-	3	3	-	-	1	-	1	1	-	-
CO3	-	2	1	-	-	3	3	-	-	1	1	1	1	-	-
CO4	-	1	1	-	-	3	3	-	1	1	1	1	-	-	-
CO5	2	1	1	2	-	3	3	-	3	2	-	2	2	-	-
Avg	0.4	1.2	0.8	0.4	-	3	3	-	0.8	1.2	0.4	1.2	1.0	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH206	WASTE MANAGEMENT TECHNIQUES			Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the characteristics, types and sources of solid wastes and the present scenario of solid waste management
2	To evaluate on-site processing, recycling and reuse of waste
3	To evaluate the need for economics in collection and transportation of solid waste and clearly discuss various types of collection systems
4	To gain knowledge about off-site processing of solid wastes and its recovery
5	To concise idea on various disposal options for solid waste

Unit I	SOURCES AND TYPES OF SOLID WASTES	9	0	0	9

Sources and types of solid wastes - Quantity – factors affecting generation of solid wastes; characteristics – methods of sampling and characterization-Effects of improper disposal of solid wastes – public health effects. Principle of solid waste management – social & economic aspects- Public awareness- Role of NGOs- Legislation.

Unit II	ON-SITE STORAGE & PROCESSING	9	0	0	9

On-site storage methods – materials used for containers – on-site segregation of solid wastes – public health & economic aspects of storage – options under Indian conditions – Critical Evaluation of Options.

Unit III	COLLECTION AND TRANSFER	9	0	0	9

Methods of Collection – types of vehicles – collection equipment – collection routes- transfer stations – selection of location, operation & maintenance; options under Indian conditions.

Unit IV	OFF-SITE PROCESSING	9	0	0	9

Processing techniques and Equipment; Resource recovery from solid wastes – composting, incineration, Pyrolysis - options under Indian conditions.

Unit V	DISPOSAL	9	0	0	9

Impacts of open dumping, site investigation and selection, sanitary land filling - Types, design criteria and design, Liners – Leachate collection & treatment.

Total= 45 Periods

Text Books:

1	Tchobanoglous G., Theissen H., and EIiassen R., “Solid Waste Engineering Principles and Management Issues”, McGraw Hill, New York.
2	Peavy, Rowe and Tchobanoglous, “Environmental Engineering”, McGraw Hill.

Reference Books:	
1	Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government ofIndia, NewDelhi, 2014.
2	Peavy S.W., Rowe D.R. and Tchobanoglous G. Environmental Engineering, McGraw Hill, New Delhi, 1985.
3	Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers, New Delhi

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the characteristics, types and sources of solid wastes and the present scenario of solid waste management	Remember
CO2	Analyze On-site processing of municipal solid wastes and apply knowledge for recycling and reuse of waste	Understand
CO3	Learn the collection methods of solid waste and to transfer it to the disposal site	Apply
CO4	Know about off-site processing of solid wastes and its recovery	Remember
CO5	Apply the effective solid waste disposal methods	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	1
CO2	-	3	-	-	-	2	1	-	-	-	1	-	3	2	2
CO3	1	-	2	-	-	3	-	-	-	-	1	-	2	2	-
CO4	1	2	1	-	1	2	1	1	1	1	1	-	3	1	2
CO5	2	1	1	1	1	1	2	-	2	-	1	1	3	1	1
Avg	1.3	1.8	1.5	1.0	1.0	2.0	1.3	1.0	1.5	1.0	1.0	1.0	2.6	1.6	1.5
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEH207</td><td colspan="5">UNIT OPERATIONS AND PROCESSES IN WATER AND WASTE WATER TREATMENT</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="3">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Waste Water Engineering</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 understand the various general unit operations in waste water treatment.</td></tr>
<tr><td>2</td><td colspan="7">To examine the physical unit operations and chemical unit processes.</td></tr>
<tr><td>3</td><td colspan="7">To gain the knowledge about chemical unit processes and to examine the biological unit processes</td></tr>
<tr><td>4</td><td colspan="7">To apply the unit operations and processes in waste water treatment methods</td></tr>
<tr><td>5</td><td colspan="7">To apply the unit operations and processes in Sludge disposal methods</td></tr>
<tr><td>Unit I</td><td colspan="3">GENERAL UNIT OPERATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Important Unit Operation- Gas Transfer, Ion transfer, Solute stabilization, Solids Transfer, Nutrient transfer- Miscellaneous operations- Solid concentration and stabilization</td></tr>
<tr><td>Unit II</td><td colspan="3">PHYSICOCHEMICAL TREATMENT PROCESSES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Role of Physical Unit operations – Preliminary Treatments-Screening, Principles of screening– different types of screens – Flow equalization and Aeration-Types - Skimming tank – grit chamber- Studies on filtration –characteristics of filter media – Coagulation and Flocculation -Sedimentation and Chemical Clarification-Types of settling- Batch studies on settling.</td></tr>
<tr><td>Unit III</td><td colspan="3">CHEMICAL AND BIOLOGICAL UNIT PROCESSES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Chemical Unit processes-Chemical precipitation, Adsorption, Water softening -Disinfection, Ion exchange, Electro dialysis – Photocatalysis

Biological Unit Processes-SVI-Aerobic process-Trickling filter, Activated sludge process, lagoons- An-aerobic process-sludge digestion, lagoons or ponds</td></tr>
<tr><td>Unit IV</td><td colspan="3">METHODS OF TREATMENT OF WASTEWATER</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Conventional Treatment Methods-Preliminary processes-Primary treatment-Biological treatment, their functions and efficiencies - Advanced waste water treatment- tertiary treatment- Application of unit operations and processes in wastewater treatment methods.</td></tr>
<tr><td>Unit V</td><td colspan="3">METHODS OF SLUDGE PROCESSING AND DISPOSAL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Sludge treatment processes-sludge thickening or concentration- Anaerobic digestion-Aerobic Digestion- Sludge Conditioning-Sludge Dewatering-Final disposal of sludge-Application of unit operations and processes in Sludge processing and disposal methods.</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	METCALF & EDDY, "Wastewater Engineering Treatment Disposal Reuse", Tata McGraw-Hill, New York, 2003 5th edition,2013
2	"WASTE WATER ENGINEERING", Dr. B.C. Punmia, Er. Ashok K. Jain, Dr. Arun K. Jain, LAXMI PUBLICATIONS(P)LTD
3	S.K.GARG, "Water supply engineering" and "Sewage waste disposal and air pollution engineering" (VOL 1 & 2), Khanna Publishers, 2017.
Reference Books:	
1	KARIA.G.L, "Wastewater treatment- Concepts and design approach", PHI learning private ltd, 2013.
2	WEBER, W.J. Physicochemical processes for water quality control, John Wiley and sons, New York, 1983. 5. S.K.GARG, "Water supply
3	"WATER SUPPLY ENGINEERING", Dr.B.C.Punmia, Er. Ashok K.Jain, Dr.ArunK.Jain, LAXMI PUBLICATIONS (P) LTD

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understood the various general unit operations in waste water treatment.	Understand
CO2	Examine the physical unit operations and chemical unit processes.	Analyse
CO3	Develop the knowledge about chemical unit processes and to examine the biological unit processes	Apply
CO4	Categorize the unit operations and processes in waste water treatment methods	Analyse
CO5	Categorize the unit operations and processes in Sludge disposal methods	Analyse

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	2	2	2	-	2
CO2	3	3	1	1	-	-	2	-	1	1	2	2	2	-	2
CO3	3	3	1	1	-	-	2	-	1	1	2	2	2	-	2
CO4	2	2	1	1	-	1	2	-	1	2	2	2	3	-	2
CO5	2	2	1	1	-	1	2	-	1	2	2	2	3	-	2
Avg	2.2	2.0	0.8	1	-	0.4	2	-	1	1.4	2	2	2.4	-	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH301	**SMART MATERIALS AND SMART STRUCTURES**		**Semester**				
PREREQUISITES		**Category**	**PE**	**Credit**		**3**	
Construction Materials and Technology		**Hours/Week**	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives

1	To Learn about different types of smart materials
2	To Study about advanced measuring instrument
3	To Understand about sensors and its functions
4	To Study about various actuator materials and their role
5	To Learn about Data acquisition system

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction to smart materials and structures – Instrumented structures functions and response – Sensing systems – Self-diagnosis – Signal processing consideration – Actuation systems and effectors.

Unit II	**MEASURING TECHNIQUES**	**9**	**0**	**0**	**9**

Strain measuring techniques using electrical strain gauges, types – Resistance – Capacitance – Inductance – Wheatstone bridges – Pressure transducers – Load cells – Temperature Compensation – Strain Rosettes.

Unit III	**SENSORS**	**9**	**0**	**0**	**9**

Sensing Technology – Types of Sensors – Physical Measurement using Piezo Electric Strain measurement – Inductively Read Transducers – The LVOT – Fibre optic Techniques. Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors –Spectroscopes – Fibre Optic Chemical Sensing Systems and Distributed measurement.

Unit IV	**ACTUATORS**	**9**	**0**	**0**	**9**

Actuator techniques – Actuator and actuator materials – Piezoelectric and electro strictive material – Magneto structure material – Shape memory alloys – Electrorheological fluids– Electromagnetic actuation – Role of actuators and actuator materials.

Unit V	**SIGNAL PROCESSING AND CONTROL SYSTEMS**	**9**	**0**	**0**	**9**

Data acquisition and processing – Signal processing and control for smart structures – Sensors as geometrical processors – Signal processing – Control system – Linear and Non-linear.

Total= 45 Periods

Text Books:	
1	U. C. Jindal – Experimental Stress Analysis – Pearson Education India, 1st Edition,2012
2	Brain Culshaw – Smart Structure and Materials – Artech House – Borton. London, 7th Edition,2004
Reference Books:	
1	J. W. Dally & W. F. Riley – Experimental Stress Analysis – Tata McGraw- Hill,2nd Edition,1978

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the knowledge on the self-diagnosis, functions and response of various smart materials	Understand
CO2	Explain the knowledge on instrumentation for measuring strains, load and deflection	Understand
CO3	Discuss the concepts of sensors parameters and characteristics	Understand
CO4	Explain about actuator techniques and Materials	Understand
CO5	Discuss the concepts of signal processing and control system	Understand

COURSE ARTICULATION MATRIX

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

22CEH302	CONSTRUCTION TECHNIQUES AND EQUIPMENT			Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Construction Practice		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To impart knowledge about the various construction techniques, practices and equipments
2	To impart knowledge about the various construction procedures for sub to super structure
3	To study equipment needed for construction of various types of structures from foundation to super structure.
4	To attain adequate knowledge in various tunneling techniques and piling techniques.
5	To introduce the students to advanced earthwork equipments.

Unit I	**EARTHWORK AND MATERIAL HANDLING EQUIPMENTS**	**9**	**0**	**0**	**9**
Fundamentals of earth work operations-Selection of equipment for earth work- Types of earth work equipment-Tractors, Motor graders, Scrapers, Front end waders, Earth movers. Material handling equipment-Forklifts and related equipment-Portable material bins-conveyors-hauling equipment					
Unit II	**EQUIPMEMTS FOR AGGREGATE PRODUCTION AND CONCRETING**	**9**	**0**	**0**	**9**
Crushers-Feeders-screening equipment-handling equipment-batchingand mixing equipment, hauling, pouring and pumping equipment, RMC equipment					
Unit III	**OTHER CONSTRUCTION EQUIPMENTS**	**9**	**0**	**0**	**9**
Equipment for Concreting Equipment for Foundation, Pile driving equipment, micro piling-Equipment for compaction -Equipment for dewatering and grouting Rehabilitation techniques.					
Unit IV	**SUBSTRUCTURE CONSTRUCTION**	**9**	**0**	**0**	**9**
Techniques for box jacking, pipe jacking, diaphragm wall construction-piling techniques-driving well and caisson-cofferdam -sheet piles-dewatering and stand by plant equipment for underground open excavation					
Unit V	**SUPERSTRUCTURE CONSTRUCTION**	**9**	**0**	**0**	**9**
Vacuum dewatering for concrete flooring-Techniques for continuous concreting operations - Concrete paving technology-Erection techniques of fall structures-pre stressing in high rise structures- aerial transporting					
					Total= 45 Periods

Text Books:	
1	Peurifoy, R.L., Ledbetter, W.B. and Schexnayder, C., "Construction Planning,Equipment and Methods", 5th Edition, McGraw Hill, Singapore, 1995.
2	Arora S.P. and Bindra S.P., "Building Construction, Planning Techniques and Method of Construction", Dhanpat Rai and Sons, 1997."Concrete Technology, Theory and Practice", S. Chand and Company Ltd, New Delhi, 2008.
3	Varghese, P.C. " Building construction", Prentice Hall of India Pvt. Ltd, New Delhi,2007. 4. Shetty, M.S,
4	Hopkinson and Kay J.D. *The lighting of buildings*, Faber and Faber, London

Reference Books:	
1	Jha J and Sinha S.K., "Construction and Foundation Engineering", Khanna Publishers, 1999.
2	Sharma S.C. “Construction Equipment and Management”, Khanna Publishers New Delhi, 2002.
3	Deodhar, S.V. “Construction Equipment and Job Planning”, Khanna Publishers,New Delhi, 2012.
4	Dr. Mahesh Varma, “Construction Equipment and its Planning and Application”,Metropolitan Book Company, New Delhi, 1983.
5	Gambhir, M.L, " Concrete Technology", Tata McGraw Hill Publishing Company Ltd,New Delhi,2004

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Apply engineering fundamentals and analysis to the planning, selection utilization of earthwork and material handling equipment	Apply
CO2	Describe Concreting and aggregate production equipment its application and utilization	Apply
CO3	Demonstrate various Equipment for Construction and Rehabilitation works.	Understand
CO4	Identify Sub-structure construction techniques and explain their utilization in Construction Industry	Understand
CO5	Apply appropriate techniques for the construction of Super-structures	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	3	-	3	1	-	-	-	-	2	-	1
CO2	-	-	-	2	2	2	1	1	-	-	-	-	2	-	1
CO3	-	-	-	2	2	2	1	2	-	-	-	-	2	-	1
CO4	-	-	-	2	2	3	2	3	-	3	-	-	2	-	1
CO5	-	-	-	2	2	3	2	3	-	3	-	-	2	-	1
Avg	-	-	-	2	2	2.5	1.8	2	-	3	-	-	2	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td>22CEH303</td><td colspan="4">PROJECT SAFETY MANAGEMENT</td><td colspan="2">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To know the basics of project & construction management & safety standards.</td></tr>
<tr><td>2</td><td colspan="7">To understand the concepts of construction planning and scheduling in terms of safety in the construction.</td></tr>
<tr><td>3</td><td colspan="7">To know the basis safety in material handling, storage and staking of construction materials.</td></tr>
<tr><td>4</td><td colspan="7">To understand the safety concepts of machinery and equipment management.</td></tr>
<tr><td>5</td><td colspan="7">To understand the various rules and regulations involved in safety in construction.</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="2">SAFETY ISSUES IN CONSTRUCTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Introduction to Construction Industry- Safety issues in construction- Human factors in construction safety management. Roles of various groups in ensuring safety in construction industry. Framing Contract conditions on safety, and related matters. Relevance of ergonomics in construction safety.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">SAFETY IN CONSTRUCTION OPERATIONS & CODAL PROVISIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Safety in various construction operations- Excavation- under- water works- under- pinning & shoring Ladders & Scaffolds- Tunneling- Blasting- Demolition- Pneumatic caissons- confined Space Temporary Structures. Indian Standards on construction safety- National Building Code Provisions on construction safety.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">MATERIAL HANDLING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Safety in material handling and equipments-Safety in storage & stacking of construction materials.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">CONSTRUCTION EQUIPMENTS & ITS SAFETY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Safety in these of construction equipments- Vehicles, Cranes, Tower Cranes, Lifting gears, Hoists & Lifts, Wire Ropes, Pulley blocks, Mixers, Conveyors, Pneumatic and hydraulic tools in construction. Temporary power supply.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="2">CONTRACT LABOR (R&A) ACT AND CENTRAL RULES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Definitions, Registration of Establishments, Licensing of Contractors, Welfare and Health provisions in the Act and the Rules, Penalties, Rules regarding wages. Building & Other Construction Workers (RE&CS) Act,1996 and Central Rules, 1998: Applicability, Administration, Registration, Welfare Board & Welfare Fund, Training of Building workers, General Safety, Health & Well fare provisions, Penalties.</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

Text Books:	
1	Kumar Neeraj Jha, “Construction Project Management, Theory and Practices” Pearson Education India, 2nd Edition,2015.
2	Srinath L S, “PERT/CPM Principles and Applications”, Affiliated East West Press (P) ltd, 3 rd Edition 2002.
3	Chitkara, K.K. “Construction Project Management Planning, Scheduling and Control”, Tata McGraw-Hill Publishing Co., New Delhi, 3rd Edition 2014.
4	Punmia B C and Khandelwal K K, “Project Planning and Control with PERT and CPM”, Laxmi Publications, 4thEdition 2016.
5	Chris Hendrickson and Tung Au, “Project Management for Construction – Fundamentals Concepts for Owners, Engineers, Architects and Builders”, Prentice Hall, Pitsburgh, 3rd Reprint 2012.
Reference Books:	
1	Civil Engineering Project Management 4Th Edition by Twort; Gordon Rees, Taylor & Francis
2	Handbook of Civil Engineering (Ready Reference for Practicing Engineers) By Prof. V. N. Vazirani & Prof. S.P. Chandola.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Carry out the resource planning, pre-contract planning and prepare safety measurements for projects.	Remember
CO2	Identify and smoothen the level of safety demand during project execution.	Understand
CO3	Handling the resources and safety management simultaneously.	Create
CO4	Managing safety in equipment and machinery requirements.	Analyze
CO5	Knowing and satisfies the Codal requirements and Laws	Apply

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

22CEH304	SUSTAINABLE AND GREEN BUILDING TECHNOLOGY			Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Construction Materials and Technology, Environmental Science and Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To Know various aspects of green buildings
2	To Use different steps involved in measuring environmental impact assessment.
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 AND DESIGN FEATURES**	**9**	**0**	**0**	**9**

Definition of Green Building, Benefits of Green Building, Components/ features of Green Building, Site selection, Energy Efficiency, Water efficiency, Material Efficiency, Indoor Air Quality.
Site selection strategies, Landscaping, building form, orientation, building envelope and fenestration, material and construction techniques, roofs, walls, fenestration and shaded finishes, advanced passive heating and cooling techniques, waste reduction during construction.

Unit II	**ENERGY AUDIT AND ENVIRONMENTAL IMPACT ASSESSMENT**	**9**	**0**	**0**	**9**

Meaning, Necessity, Procedures, Types, Energy Management Programs.
Introduction, EIA regulations, Steps in environmental impact assessment process, Benefits of EIA, Limitations of EIA, Environmental clearance for civil engineering projects.

Unit III	**ENERGY AND ENERGY CONSERVATION**	**9**	**0**	**0**	**9**

Renewable Energy Resources:
Solar Energy, Wind Energy, Ocean Energy, Hydro Energy, Biomass Energy.
Non-renewable Energy Resources: Coal, Petroleum, Natural Gas, Nuclear Energy, Chemical Sources of Energy, Fuel Cells, Hydrogen, Biofuels. Introduction, Specific objectives, present scenario, Need of energy conservation, LEED India Rating System and Energy Efficiency. Energy-saving houses, Green House, Passive house, Passive house construction, Low-energy house, Zero-energy house, Energy consulting, Energy efficiency:

Unit IV	**PRINCIPLES AND PLANNING OF GREEN BUILDING**	**9**	**0**	**0**	**9**

Features: Salient features of Green Building, Environmental design (ED) strategies for building construction.
Process: Improvement in environmental quality in civil structure Materials: Green building materials and products- Bamboo, Rice husk ash concrete, plastic bricks, Bagasse particle board, Insulated concrete forms. reuse of waste material-Plastic, rubber, Newspaper wood, Nontoxic paint, green roofing.
Housing modernization and management (building and construction safety, energy efficiency in housing, Property Refurbishment / Upgrade / Modernization / Renovation - Modular kitchens, bathrooms

Unit V	**RATING SYSTEM**	**9**	**0**	**0**	**9**

Introduction to (LEED) criteria, Indian Green Building council (IGBC) Green rating, Green Rating for Integrated Habitat Assessment. (GRIHA) criteria Heating Ventilation Air Conditioning (HVAC) unit in green Building Functions of Government organization working for Energy conservation and Audit(ECA) - National Productivity council (NPC) Ministry of New and Renewable Energy (MNRE) Bureau of Energy efficiency (BEE) -BER (Building Energy Rating) - Certificates – Plumbing and Electrical to heating efficiency

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, New 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 and its Design Features.	Understand
CO2	Assess Environmental Impacts.	Evaluate
CO3	Explain the concept of Energy and Energy Conservation.	Understand
CO4	Discuss the Principles and Planning of Green Building.	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**	**1**	**2**	**3**	-	-	**1**	**2**	**1**	**2**	-	-
CO2	-	**1**	**1**	**2**	-	-	-	**1**	-	**2**	-	-	**1**	**3**	-
CO3	-	-	**3**	-	**3**	-	-	-	-	**2**	-	-	-	-	-
CO4	**1**	-	-	-	**3**	-	-	-	-	**2**	**2**	-	-	-	-
CO5	**1**	**1**	**2**	**3**	**3**	-	-	-	-	**3**	**2**	-	-	**3**	-
Avg	**1**	**1**	**2**	**2**	**2.5**	**2**	**3**	**1**	-	**2**	**2**	**1**	**1.5**	**3**	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td colspan="2">22CEH305</td><td colspan="2">FUNCTIONAL PLANNING IN BUILDING SERVICES</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="3">PREREQUISITES</td><td>Category</td><td>PE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Construction Materials</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 general planning considerations and development control rules for different types of buildings</td></tr>
<tr><td>2</td><td colspan="7">To understand the relevant code and manuals for designing of building services</td></tr>
<tr><td>3</td><td colspan="7">To apply the principles of electrical and lighting and plumbing services for different uses in buildings</td></tr>
<tr><td>4</td><td colspan="7">To Plan and design the requirements for HVAC systems, fire-fighting and other necessary services for a various types building</td></tr>
<tr><td>5</td><td colspan="7">To incorporate the integrated planning and designing of necessary building services for better usage of buildings</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="2">GENERAL PLANNING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">classifications of buildings, Planning permissions, permitted activity, Area and height limitations, Community open spaces and amenities – Green Buildings-Intelligent buildings</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">ELECTRICAL SYSTEMS AND INSTALLATIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Basics of electricity – Single and three phase supply- Protective devices in electrical installation – types of earthing, Planning electrical wiring for building-Electrical layout for residential buildings</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">LIGHTING AND PLUMBING SERVICES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Classification of Lighting, -Energy conservation in lighting-Minimum level of illumination required for different types of buildings.
Principles of Water supply and distribution, Sanitation in buildings, Water Conservation measures – Plan and design of storm water drainage and rain water harvesting system. –Decentralized wastewater treatment system.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">HEATING VENTILATION AND AIR CONDITIONING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Behavior of Heat Propagation, General methods of Thermal Insulation- Basic principles of Ventilation-Systems of ventilation, Basic principles and essentials of Air Conditioning</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="2">FIRE FIGHTING AND MISCELLANEOUS SERVICES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Classification of buildings based on occupancy- fire fighting protection and fire resistance rating, planning considerations in building for Fire protection-fire detection and fire fighting installation in buildings.
Miscellaneous: Building safety and security systems - Elevators and Escalators their standards and uses - Acoustic services - Necessity of integrated planning and designing of different services in buildings</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>National Building Code of India -2005</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1</td><td>Development Control Rules by Chennai Metropolitan Development Agency - 2006</td></tr>
<tr><td>2</td><td>Energy Conservation Building Code – 2007</td></tr>
<tr><td>3</td><td>CPHEEO Manual on Sewerage and sewage treatment systems – 2013</td></tr>
<tr><td>4</td><td>Manual for environmental clearance for large construction projects – by Ministry of environment, forest and climate change.</td></tr>
</table>

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the general planning considerations and development control rules for different types of buildings	Apply
CO2	Understand the Relevant code and manuals for designing of building services	Understand
CO3	Apply the principles of electrical and lighting and plumbing services for different uses in buildings	Apply
CO4	Plan and design the requirements for HVAC systems, fire fighting and other necessary services for a various types building	Apply
CO5	Incorporate the integrated planning and designing of necessary building services for better usage of buildings	Apply

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	2	-	2	2	2	3	-	-	3	1	3	-	-
CO2	-	-	2	-	3	2	2	3	-	-	3	2	3	-	-
CO3	-	-	2	-	3	3	3	3	-	-	3	2	3	-	-
CO4	-	-	3	-	3	3	3	3	-	-	3	2	3	-	-
CO5	-	-	3	-	3	3	3	3	-	-	3	2	3	-	-
Avg	-	-	2.4	-	2.8	2.6	2.6	3	-	-	3	1.8	3	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH306	BUILDING VALUATION				Semester		
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Construction Materials, Concrete Technology		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To study the different methods of valuation
2	To understand procedure of depreciation for all building.
3	To study rental Process, Calculations of Rent and Lease for Building
4	To Understand the Valuation of land
5	To Study the Environmental issues in valuation

Unit I	**INTRODUCTION TO VALUATION**	**9**	**0**	**0**	**9**
Definitions -Necessity of valuation -Valuation of building- Methods of Valuation-factors affecting the valuation building- Various types of valuation-Cost from record-Cost by detailed Measurement-Cost by plinth area methods.					
Unit II	**VALUATION ON DEPRECIATION**	**9**	**0**	**0**	**9**
Age of building- Effective age- Economic life and Remaining life- Depreciated replacement cost- Depreciation method of valuation Capitalized value – sinking fund – Escalation					
Unit III	**RENTAL FIXATION OF BUILDINGS**	**9**	**0**	**0**	**9**
Fixation of Rent-Gross rent-Net rent- Calculation of Standard rent-Methods of rental Calculation-rent Statement-Fixation and Calculation of Rent of government building- Mortgage-lease-building lease-Occupational lease-Easement.					
Unit IV	**VALUATION OF LAND**	**9**	**0**	**0**	**9**
Land Characteristics– Cost approach to values – Market approach to values– Income approach to values – limitation-Factors to be consider for land valuation-Valuation of Properties-valuation of special type of properties-Valuation of Agricultural lands.					
Unit V	**ENVIRONMENTAL ISSUES IN VALUATION**	**9**	**0**	**0**	**9**
Environment and Valuation – Difference between the market price and the negative value consequent on environmental impact – Environmental issues of air pollution, water pollution, environmental factors and their effects, measures to restore the damage cost to cure –Outlines of environmental legislation-Laws related to environmental protection acts-Case studies. Necessity — Valuation of land – Buildings – Lease.					
Total= 45 Periods					

Text Books:	
1	Dutta BN, Estimating & costing in Civil Engineering, UBS Publishers & Distributors Pvt. Ltd, 28th Edition 2020
2	Theory and practice of Valuation, Roshan H, Namavati, Lakshmi Book Deport Pvt Ltd, 1ST January 2016
3	Rangwala SC Estimating &Costing, CCharotar Publishing House Pvt Ltd, 1ST January 2017
4	Valuation of Immovable Properties, K.Dhivakar, Star Color Park India Pvt Ltd, 1ST January 2021

Reference Books:	
1	M. Chakraborty, Estimation, costing, Specification & Valuation in Civil Engineering, Charotar Publishing House Pvt Ltd1st January 2006
2	Valuation of Relating of standard Rent, Roshan H,Namavati, Lakshmi Book Deport Pvt Ltd, 1ST January 2016
3	Valuation of Real Property, Shymles Datta, Syamales Datta Pvt Ltd, 1st Edition 2016
4	Law of Land Acquisition and Compensation, V.G.Ramachandran Eastern Book Co 8th Edition 2020.
5	Environmental Protection Act 1986.Universal/ LexisNexis, 31 December 2020

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand knowledge in valuation of building.	Understand
CO2	Analyze the Depreciation values of building.	Analyze
CO3	Evaluate the Rental Fixation of Building.	Evaluate
CO4	Understand knowledge in valuation of land.	Understand
CO5	Remember the Environmental issues in Valuation	Remember

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	-	2	-	-	-	-	-	-	1	-	3	-
CO2	2	3	2	-	-	-	-	-	-	-	-	1	-	3	-
CO3	2	2	1	-	1	-	-	1	-	-	-	1	-	2	-
CO4	2	2	1	-	1	-	-	-	-	-	-	1	-	2	-
CO5	2	2	3	-	1	2	3	-	-	-	-	1	1	2	-
Avg	2	2.2	1.8	-	1.2	2	3	1	-	-	-	1	1	2.4	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CEH307	QUALITY CONTROL AND ASSURANCE IN CONSTRUCTION				Semester		
PREREQUISITES			**Category**	**PE**	**Credit**		**3**
Construction Management			**Hours/Week**	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Learning Objectives

1	To impart basic knowledge about the basics of quality management and quality plan.
2	To introduce the students about the preparation of quality system documentation.
3	To make the students acquire a wide knowledge in the key drivers on methods about the quality policies.
4	To learn the methods of techniques and their needs for quality assurance and quality control
5	To make the students understand the quality construction techniques

Unit I	**QUALITY MANAGEMENT**	**9**	**0**	**0**	**9**

Introduction – Definitions and objectives – Factor influencing construction quality - Responsibilities and authority - Quality plan - Quality Management Guidelines – Quality circles.

Unit II	**QUALITY SYSTEMS**	**9**	**0**	**0**	**9**

Introduction - Quality system standard – ISO 9000 family of standards – Requirements –Preparing Quality System Documents – Quality related training – Implementing a Quality system – Third party Certification.

Unit III	**QUALITY PLANNING**	**9**	**0**	**0**	**9**

Quality Policy, Objectives and methods in Construction industry - Consumers satisfaction, Ergonomics - Time of Completion - Statistical tolerance – Taguchi's concept of quality – Codes and Standards – Documents – Contract and construction programming – Inspection procedures - Processes and products – Total QA / QC programme and cost implication.

Unit IV	**QUALITY ASSURANCE AND CONTROL**	**9**	**0**	**0**	**9**

Objectives - Regularity agent, owner, design, contract and construction-oriented objectives, methods - Techniques and needs of QA/QC - Different aspects of quality - Appraisals, Factors influencing construction quality - Critical, major failure aspects and failure mode analysis, -Stability methods and tools, optimum design - Reliability testing, reliability coefficient and reliability prediction.

Unit V	**QUALITY IMPROVEMENT TECHNIQUES**	**9**	**0**	**0**	**9**

Selection of new materials - Influence of drawings, detailing, specification, standardization - Bill preparation - Construction activity, environmental safety, social and environmental factors - Natural causes and speed of construction - Life cycle costing - Value engineering and value analysis.

Total= 45 Periods

Text Books:

1	James, J.O' Brian, Construction Inspection Handbook – Quality Assurance and Quality Control, Van Nostrand, New York, 1989.
2	Kwaku, A., Tena, Jose, M. Guevara, Fundamentals of Construction Management and Organisation, Reston Publishing Co., Inc., Virginia, 1985.
3	Juran Frank, J.M. and Gryna, F.M. Quality Planning and Analysis, Tata McGraw Hill, 1993

Reference Books:

1	Hutchins.G, ISO 9000, Viva Books, New Delhi, 2000
2	Clarkson H. Oglesby, Productivity Improvement in Construction, McGraw-Hill, 1989.
3	John L. Ashford, The Management of Quality in Construction, E &F.N.Spon, New York, 1989.
4	Steven McCabe, Quality Improvement Techniques in Construction, Addison Wesley Longman Ltd, England. 1998.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand basic knowledge about the basics of quality management and quality plan.	Understand
CO2	To know the preparation of quality system documentation and their Standards.	Remember
CO3	Understanding the methods about the quality policies.	Understand
CO4	Apply the methods of techniques and their needs for quality assurance/ quality control and failure modes	Apply
CO5	To create the bill preparation for quality construction techniques	Create

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	-	-	2	-	-
CO2	2	-	-	-	-	-	-	-	-	3	2	2	1	-	-
CO3	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
CO4	-	-	-	1	3	-	-	-	-	-	1	1	1	-	-
CO5	1	1	-	1	3	-	-	-	-	-	1	1	1	-	-
Avg	1.5	1	-	1	3	1	-	-	1	2	1.2	1.2	1.2	-	-
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

ELECTIVES FOR MINOR

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="3">BUILDING CONSTRUCTION & EQUIPMENT</td><td colspan="2">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" align="right">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)**															

22CEM03	CONCRETE TECHNOLOGY				Semester		
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
NIL		**Hours/Week**	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	To understand the properties of ingredients of concrete.
2	To study the behavior of concrete at its fresh and hardened state.
3	To study about the concrete design mix.
4	To know about the procedures in concrete at different stage.
5	To understand special concrete and their uses.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Concrete materials, Cement: Field and laboratory tests on cement, Types of cement and their uses, different tests for aggregates. Methods for manufacturing of cement- Wet and dry process. Hydration of cement, Bogue's compound.

Unit II	**ADMIXTURES**	**9**	**0**	**0**	**9**

Accelerating admixtures, Retarding admixtures, water reducing admixtures, Air entraining admixtures, coloring agent, Plasticizers. Batching, Mixing, Transportation, placing of concrete, curing of Concrete

Unit III	**MIX DESIGN**	**9**	**0**	**0**	**9**

Factors influencing mix proportion, Mix design by ACI method and I.S. code method, Design of high strength concrete.

Unit IV	**BEHAVIOUR OF CONCRETE**	**9**	**0**	**0**	**9**

Strength of concrete, Shrinkage and temperature effects, creep of concrete, permeability of concrete, durability of concrete, Corrosion, Causes and effects, remedial measures, Thermal properties of concrete, Micro cracking of concrete.

Unit V	**SPECIAL CONCRETE**	**9**	**0**	**0**	**9**

Light-weight concrete, Fibre reinforced concrete, Polymer modified concrete, Ferro cement, Mass concrete, Ready-mix concrete, Self-compacting concrete, Quality control, Sampling and testing, Acceptance criteria.

Total= 45 Periods

Text Books:

1	Neville A.M Properties of Concrete, Pearson publication, 2012.
2	Shetty M.S Concrete technology, S.Chand and Company Ltd, New Delhi 2022.
3	Santha Kumar A.R Concrete Technology, Oxford university Press, NewDelhi, 2022.
4	Mehta K.P Concrete Technology, Chand & Co, NewDelhi, 2006.
5	Robert RatayForensic Structural Engineering Handbook, McGraw Hill LLC, 2009

Reference Books:	
1	Indian Standard Recommended Guide lines for Concrete Mix Design, IS:10262 – 2019, Bureau of Indian Standards, NewDelhi.
2	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete IS:383-1970 R2011, Bureau of Indian Standards, NewDelhi.
3	Gambhir.M.L,Concrete Technology, Volume I & II, Tata McGraw-HillBookCompany,Third print, 2003
4	Krishna Raju N. Design of Concrete Mixes, CBS publishers. NewDelhi, 2002.
5	Stephen E. Petty,Forensic Engineering: Damage Assessments for Residential and Commercial Structures,CRCpress,Taylor& Francis,2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To identify suitable materials to be used in the cement concrete by conducting various tests as per BIS code.	Evaluate
CO2	To know about the specific applications and uses of admixtures.	Understand
CO3	Design the concrete mix using ACI and BIS code methods.	Create
CO4	Determine the properties of fresh and hardened of concrete.	Evaluate
CO5	Design special concretes and to Ensure quality control while testing/ sampling and acceptance criteria for pre and post construction work.	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	3	-	1	1	1	2	1	1	1	-	1
CO2	-	-	-	-	3	-	3	-	1	1	-	-	2	-	1
CO3	-	-	-	-	3	-	3	-	-	1	-	-	1	-	1
CO4	-	-	-	-	3	2	1	-	-	-	-	-	-	-	1
CO5	-	-	-	-	3	3	3	1	1	3	1		3	-	1
Avg	-	-	-	-	3	2.5	2.2	1	1	1.75	1	1	1.75	-	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

<table>
<tr><td colspan="2">22CEM04</td><td colspan="2">ENVIRONMENTAL ENGINEERING</td><td colspan="3">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">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">To evaluate the sources of water and analyse its characteristics and processes in water treatment, express the analysis of distribution network</td></tr>
<tr><td>2</td><td colspan="7">To design sewer system, basic design of the biological treatment processes, gain knowledge on sludge treatment and its disposal</td></tr>
<tr><td>3</td><td colspan="7">To predict the sources, effects, dispersion of air pollutants air quality management and its control measures</td></tr>
<tr><td>4</td><td colspan="7">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</td></tr>
<tr><td>5</td><td colspan="7">To assess the sources, effects and control measures of noise pollution</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="2">WATER TREATMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="2">WASTEWATER TREATMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="2">AIR POLLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Air Pollution: Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality Index and limits.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="2">SOLID WASTE MANAGEMENT</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="2">NOISE POLLUTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Noise pollution: Sources; Health effects; Standards; Measurement and control methods</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Garg, S.K. Water supply Engineering, Khanna Publishers, New Delhi, 2010.</td></tr>
<tr><td>2</td><td>Garg, S.K. Sewage water disposal and Air pollution, Khanna Publishers, New Delhi, 2010.</td></tr>
<tr><td>3</td><td>George Tchobanoglous et.al., Integrated Solid Waste Management, McGraw-Hill, Publishers, 1993.</td></tr>
<tr><td>4</td><td>Rao, C.S., Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.</td></tr>
</table>

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)**															

<table>
<tr><td>22CEM06</td><td colspan="4">REPAIR AND REHABILITATION OF STRUCTURES</td><td colspan="3">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">NIL</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="7">Study the various types and properties of repair materials</td></tr>
<tr><td>2</td><td colspan="7">Learn various distress and damages to concrete structures</td></tr>
<tr><td>3</td><td colspan="7">Understand the importance of maintenance of structures</td></tr>
<tr><td>4</td><td colspan="7">Assess the damage to structures using various tests</td></tr>
<tr><td>5</td><td colspan="7">Learn various repair techniques of damaged structures, corroded structures</td></tr>
<tr><td>Unit I</td><td colspan="3">MAINTENANCE AND REPAIR STRATEGIES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Maintenance, repair and rehabilitation, Facts of Maintenance, importance of Maintenance various aspects of inspection, assessment procedure for evaluating a damaged structure, causes of deterioration.</td></tr>
<tr><td>Unit II</td><td colspan="3">SERVICEABILITY AND DURABILITY OF CONCRETE</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit III</td><td colspan="3">MATERIALS AND TECHNIQUES FOR REPAIR</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit IV</td><td colspan="3">REPAIRS, REHABILITATION AND RETROFITTING OF STRUCTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">Strengthening of Structural elements, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure.</td></tr>
<tr><td>Unit V</td><td colspan="3">DEMOLITION TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="8" align="right">Total= 45 Periods</td></tr>
</table>

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)**															

<table>
<tr><td>22CEM07</td><td colspan="4">GREEN BUILDING TECHNOLOGY</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="4">PREREQUISITES</td><td>Category</td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="4" 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="9">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="8">To Know various aspects of green buildings</td></tr>
<tr><td>2</td><td colspan="8">To Learn the principles of planning and orientation of buildings.</td></tr>
<tr><td>3</td><td colspan="8">To Relate the construction of green building with prevailing energy conservation policy and regulations.</td></tr>
<tr><td>4</td><td colspan="8">To Know and identify different green building construction materials.</td></tr>
<tr><td>5</td><td colspan="8">To Learn different rating systems and their criteria</td></tr>
<tr><td colspan="2">Unit I</td><td colspan="3">INTRODUCTION TO GREEN BUILDING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="2">Unit II</td><td colspan="3">SITE SELECTION AND PLANNING</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="2">Unit III</td><td colspan="3">ENERGY AND ENERGY CONSERVATION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="2">Unit IV</td><td colspan="3">BUILDING MATERIALS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="2">Unit V</td><td colspan="3">RATING SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="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.</td></tr>
<tr><td colspan="9" align="right">Total= 45 Periods</td></tr>
</table>

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	Title	L	T	P	TH
Unit I	LINEAR DATA STRUCTURES – LIST	9	0	0	9
Abstract Data Types (ADTs) – List ADT - Array based Implementation - Linked List Implementation – Singly Linked Lists - Circularly Linked Lists - Doubly-Linked Lists - Applications of Lists – Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).					
Unit II	LINEAR DATA STRUCTURES –STACKS AND QUEUES	9	0	0	9
Stack ADT - Operations - Applications of Stacks - Evaluating Arithmetic Expression - Conversion of infix to postfix Expression - Queue ADT - Operations - Circular Queue - DeQueue - Applications of Queue					
Unit III	NON LINEAR DATA STRUCTURES – TREES	9	0	0	9
Tree ADT – Tree traversals – Binary Tree ADT – Expression Trees – Applications of Trees – Binary Search Tree ADT – Threaded Binary Trees- AVL Trees – B-Tree – Heaps - Operations of Heaps - Priority Queues - Binary Heap - Max Heap - Min Heap - Applications of Heap.					
Unit IV	NON LINEAR DATA STRUCTURES – GRAPHS	9	0	0	9
Definition – Representation of Graphs –Types of Graphs - Graph Traversals - Breadth First Search - Depth First Search - Application of Graph Structures: Shortest Path Problem: Dijkstra's Algorithm - Minimum Spanning Trees: Prim's Algorithm - Kruskal's Algorithms					
Unit V	SEARCHING, SORTING AND HASHING TECHNIQUES	9	0	0	9
Searching: Linear Search - Binary Search - Sorting Algorithms - Insertion Sort - Selection Sort - Shell Sort - Bubble Sort - Quick Sort - Merge Sort - Radix Sort - Hashing: Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.					
					Total (45 L) =45 Periods

Text Books:	
1	Mark Allen Weiss, " Data Structures and Algorithm Analysis in C ", 4/E Pearson Education, 2013.
Reference Books:	
1	Seymour Lipschutz, "Data Structures With C ",(Schaum`s Outline Series) Published by Tata McGraw-Hill Education Pvt. Ltd., 2015
2	Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, "Fundamentals of Data Structures In C", Second Edition, Silicon Press, 2008.
3	Richard F.Gilberg & Behrouz A.Forouzan, "Data Structures: A Pseudo code Approach With C", Second Edition, Cengage Learning Publishers,2005.
4	Classic Data Structures", Second Edition by Debasis Samanta, PHI Learning, 2009.

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Level
CO1	Implement various abstract data types to solve real time problems by using Linear Data Structures	Apply
CO2	Apply the different Non-Linear Data Structures to solve problems	Apply
CO3	Analyze and implement graph data structures to solve various computing problems.	Analyze
CO4	Critically analyze the various sorting and searching algorithms	Analyze

22CSM03	COMPUTER ORGANIZATION AND DESIGN					
PREREQUISITES		**Category**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the basic structure and operations of digital computer
2	To learn the working of different arithmetic operations
3	To understand the different types of control and the concept of pipelining
4	To study the hierarchical memory system including cache memory and virtual memory
5	To understand the different ways of communication with I/O devices and standard I/O interfaces

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

Functional units ,Basic Operational Concepts, Bus Structure ,Memory Locations and Addresses, MemoryOperations, Instruction and Instruction Sequencing, Addressing modes.

UNIT II	**ARITHMETIC UNIT**	**9**	**0**	**0**	**9**

Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, BoothAlgorithm, Fast Multiplication, Integer Division, Floating point number operations.

UNIT III	**PROCESSOR UNIT AND PIPELINING**	**9**	**0**	**0**	**9**

Fundamental Concepts, Execution of Instruction, Multi Bus Organization, Hardwired control, Micro programmed control, Basic Concepts of pipelining, Data Hazards, Instruction Hazards ,Data path & Control Considerations.

UNIT IV	**MEMORY SYSTEMS**	**9**	**0**	**0**	**9**

Basic Concepts, Semiconductor RAM, ROM, Cache memory, Improving Cache Performance, Virtual memory,Memory Management requirements, Secondary Storage Device.

UNIT V	**INPUT AND OUTPUT ORGANIZATION**	**9**	**0**	**0**	**9**

Accessing I/O devices, Programmed I/O, Interrupts, Direct Memory Access, Interface circuits, Standard I/O Interfaces (PCI, SCSI, USB).

Total (45 L) =45 Periods

Text Books:

1	Carl Hamacher V.,Zvonko G.Vranesic, Safwat G. Zaky, " Computer organization ", Tata McGraw Hill,5th Edition, 200

Reference Books:

1	Patterson and Hennessey, “Computer Organization and Design ". The Hardware/Software interface,Harcourt Asia Morgan Kaufmann, 3rd Edition, 2007
2	Hayes, “Computer Architecture and Organization ", 3rd edition,Tata McGraw Hill, 2006
3	Heuring V.P., Jordan H.F., " Computer System Design and Architecture ", 6th edition ,Addison Wesley,2008

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the working principles of computer componets	Understand
CO2	Design the arithmetic and processing units	Create
CO3	Analyze the various computer components	Analyze

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22CSM04	ADVANCED OPERATING SYSTEMS			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
		Hours/Week	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Learning Objectives

1	To understand the structure and functions of Operating systems
2	To understand the process concepts and scheduling algorithms
3	To understand the concept of process synchronization and deadlocks
4	To learn various memory management schemes
5	To illustrate various file systems and disk management strategies

UNIT I	**INTRODUCTION AND OPERATING SYSTEM STRUCTURES**	**9**	**0**	**0**	**9**

Main frame Systems, Desktop Systems, Multiprocessor Systems, Distributed Systems, Clustered Systems, Real Time systems, Hand held Systems; Operating Systems Structures - System Components, Operating System Services, System calls, System Programs, System Design and Implementation.

UNIT II	**PROCESS MANAGEMENT**	**9**	**0**	**0**	**9**

Processes-Process Concepts, Process Scheduling, Operation on Processes, Co-Operating Processes, InterProcess Communication; Threads- Multithreading Models, Threading Issues; CPU Scheduling-Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

UNIT III	**PROCESS SYNCHRONIZATION AND DEADLOCKS**	**9**	**0**	**0**	**9**

Process Synchronization- The Critical Section Problem, Synchronization Hardware, Semaphores, Classical Problem of Synchronization, Monitors; Deadlocks- Deadlock Characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance ,Deadlock Detection, Recovery from Deadlock.

UNIT IV	**MEMORY MANAGEMENT AND VIRTUAL MEMORY**	**9**	**0**	**0**	**9**

Memory Management- Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging; Virtual Memory - Demand paging, Page Replacement, Thrashing.

UNIT V	**FILE SYSTEM AND MASS-STORAGE STRUCTURE**	**9**	**0**	**0**	**9**

File System Interface - File Concepts, Access methods, Directory Structure, File Sharing, File Protection; File System Implementation- File System Structure and Implementation, Directory Implementation, Allocation Methods, Free Space Management; Mass-Storage Structure - Disk Structure, Disk scheduling, Disk Management, RAID Structure; Case study: Linux system.

Total (45 L) =45 Periods

Text Books:

1	Abraham Silberschatz, P.B.Galvin, G.Gagne ―Operating System Concepts 6th edition, John Wiley & Sons, 2003.

Reference Books:

1	Andrew S. Tanenbaum, ―Modern Operating Systems, PHI , 2nd edition, 2001
2	D.M.Dhamdhere, "Systems Programming and Operating Systems ", 2nd edition, Tata McGraw Hill Company, 1999.
3	Maurice J. Bach, ―The Design of the Unix Operating System, 1st edition, PHI, 2004.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Identify the components and their functionalities in the operating system	Apply
CO2	Apply various CPU scheduling algorithms to solve problems	Apply
CO3	Analyze the needs and applications of process synchronization and deadlocks	Analyze
CO4	Apply the concepts of memory management including virtual memory and page replacement to the issues that occur in real time applications	Apply
CO5	Solve issues related to file system implementation and disk management	Apply

22CSM05	DATA COMMUNICATION AND COMPUTER NETWORKS			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**		**3**	
		Hours/Week	**L**	**T**	**P**	**TH**	
			3	**0**	**0**	**3**	

Course Learning Objectives

1	To study the concepts of data communications and functions of different ISO/OSI reference architecture
2	To understand the error detection and correction methods and also the types of LAN
3	To study the concepts of subnetting and routing mechanisms
4	To understand the different types of protocols and congestion control
5	To study the application protocols and network security

UNIT I	DATA COMMUNICATIONS AND PHYSICAL LAYER	9	0	0	9

Data Communication; Networks- Physical Structures (Types of Connections, Physical Topology),Categories of Networks, Interconnection of Networks: Internetwork; Protocols and Standards; Network Models-The OSI Model, Layers in the OSI Model, Addressing; Transmission media-Guided Media, Unguided Media.

UNIT II	DATA LINK LAYER	9	0	0	9

Introduction-Types of errors, Redundancy, Detection versus Correction, Modular Arithmetic; Block Coding-Error Detection and Correction (VRC,LRC,CRC, Checksum, Hamming Code);Data link Control- Flow Control (Stop- and-Wait, Sliding Window),Error Control (Automatic Repeat Request, Stop-and-wait ARQ, Sliding Window ARQ), HDLC; Local Area Networks-Ethernet, Token Bus, Token Ring, FDDI.

UNIT III	NETWORK LAYER	9	0	0	9

Network Layer services-Packet Switching-Network Layer Performance-IPv4 addresses-IPv6 addressing- Subnetting-Bridges-Gateways- Routers-Routing Algorithm-Distance Vector Routing, Link State Routing.

UNIT IV	TRANSPORT LAYER	9	0	0	9

Duties of the Transport layer-User Datagram Protocol-Transmission Control Protocol- Congestion Control and Quality of Service-Congestion, Congestion Control, Quality of Service, Techniques to improve QoS, Integrated Services.

UNIT V	PRESENTATION LAYER AND APPLICATION LAYER	9	0	0	9

Domain Name System - Domain Name Space, DNS in the Internet; Electronic Mail-FTP- HTTP- World Wide Web.

Total (45 L) =45 Periods

Text Books:

1	Behrouz A.Ferouzan, “Data Communications and Networking”, 4th Edition, Tata McGraw-Hill, 2007.

Reference Books:

1	Andrew S. Tanenbaum, “Computer networks “PHI, 4th edition 2008
2	William Stallings,” Data and computer communications”, 10th edition,PHI, 2012
3	Douglas E. comer,” Internetworking with TCP/IP-Volume-I”, 6th edition,PHI, 2008

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Classify the fundamentals of data communications and functions of layered architecture	Understand
CO2	Apply the error detection and correction methods and also identify the different network technologies	Apply
CO3	Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and routing technologies	Analyze
CO4	Illustrate the transport layer principles and reliable data transfer using protocols	Apply
CO5	Analyze the application layer protocols and also the use of network security	Analyze

22CSM06	PROGRAMMING ESSENTIALS IN PYTHON			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
		Hours/Week	**L**	**T**		**P**	**TH**
			3	**0**		**0**	**3**

Course Learning Objectives	
1	To learn Python data structures, conditional and control structures and files
2	To study Python Modules, packages, Functions and Exceptions.
3	To describe Object oriented programming features and Regular Expressions.
4	To learn about Web programming, GUI Programming and Database programming

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**
Python: Features - The Basics-Python Objects-Numbers-Sequences-Mapping and set types- Conditionals and loops-if statement-else statement-elif-Conditional Expressions-while statement-for statement-break-continue.					
UNIT II	**FUNCTIONS, MODULES AND PACKAGES**	**9**	**0**	**0**	**9**
Functions-Calling functions-Creating functions-Passing Functions-Formal Arguments-Variable length arguments-variable scope-Recursion, Modules-Packages.					
UNIT III	**FILES AND EXCEPTIONS**	**9**	**0**	**0**	**9**
Files and Input/ Output –Errors and Exceptions-Introduction-Detecting and handling Exceptions-Context Management-Raising Exceptions-Assertions-Standard Exceptions.					
UNIT IV	**OBJECT ORIENTED PROGRAMMING AND REGULAR EXPRESSIONS**	**9**	**0**	**0**	**9**
Object Oriented Programming Introduction-Classes-class Attributes-Instances-Instances attributes-Building and Method Invocation-Static methods and class Methods-Inheritance-Operator overloading - Regular Expressions-Network Programming – Multithreaded Programming					
UNIT V	**ADVANCED TOPICS**	**9**	**0**	**0**	**9**
GUI Programming- Web Programming-Database Programming					
					Total (45 L) =45 Periods

Text Books:	
1	Wesley J.Chun-“Core Python Programming” –Prentice Hall, Second Edition, 2006.
Reference Books:	
1	Swaroop C N, “ A Byte of Python “, ebshelf Inc., 1st Edition, 2013
2	“A Practical Introduction to python programming”, Brian Heinold,Mount St.Mary’s University,2012
3	Learning to Program with Python,” Richard L. Halterman”., Southern Adventist University

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Develop programs using control structures and files. .	Create
CO2	Create own Python Modules, packages, functions and Exceptions. .	Create
CO3	Illustrate Object oriented Programming features and Regular Expressions.	Apply
CO4	Create own Web programs, GUI and database programs.	Create

<table>
<tr><td>22CSM07</td><td colspan="3">ADVANCED DATABASE SYSTEM CONCEPTS</td><td colspan="2">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"></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 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

<table>
<tr><td>UNIT I</td><td>RELATIONAL DATABASES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT II</td><td>DATABASE DESIGN</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT III</td><td>TRANSACTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT IV</td><td>IMPLEMENTATION TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT V</td><td>ADVANCED TOPICS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6" align="right">Total (45 L) =45 Periods</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Abraham Silberschatz, Henry F.Korth and S.Sundarshan “Database System Concepts”, Sixth Edition,Tata McGraw Hi 2011.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td>1</td><td>Ramez Elamassri and Shankant B-Navathe, “Fundamentals of Database Systems”, Sixth Edition,Pearson Education, 2011.</td></tr>
<tr><td>2</td><td>C.J. Date, “An Introduction to Database Systems”, Eighth Edition, Pearson Education Delhi, 2008.</td></tr>
<tr><td>3</td><td>Raghu Ramakrishnan, ―Database Management Systems, Fourth Edition, McGraw-Hill CollegePublications, 2015.</td></tr>
<tr><td>4</td><td>G.K.Gupta,”Database Management Systems”, Tata McGraw Hill, 2011.</td></tr>
</table>

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

22CSM08	VIRTUALIZATION AND CLOUD COMPUTING			Semester			
PREREQUISITES		**Category**	**OE**	**Credit**			**3**
		Hours/Week	**L**	**T**	**P**		**TH**
			3	**0**	**0**		**3**

Course Learning Objectives

1	To introduce the broad perceptive of Parallel Computing, Distributed Computing and Cloud Computing.
2	To understand the concept of Virtualization
3	To identify the approaches of SLA and programming model in Cloud
4	To understand the Cloud Platforms in Industry and Software Environments.
5	To learn to design the trusted Cloud Computing system

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

Principles of Parallel and Distributed Computing – Elements of Parallel and Distributed Computing, Technologies for Distributed Computing; Vision of Cloud, Defining a Cloud, characteristics and benefits; Cloud Computing Architecture- Cloud Reference Model, Types of Clouds, Open Challenges.

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, Virtualization and Cloud computing, Pros and cons of Virtualization, Technology examples-Xen: Para virtualization, VMware: Full Virtualization.

UNIT III	**SLA MANAGEMENT IN CLOUD COMPUTING AND PROGRAMMING MODEL**	**9**	**0**	**0**	**9**

Traditional Approaches to SLA Management, Types of SLA, Life Cycle of SLA, SLA Management in Cloud; Data Intensive Computing - Technologies for Data Intensive Computing, MapReduce Programming Model.

UNIT IV	**CLOUD INDUSTRIAL PLATFORMS AND SOFTWARE ENVIRONMENTS**	**9**	**0**	**0**	**9**

Cloud Platforms in Industry - Amazon Web Service, Google App Engine; Cloud Software Environments –Eucalyptus, OpenNebula; Aneka Cloud Application Platform-Aneka Framework Overview, Anatomy of Aneka Container.

UNIT V	**CLOUD SECURITY AND APPLICATIONS**	**9**	**0**	**0**	**9**

An Introduction to the Idea of Data Security, The Current State of Data Security in the Cloud, Cloud Computing and Data Security Risk, Cloud Computing and Identity; The Cloud, Digital Identity, and Data Security, Content Level Security, Pros and Cons; Cloud Scientific Applications.

Total (45L) = 45 Periods

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	Title	L	T	P	TH
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	Title	L	T	P	TH
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	Title	L	T	P	TH
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	Title	L	T	P	TH
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	Title	L	T	P	TH
Unit V	**OPERATIONAL AMPLIFIERS AND ITS APPLICATIONS**	**9**	**0**	**0**	**9**

Basic structure and principle of operation - Calculation of differential gain - Common Mode gain, CMRR - OP-AMP design - DC and AC characteristics of OP-AMP. Applications: Inverting and non-inverting amplifiers - Integrator and Differentiator - Summing amplifier - Precision rectifier - Schmitt trigger and its applications - Active filters: Low pass, high pass, band pass and band stop filters - Sine wave oscillators – Comparator – Multi vibrator.

Total (45 L) = 45 Periods

Text Books:

1	B.Visvesvara Rao, K.Raja Rajeswari, P.Chalam Raju Pantulu, K.Bhaskara Rama Murthy, "Electronic Circuits-II", Pearson Education,2012
2	D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2011.

Reference Books:

1	Millman J. and Taub H., "Pulse Digital and Switching waveform", 3rd Edition, McGraw-Hill International , 2011.
2	Sedera& Smith, “Micro Electronic Circuits”, 4 th Edition, Oxford University Press, Chennai.
3	Michael Jacob, ‘Applications and Design with Analog Integrated Circuits’, Prentice Hall of India, 1996.
4	K.R.Botkar, ‘Integrated Circuits’, 10th edition, Khanna Publishers, 2010.
e-Reference:	
1	http://nptel.ac.in/courses/117105080/40
2	http://nptel.ac.in/courses/117108038/1
3	https://freevideolectures.com/course/2915/linear-integrated-circuits

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	To analyze small signal amplifiers and Large signal Amplifiers.	Applying
CO2	Analyze the frequency response characteristics of amplifiers	Applying
CO3	Develop insight of on oscillator design.	Applying
CO4	Construct and analyse tuned amplifiers and multivibrators.	Applying
CO5	Develop competence in linear and nonlinear Op amp circuit analysis.	Applying

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

22ECM04	SIGNAL PROCESSING					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To understand and perform Fourier and Laplace analysis on signals and systems respectively.
2.	To analyse the Discrete Fourier Transform, Fast Fourier Transform algorithms.
3.	To design and realize IIR, FIR filters.

Unit I	**INTRODUCTION TO SIGNALS AND SYSTEMS**	**9**	**0**	**0**	**9**

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

Unit II	**ANALYSIS OF SIGNAL AND SYSTEMS**	**9**	**0**	**0**	**9**

Introduction to Fourier Transform, Fourier Series, Relating the Laplace Transform to Fourier Transform, Frequency response of continuous time systems. Introduction to z- Transform.

Unit III	**DISCRETE FOURIER TRANSFORM**	**9**	**0**	**0**	**9**

Introduction to DFT – Properties of DFT - Circular convolution - FFT algorithms – Radix-2 FFT algorithms – Decimation in Time and Decimation in Frequency algorithms.

Unit IV	**INFINITE IMPULSE RESPONSE FILTER DESIGN**	**9**	**0**	**0**	**9**

Characteristics of Analog Butterworth filter - Chebyshev filter - Low pass filter, High pass filter, Band pass filter and Band stop filter - Transformation of analog filters in to equivalent digital filters using bilinear transformation method - Realization structure for IIR filters-Direct form - Cascade form - Parallel form.

Unit V	**FINITE IMPULSE RESPONSE FILTER DESIGN**	**9**	**0**	**0**	**9**

Linear phase response of FIR filter - FIR design using window method: Rectangular, Hamming, Hanning and Blackmann Windows - Park-McClellan's method - Realization structures for FIR filters - Linear phase structures and Direct form structure - Comparison of FIR and IIR filters.

Total (45L)= 45 Periods

Text Books:

1.	A.Anand Kumar, “Signals and Systems” , 3rd Edition, PHI, 2013.
2.	John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, 4th Edition, Pearson Education, 2009.

Reference Books:

1.	Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, “Signals and Systems”, 2nd edition, PHI Learning Private Limited, New Delhi, 2010.
2.	B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2009.
3.	Emmanuel C. Ifeacher, Barry W. Jervis, “Digital Signal Processing: A Practical Approach”, 2nd Edition, Pearson Education, 2004.
4.	S.K. Mitra, “Digital Signal Processing, A Computer Based approach”, 4th Edition, McGraw-Hill, 2010.

E-References:

1.	http://nptel.ac.in/courses/117104074/
2.	https://www.coursera.org/learn/dsp
3.	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse and understands different types of signals.	Analysing
CO2	Represent continuous signals and systems in time and frequency domain using different transforms.	Analysing
CO3	Analyse the need for Discrete Fourier Transform, Fast Fourier Transform algorithms in digital signals & systems.	Analysing
CO4	Design and realize IIR filters.	Applying
CO5	Design and realize FIR filters.	Applying

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	-	-	-	-	-	-	-	2	2	2
CO2	3	2	2	3	3	2	-	-	-	-	-	-	2	2	2
CO3	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO4	3	2	2	2	1	-	1	-	-	-	-	-	1	1	1
CO5	1	1	1	1	1	-	-	-	-	-	-	-	2	2	1
Avg	2.6	1.8	2	2.2	1.8	2	1						1.6	1.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM05	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

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

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

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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Describe and analyse the architecture of 8086 microprocessor and 8051 architectures.	Remembering
CO2	Develop assembly language programs and Interface peripherals with 8086.	Applying
CO3	Develop assembly language programs and Interface peripherals with 8051.	Applying
CO4	Determine application specific circuit for real-time applications.	Understanding
CO5	Associate appropriate PIC microcontroller for a given application.	Understanding

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	2	-	1	-	-
CO2	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO3	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	-	2	-	-	-	-	-	-	-	-	2	2	-
Avg	2	2	2	2	-	-	-	-	-	-	2	-	1.8	2	2

22ECM06	ANALOG AND DIGITAL COMMUNICATION					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	Understand analog and digital communication techniques.
2.	Learn data and pulse communication techniques.
3.	Be familiarized with source and Error control coding.

Unit	Title	L	T	P	TH
Unit I	**INFORMATION THEORY**	**9**	**0**	**0**	**9**
Uncertainty, information and entropy – Source coding theorem – Shannon Fano coding – Huffman coding – Discrete memoryless channels – Mutual information – Channel capacity – Channel coding theorem.					
Unit II	**ANALOG COMMUNICATION**	**9**	**0**	**0**	**9**
Noise: Source of Noise – External Noise- Internal Noise- Noise Calculation. Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).					
Unit III	**DIGITAL COMMUNICATION**	**9**	**0**	**0**	**9**
Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).					
Unit IV	**PULSE COMMUNICATION AND MULTIPLE ACCESS TECHNIQUES**	**9**	**0**	**0**	**9**
Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication System (PAM – PTM – PCM). Multiple access techniques: FDMA, CDMA, TDMA, SDMA.					
Unit V	**ERROR CONTROL CODING**	**9**	**0**	**0**	**9**
Linear block codes - Cyclic codes - Convolution codes – Maximum likelihood decoding of convolutional codes – Sequential decoding of convolutional codes – Trellis codes – Applications.					
					Total (45L)= 45 Periods

Text Books:	
1.	Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2014.
2.	J.G.Proakis, M.Salehi, ―Fundamentals of Communication Systems‖, Pearson Education 2014.
Reference Books:	
1.	B.P.Lathi, ―Modern Digital and Analog Communication Systems‖, 4th Edition, Oxford University Press, 2013.
2.	D.Roody, J.Coolen, ―Electronic Communications, 4th edition PHI 2015.
3.	B.Sklar, ―Digital Communications Fundamentals and Applications‖, 5th Edition Pearson Education 2017
4.	H P Hsu, Schaum Outline Series - ―Analog and Digital Communications‖ TMH, 5th edition 2006
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc21_ee74/preview
2.	https://nptel.ac.in/courses/117101051
3.	https://www.digimat.in/nptel/courses/video/117105143/L51.html

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO	:	Apply the concepts of Random Process to the design of Communication	Applying
CO	:	Apply analog and digital communication techniques.	Applying
CO	:	Understand the use of data and pulse communication techniques.	Understanding
CO	:	Analyze Source and Error control coding.	Analysing
CO	:	Design AM communication systems and Angle modulated communication	Applying

COURSE ARTICULATION MATRIX															
COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-	3	2	1
CO3	2	2	2	3	1	-	-	-	-	-	-	-	3	2	-
CO4	1	1	2	1	2	-	-	-	-	-	-	-	2	3	-
CO5	1	1	2	2	2	-	-	-	-	-	-	-	2	3	1
Avg	1.8	1.8	2	1.6	1.4	-	-	-	-	-	-	-	2.6	2.5	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM07	COMMUNICATION NETWORKS						
PREREQUISITES		CATEGORY	OE	Credit		3	
		Hours/Week	L	T	P	TH	
			3	0	0	3	

Course Objectives:	
1.	Understand the division of network functionalities into layers.
2.	Be familiar with the components required to build different types of networks
3.	Be exposed to the required functionality at each layer
4.	Learn the flow control and congestion control algorithms

Unit I	**FUNDAMENTALS & LINK LAYER**	9	0	0	9
Overview of Data Communications- Networks – Building Network and its types– Overview of Internet - Protocol Layering - OSI Mode – Physical Layer – Overview of Data and Signals - introduction to Data Link Layer - Link layer Addressing- Error Detection and Correction					
Unit II	**MEDIA ACCESS & INTERNETWORKING**	9	0	0	9
Overview of Data link Control and Media access control - Ethernet (802.3) - Wireless LANs – Available Protocols – Bluetooth – Bluetooth Low Energy – WiFi – 6LowPAN–Zigbee - Network layer services – Packet Switching – IPV4 Address – Network layer protocols (IP, ICMP, Mobile IP)					
Unit III	**ROUTING**	9	0	0	9
Routing - Unicast Routing – Algorithms – Protocols – Multicast Routing and its basics – Overview of Intradomain and interdomain protocols – Overview of IPv6 Addressing – Transition from IPv4 to IPv6					
Unit IV	**TRANSPORT LAYER**	9	0	0	9
Introduction to Transport layer –Protocols- User Datagram Protocols (UDP) and Transmiision Control Protocols (TCP) –Services – Features – TCP Connection – State Transition Diagram – Flow, Error and Congestion Control - Congestion avoidance (DECbit, RED) – QoS – Application requirements					
Unit V	**APPLICATION LAYER**	9	0	0	9
Application Layer Paradigms – Client Server Programming – World Wide Web and HTTP - DNS- Electronic Mail (SMTP, POP3, IMAP, MIME) – Introduction to Peer to Peer Networks – Need forCryptography and Network Security – Firewalls.					
Total (45L)= 45 Periods					

Text Books:	
1.	Behrouz A Forouzan, Data Communications and Networking, 4th Edition, 2020
2.	James F. Kurose, Keith W. Ross, Computer Networking - A Top-Down Approach Featuring the Internet, Seventh Edition, Pearson Education, 2016.
Reference Books:	
1.	Nader. F. Mir,“ Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2nd Edition, 2014.
2.	Alberto Leon-Garcia, IndraWidjajaCommunication Networks 2nd Edition McGraw-Hill Education, 2003
3.	Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, McGraw Hill Publisher, 2011.
4.	Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers, 2011.
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee61/preview
2.	https://www.ee.iitb.ac.in/~sarva/courses/EE706/2012/EE706LecNotes.pdf
3.	http://www.cs.kent.edu/~farrell/net01/lectures/

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

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	-	1	-	-	-	-	-	-	-	2	-	1
CO2	2	1	2	-	1	-	-	-	-	-	-	-	2	1	1
CO3	2	1	1	-	-	-	-	-	-	-	-	-	3	1	2
CO4	3	2	1	-	2	-	-	-	-	-	-	-	2	-	2
CO5	2	1	1	-	1	-	-	-	-	-	-	-	1	1	1
Avg	2.2	1.2	1.2	-	1.25	-	-	-	-	-	-	-	2	1	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM08	FUNDAMENTALS OF IOT					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To understand Smart Objects and IoT Architectures
2	To learn about various IOT-related protocols
3	To build simple IoT Systems using Arduino and Raspberry Pi
4	To understand data analytics and cloud in the context of IoT
5	To develop IoT infrastructure for popular applications

Unit I	FUNDAMENTALS OF IOT	9	0	0	9

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

Unit II	IoT PROTOCOLS	9	0	0	9

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

Unit III	DESIGN AND DEVELOPMENT	9	0	0	9

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

Unit IV	DATA ANALYTICS AND SUPPORTING SERVICES	9	0	0	9

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

Unit V	CASE STUDIES/INDUSTRIAL APPLICATIONS	9	0	0	9

Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – Grid Blocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

Total (45 L) = 45 Periods

Text Books:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2	ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015

Reference Books:

1	Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2).
2	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

3	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.
4	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
E-References:	
1	https://online.stanford.edu/courses/xee100-introduction-internet-things
2	https://www.udemy.com/topic/internet-of-things/
3	https://www.netacad.com/courses/iot

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of IoT.	Understanding
CO2	Analyze various protocols for IoT.	Applying
CO3	Design a PoC of an IoT system using Rasperry Pi/Arduino	Applying
CO4	Apply data analytics and use cloud offerings related to IoT.	Applying
CO5	Analyze applications of IoT in real time scenario	Analysing

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

22ECM09	WIRELESS SENSORS AND NETWORKING					
PREREQUISITE:		CATEGORY	OE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

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

Unit I	**ROUTING PROTOCOLS**	9	0	0	9
Elements of Ad hoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Ad hoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).					
Unit II	**ARCHITECTURES OF WSN**	9	0	0	9
WSN application examples, Types of applications, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Single-Node Architecture: Hardware Components, Energy Consumption of Sensor Nodes, Operating systems and execution environments Network Architecture: Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, gateway concepts.					
Unit III	**MAC PROTOCOLS AND ROUTING PROTOCOLS**	9	0	0	9
Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262 - ITU-T Recommendation H.263.					
Unit IV	**QUALITY OF SERVICE AND ADVANCED APPLICATION SUPPORT**	9	0	0	9
Quality of Service: Coverage and deployment, Reliable data transport, Single packet delivery, Block delivery, Congestion control and rate control - Advanced application support: Advanced in-network processing, Security and Application-specific support.					
Unit V	**SENSOR NETWORK PLATFORMS AND TOOLS**	9	0	0	9
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.					
					Total (45L) = 45 Periods

Text Books:	
1.	C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008
2.	Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.
Reference Books:	
1.	Feng Zhao and LeonidesGuibas, "Wireless sensor networks ", Elsevier publication - 2004.
2.	Charles E. Perkins, ―Ad Hoc Networking‖, Addison Wesley, 2000.
3.	William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004
4.	I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, Computer Networks, Elsevier, 2002, 394 - 422.
E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://nptel.ac.in/courses/106105183
3.	https://archive.nptel.ac.in/courses/106/105/106105160/

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

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	3	3	2	-	-	-	3	3	3	-	2
CO2	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
CO3	3	3	3	3	3	3	2	-	-	-	3	3	3	-	2
CO4	3	3	2	3	3	3	2	-	-	-	2	3	3	-	2
CO5	3	3	2	3	3	3	2	-	-	-	3	3	3	-	2
Avg	3	3	2	3	3	3	2	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM10	FUNDAMENTALS OF EMBEDDED SYSTEMS					
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
Microprocessors and Mmicrocontrollers		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To impart knowledge on embedded system architecture and embedded development Strategies
2	To understand the bus Communication in processors and peripheral interfacing
3	To understand basics of Real Time Operating System

UNIT I	**BASICS OF EMBEDDED SYSTEMS**	9	0	0	9

Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Examples - Programming Languages - Recent Trends in Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning - Development Environment.

UNIT II	**MEMORY MANAGEMENT AND INTERRUPTS**	9	0	0	9

Memory Access Procedure - Types of Memory - Memory Management Methods - DMA – Memory Interfacing - Polling Vs Interrupts - Types of Interrupts - Interrupt Latency - Interrupt Priority – Programmable Interrupt Controllers - Interrupt Service Routines

UNIT III	**COMMUNICATION INTERFACES**	9	0	0	9

Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth

UNIT IV	**REAL TIME OPERATING SYSTEMS**	9	0	0	9

Real-Time Concepts - Task Management - Task Scheduling - Classification of Scheduling Algorithms - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing - Priority Inheritance Protocol - Priority Ceiling Protocol - Inter Task Communication - Mutex - Semaphores - Message Queues - Timers - Commercial RTOS.

UNIT V	**VALIDATION AND DEBUGGING**	9	0	0	9

Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer – Background Debug Mode - InCircuit Emulator CASE STUDY: RFID Systems - GPS Navigation System – Development of Protocol Converter.

Total (45 L) = 45 Periods

Text Books:

1	Sriram V Iyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2	Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.

Reference Books:

1	Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003
2	Heath, "Embedded Systems Design‖", Newnes an Imprint of Elsevier, Massachusetts, 2003.
3	Tammy Noergaard, "Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013

E-References:

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

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Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Outline the concepts of embedded systems	Understanding
CO2	Understand the concept of memory management system and interrupts.	Understanding
CO3	Know the importance of interfaces.	Understanding
CO4	Understand real time operating system concepts.	Understanding
CO5	To realize the applications of validation and debugging.	Applying

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	-	-	-	-	-	-	3	3	3	-	2
CO2	3	3	2	3	-	-	-	-	-	-	3	3	3	-	2
CO3	3	3	3	3	-	-	-	-	-	-	3	3	3	-	2
CO4	3	3	2	3	-	-	-	-	-	-	2	3	3	-	2
CO5	3	3	2	3	-	-	-	-	-	-	3	3	3	-	2
Avg	3	3	2	3	-	-	-	-	-	-	2.8	3	3	-	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EEM01	LINEAR AND DIGITAL ELECTRONICS CIRCUITS		SEMESTER			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Electron Devices and Circuits		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on the characteristics& applications of Operation Amplifier, functional diagram and applications of linear ICs.
2.	To simplify the switching functions
3.	To design the combinational logic circuits and sequential logic circuits

Unit I	**OPERATIONAL AMPLIFIERS**	**9**	**0**	**0**	**9**

Operational amplifiers - Equivalent circuit, voltage transfer curve - Open loop Op-amp configurations –Voltage series, Voltage shunt feedback amplifiers configurations, closed loop differential amplifiers for single and differential outputs.
Output offset voltage, minimizing output offset voltage due to input bias current and input offset current, factors affecting off set parameters, CMRR - Open loop and closed loop frequency response of op-amps, circuit stability, slew rate and its effects in applications.

Unit II	**APPLICATION OF OPERATIONAL AMPLIFIER AND LINEAR ICS**	**9**	**0**	**0**	**9**

DC & AC amplifiers- Summing, Scaling and Averaging amplifiers-Instrumentation amplifier- Voltage to Current converter for floating and grounded loads - Current to voltage converter - Integrator, Differentiator. Voltage comparators - Zero Crossing Detector - Schmitt trigger with voltage limiter- Precision Rectifier Circuits-Peak Detector-Sample and Hold circuit, Active Filters - Frequency response characteristics of major active filters, first and higher order low pass and high pass filters, all pass filters.
Functional block diagram and Applications of Linear ICs: IC 555 Timer -IC 566 Voltage controlled oscillator- IC 565 Phase-locked loops - IC LM317 voltage regulators.

Unit III	**COMBINATIONAL LOGIC CIRCUITS**	**9**	**0**	**0**	**9**

Representation of logic functions: SOP and POS forms - Simplification of switching functions: K-maps method and QuineMcCluskey (Tabulation) method.
Design:Adders -Subtractors– 2 bit Magnitude Comparator-Multiplexer- Demultiplexer- Encoder - Priority Encoder - Decoder – Code Converters. Implementation of combinational logic circuits using multiplexers and Decoder.

Unit IV	**SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS**	**9**	**0**	**0**	**9**

Flip-flops: SR, D, JK and T- Conversion of flip-flops; Classification of sequential circuits: Moore and Mealy models - Analysis and design of synchronous sequential circuits - Design of synchronous counters- Universal shift register.

Unit V	**ASYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS**	**9**	**0**	**0**	**9**

Fundamental mode and pulse mode circuits , Analysis procedure of asynchronous circuits with /without using of SR latches-primitive state / flow table – Reduction of state and flow table - state assignment –Design Procedure of asynchronous circuits with /without using of SR latches-Problems in asynchronous sequential circuits: cycles -Races –Hazards.

Total (45L+0T) = 45 Periods

Text Books:

1.	Ramakant A Gayakward, “Op-Amps and Linear Integrated Circuits”, Fourth Edition, Pearson Education, 2003.
2.	Donald.E.Neaman, “Electronic Circuit, Analysis and Design”, Tata McGraw Hill Publishing Company Limited, Second Edition, 2002.
3.	D.Roy Chowdhury and Shail B. Jain, “Linear Integrated Circuits”, Fourth Edition, New Age International (P) Ltd Publishers, 2014.
4.	M. Morris Mano, “Digital Design” , Third Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2010 .
5.	S. Salivahanan and S. Arivazhagan, “Digital Circuits and Design”, Third Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 201

Reference Books:	
1.	Jacob Millman, Christos C.Halkias, “Integrated Electronics - Analog and Digital circuits system”, Tata McGraw Hill 2003.
2.	R.P.Jain, “Modern Digital Electronics”, Third Edition, Tata McGraw–Hill Publishing company limited, New Delhi, 2011.
3.	Thomas L. Floyd, “Digital Fundamentals”, Pearson Education, Inc, New Delhi, 2015
4.	Donald P.Leach and Albert Paul Malvino, “Digital Principles and Applications”, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2012.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Understand the Op-amp characteristics	L2: Understanding
CO2	:	Understand the applications of Op-amp and other linear ICs.	L2: Understanding
CO3	:	Apply K-map and Tadulation methods to simplify the switching functions	L3: Applying
CO4	:	Design and implement of combinational logic circuits	L6: Creating
CO5	:	Analyse and design of synchronous & asynchronous sequential logic circuits	L4: Analyzing

COURSE ARTICULATION MATRIX

CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1											2		
CO2	3	2	1	1									3		
CO3	3	2		2	2								3	3	
CO4	3	2	3	1	2							2	3	3	1
CO5	3	2	3	1	2							2	3	3	1
Avg.	**2.8**	**1.8**	**2.3**	**1.25**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2.8**	**3**	**1**

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

22EEM02	MICROPROCESSOR AND MICROCONTROLLER		SEMESTER			
PREREQUISTIES		**CATEGORY**	**PE**	**Credit**		**3**
C Programming		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To study the architecture of μP8085 and μC 8051.
2.	To study the Interrupt structure of 8085 and 8051.
3.	To do simple applications development with programming 8085 and 8051.

UNIT I	**8085 8 BIT MICROPROCESSOR**	**9**	**0**	**0**	**9**

Fundamentals of microprocessors – Architecture of 8085 – Groups of Instructions - Addressing modes – Basic timing diagram – Organization and addressing of Memory and I/O systems –Interrupt structure – Stack and sub-routines - Simple 8085 based system design and programming.

UNIT II	**8051 8 BIT MICROCONTROLLER**	**9**	**0**	**0**	**9**

Fundamentals of microcontrollers – Architecture of 8051 – Groups of Instructions - Addressing modes – Organization of Memory systems – I/O Ports – Timers/Counters – Serial Port - Interrupt structure – Simple programming concepts using Assemblers and Compliers.

UNIT III	**INTERFACING WITH 8051 MICROCONTROLLER**	**9**	**0**	**0**	**9**

Need and requirements of interfacing – Interfacing – LED, 7 segment and LCD Displays – Tactile switches, Matrix keyboard – Parallel ADC – DAC – Interfacing of Current, Voltage, RTD and Hall Sensors.

UNIT IV	**EXTERNAL COMMUNICATION INTERFACE**	**9**	**0**	**0**	**9**

Synchronous and Asynchronous Communication. RS232, RS 485, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.

UNIT V	**APPLICATIONS OF MICROCONTROLLERS**	**9**	**0**	**0**	**9**

Simple programming exercises- key board and display interface –Control of servo motor stepper motor control- Application to automation systems.

Total (45L+0T)= 45 Periods

Text Books:

1.	R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2.	K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004.
3.	Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.

Reference Books:

1.	R. Kamal, "Embedded System", McGraw Hill Education, 2009.
2.	D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

E-References;

1.	www.onlinecourses.nptel.ac.in/noc18_ee41
2.	www.class-central.com
3.	www.mooc-list.com

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand basics of microprocessor and microcontroller	L2: Understanding
CO2	:	Understand the architecture of Microprocessor and Microcontroller	L1: Remembering
CO3	:	Apply the digital concepts to measure and control simple electrical systems	L3: Applying
CO4	:	Design and interface communications between digital systems	L2: Understanding
CO5	:	Design a microcontroller based electrical control system.	L5: Evaluating

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	1	1								1	1	1	
CO2	2	1	1	1								1	1	1	
CO3	2	3	2	3	2							1	1	1	2
CO4	2	3	3	3	2							2	2	2	2
CO5	2	3	3	3	2							2	2	2	2
Avg.	**2**	**2.2**	**2**	**2.2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1.4**	**1.4**	**1.4**	**2**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEM03	CONTROL SYSTEMS			SEMESTER			
PREREQUISTIES		**CATEGORY**	**PE**	**Credit**		**3**
Electrical Machines and Electric circuit analysis		**Hours/Week**	**L**	**T**	**P**	**TH**
			1	**1**	**0**	**3**

Course Objectives:

1.	To understand the methods of representation of physical systems and getting their transfer function models.
2.	To provide adequate knowledge in the time response of systems and steady state error analysis.
3.	To give basic knowledge in obtaining the open loop and closed loop frequency response of systems.
4.	To understand the concept of stability of control system and methods of stability analysis.
5.	To study the designing compensators for a feedback control system.

UNIT I	**MODELLING OF LINEAR TIME INVARIANT SYSTEMS**	**6**	**9**	**0**	**9**

Basic elements in control systems – Open and closed loop systems – Feedback control system characteristics - Mathematical model and Electrical analogy of mechanical systems – Transfer function Representation– Synchro – AC and DC servo-motors – Block diagram reduction techniques – Signal flow graphs.

UNIT II	**TIME RESPONSE ANALYSIS**	**6**	**3**	**0**	**9**

Standard test signals – Time response of first order and second order systems –time domain specifications - Steady-state errors and error constants – Type and order of control systems – Effect of adding poles and zeros to transfer functions – Response with P, PI, PD and PID controllers.

UNIT III	**FREQUENCY RESPONSE ANALYSIS**	**6**	**3**	**0**	**9**

Correlation between time and frequency response: Second order systems – Frequency domain specifications - Polar plots – Bode plots – Computation of Gain Margin and Phase Margin –– Constant M and N-circles – Nichols chart.

UNIT IV	**STABILITY OF CONTROL SYSTEM**	**6**	**3**	**0**	**9**

BIBO stability – Necessary conditions for stability – Routh-Hurwitz stability criterion – Root locus concepts – Rules for the construction of Root loci – Nyquist stability criterion – Assessment of relative stability using Nyquist criterion.

UNIT V	**COMPENSATOR AND CONTROLLER DESIGN**	**6**	**3**	**0**	**9**

Need for compensation – Types of compensators – Electric network realization and frequency characteristics of basic compensators: Lag, lead and lag-lead compensators – Design of compensators using root locus and Bode plot techniques- PID controller: Design using reaction curve and Ziegler - Nichols technique.

Total (30L+15T) = 45 Periods

Text Books:

1.	A. Anand Kumar, "Control Systems", PHI Learning Pvt. Ltd., New Delhi, 2nd Edition, 2017.
2.	I.J. Nagrath, and M. Gopal, "Control Systems Engineering", New Age International Publishers, Delhi, 7th Edition, 2021.

Reference Books:

1.	K. Ogata, "Modern Control Engineering", Pearson Education, New Delhi, 5th Edition, 2021.
2.	M. Gopal, "Control Systems: Principles and Design", TMH, New Delhi, 4th Edition, 2018.

E-Reference

1.	https://nptel.ac.in/courses/107106081
2.	https://nptel.ac.in/courses/108106098

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Develop the transfer function models of any electrical and electro-mechanical systems.	L2: Understanding
CO2	:	Obtain the time responses of the systems and construct root locus plot.	L3: Applying
CO3	:	Analyze the frequency response of the system	L3: Applying
CO4	:	Analyze the absolute / relative stability of a control system.	L4: Analyzing
CO5	:	Design the compensators and PID controller of a feedback control system.	L3: Applying

COURSE ARTICULATION MATRIX														
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	2	2	2							1	3	2	1
CO2	3	3	3	2	2							1	3	2	1
CO3	3	3	3	2	2							1	3	2	1
CO4	3	3	3	2	2							1	3	2	1
CO5	3	3	3	2	2							1	3	2	1
Avg	**3**	**3**	**2.8**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEM04	MEASUREMENTS AND INSTRUMENTATION			SEMESTER			
PREREQUISTIES		CATEGORY		PE	Credit		3
Electric Circuit Analysis		Hours/Week		L	T	P	TH
				3	0	0	3

Course Objectives:

1.	To educate the fundamental concepts and characteristics of measurement System
2.	To introduce the fundamentals of electrical and electronic instruments for measurement of Electrical and Non-electrical quantities
3.	To familiarize Oscilloscope and the bridge circuits for electrical parameters measurement

UNIT I	INTRODUCTION	9	0	0	9

Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement. Measurement of voltage and current - permanent magnet moving coil and moving iron type meters

UNIT II	MEASUREMENT OF POWER , ENERGY AND FREQUENCY	9	0	0	9

Measurement of power - single and three phase- electrodynamometer type watt meters – Construction, operation – torque equation for deflection – errors. Measurement of energy-Single phase induction type energy meters, Instrument transformers – Current and Potential transformers, Power factor meters- Single phase electrodynamometer type power factor meter, frequency meter-Electrical resonance type frequency meter

UNIT III	DC AND AC BRIDGES	9	0	0	9

Balance equations - Wheatstone bridge – Kelvin double Bridge –Maxwell’s inductance capacitance bridge – Hay’s bridge – Anderson’s bridge – Schering bridge and De Sauty’s bridge

UNIT IV	POTENTIOMETERS, OSCILLOSCOPES AND DIGITAL INSTRUMENTS	9	0	0	9

DC Potentiometer- Crompton’s Potentiometer, AC potentiometer– Drysdale polar potentiometer- Gall Tinsley co-ordinate type potentiometer, Cathode Ray Oscilloscope and Digital storage Oscilloscope-Construction, operation and Applications, Digital multi-meters, Digital voltmeters.

UNIT V	MEASUREMENT OF NON-ELECTRICAL QUANTITIES	9	0	0	9

Classification of transducers –Position transducers, Piezo-electric transducers and Hall effect transducers. Measurement of pressure, temperature and displacement– Introduction to Smart Sensors

Total (45L+0T)= 45 Periods

Text Books:

1.	A.K. Sawhney, ‘A Course in Electrical & Electronics Measurement & Instrumentation’, Dhanpat Rai and Co, 2015
2.	E.O. Doebelin, ‘Measurements Systems- Application and Design’, Tata McGraw Hill publishing company, 2015.

Reference Books:

1.	D.V.S. Moorthy, ‘Transducers and Instrumentation’, Prentice Hall of India Pvt. Ltd, 2010.
2.	H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw Hill, 2015.
3.	Martin Reissland, ‘ Electrical Measurements’, New Age International(P) Ltd., Delhi, 2011.

E-Reference:

1	https://archive.nptel.ac.in/courses/108/105/108105153/

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the fundamentals of measurement system in electrical engineering.	L1: Remembering
CO2	:	Describe the working principle of different measuring instruments	L2: Understanding
CO3	:	Choose appropriate instrument for measuring the electrical parameters	L3: Applying
CO4	:	Employ the digital instruments in real time measurements.	L3: Applying
CO5	:	Select an appropriate transducer for measurement of non-electrical quantities	L4: Analysing

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	2	3				1		2		2	2	1	1
CO2	1	3			3					2		1	2	1	
CO3	1	1		2	1	1	2		1				1	2	1
CO4	1	1		1	1		2	2	1		2	2	1	3	1
CO5	2	2	3	1	2	2	1			1	3		1	2	
Avg	**1.4**	**1.8**	**2.5**	**1.75**	**1.75**	**1.5**	**1.67**	**1.5**	**1**	**1.67**	**2.5**	**1.67**	**1.4**	**1.8**	**1**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EEM05	ELECTRICAL MACHINES				SEMESTER		
PREREQUISTIES			**CATEGORY**	**PE**	**Credit**		**3**
			Hours/Week	**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on construction, working and performance of DC generators and motors.
2.	To deliberate the construction, working and performance of single phase and three phase transformers.
3.	To impart knowledge on construction, working and performance of synchronous generators and motors.
4.	To impart knowledge on construction, principle of operation and performance of single and three-phase induction motors.

UNIT I	**DC GENERATORS**	**9**	**0**	**0**	**9**

Principle of operation, constructional details, types - EMF equation, armature reaction, demagnetizing and cross magnetizing Ampere turns, compensating winding, commutation, methods of improving commutation, interpoles, Open circuit and load characteristics of different types of DC Generators. Parallel operation of DC Generators, applications of DC Generators.

UNIT II	**DC MOTORS**	**9**	**0**	**0**	**9**

Principle of operation, significance of back emf, torque equation and power developed by armature, load characteristics of shunt, series and compound type motors, starting methods, speed control methods - losses and efficiency calculation, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne's test, Hopkinson's test, Retardation test, Separation of core losses - applications of DC motors**.**

UNIT III	**TRANSFORMER**	**9**	**0**	**0**	**9**

Single phase transformer: Construction and principle of operation, working of practical transformer - equivalent circuit, voltage regulation, losses and efficiency- testing : polarity test, open circuit and short circuit tests, back-to back test, all day efficiency, parallel operation, applications.
Autotransformer: Construction and working, saving of copper - applications, **Three phase transformer**: construction, types of connections and their comparative features.

UNIT IV	**SYNCHRONOUS GENERATOR AND MOTOR**	**9**	**0**	**0**	**9**

Synchronous Generator: Constructional and working details – Types of rotors – EMF equation – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus - Synchronizing and parallel operation – Synchronizing torque - Voltage regulation – EMF, MMF and ZPF method – steady state power angle characteristics – Two reaction theory – slip test.

Synchronous Motor: Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power Developed -Hunting – natural frequency of oscillations – damper windings- synchronous condenser.

UNIT V	**THREE PHASE AND SINGLE PHASE INDUCTION MOTOR**	**9**	**0**	**0**	**9**

Three phase induction motor: Constructional details – Types of rotors –- Principle of operation – Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Starters: DOL, Autotransformer and Star delta starters – Speed control methods: Voltage control, Frequency control and pole changing – V/f control – Slip power recovery Scheme.

Single phase induction motor: Constructional details – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – split phase, Capacitor-start, capacitor start and capacitor run Induction motor.

Total (45L+0T)= 45 Periods

Text Books:

1.	I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5th Edition, 2017.

2.	P. S. Bimbhra, "Electric Machinery", Khanna Publishers, 2nd Edition, 2021.
3.	B.L.Theraja and A.K.Theraja," A text book of Electrical Technology - Volume-II", S.Chand & Company Ltd., New Delhi, 23rd Edition, 2009.
Reference Books:	
1.	B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers,3rd Edition, Reprint 2015.
2.	Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, First edition, 2010.
3.	A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 6th Education, 2017.
4.	Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 4th Edition 2017.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the construction and working principle of DC machines, and Interpret various characteristics of DC machines.	L2: Understanding
CO2	:	Compute various performance parameters of the machine, by conducting suitable tests.	L5: Evaluating
CO3	:	Describe the working principle of transformer, auto transformer, three phase transformer connection, and determine the efficiency and regulation.	L3: Applying
CO4	:	Understand the construction and working principle of Synchronous Machines.	L3: Applying
CO5	:	Understand the construction and working principle, speed control of three phase and single phase induction motor.	L5: Evaluating

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	1	1	1			1				1	3	2	1
CO2	3	3	1	1	1			1				1	3	2	1
CO3	3	3	1	1	1			1				1	3	2	1
CO4	3	3	1	1	1			1				1	3	2	1
CO5	3	3	1	1	1			1				1	3	2	1
Avg.	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**3**	**2**	**1**

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

22EEM06	ELECTRICAL DRIVES AND CONTROL			SEMESTER			
PREREQUISTIES		**CATEGORY**		**PE**	**Credit**		**3**
DC Machines and Transformers, Synchronous and Induction Machines, and Power Electronics		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To know about the operation analyse of chopper fed DC drive, both qualitatively and quantitatively.
2.	To understand the operation and performance of AC motor drives.

UNIT I	**DC MOTOR CHARACTERISTICS & CHOPPER FED DC DRIVES**	**9**	**0**	**0**	**9**

Review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed. Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper.

UNIT II	**MULTI-QUADRANT & CLOSED-LOOP CONTROL OF DC DRIVE**	**9**	**0**	**0**	**9**

Review of Four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, current controller specification and design, speed controller specification and design.

UNIT III	**INDUCTION MOTOR CHARACTERISTICS**	**9**	**0**	**0**	**9**

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency. Review of three-phase voltage source inverter, generation of three-phase PWM signals, constant V/f control of induction motor

UNIT IV	**CONTROL OF SLIP RING INDUCTION MOTOR**	**9**	**0**	**0**	**9**

Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery. .

UNIT V	**CONTROL OF SRM AND BLDC MOTOR DRIVES.**	**9**	**0**	**0**	**9**

SRM construction - Principle of operation - SRM drive design factors-Torque controlled SRM- Block diagram of Instantaneous Torque control using current controllers and flux controllers. Construction and Principle of operation of BLDC Machine - Sensing and logic switching scheme,-Sinusoidal and trapezoidal type of Brushless dc motors – Block diagram of current controlledd Brushless dc motor drive

Total (45L+0T)= 45 Periods

Text Books:

1.	G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2.	R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall,2010
3.	Bose B K, "Modern Power Electronics and AC Drives", Pearson Education New Delhi, 2010.

Reference Books:

1.	G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2012.
2.	W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

E-Reference

1	https://www.iith.ac.in/~ketan/drives.htmL

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the characteristics of dc motors and induction motors.	L2: Understanding
CO2	:	Summarize the operation of chopper fed DC drives.	L4: Analyzing
CO3	:	Understand the principles of speed-control of dc motors and induction motors.	L2: Understanding
CO4	:	Identify suitable power electronic converters used for dc motor and induction motor speed control.	L3: Applying
CO5	:	Analyze the SRM and BLDC motor drive control	L4: Analyzing

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1	3			1	1					1	3	2	
CO2	3	3	1	3		1	1					1	3	2	
CO3	3	3	3	3	1	1	1					1	3	2	
CO4	1	3	3	2	1	1	1					1	3	2	
CO5	3	3	3	3	1	1	1					1	3	2	
Avg.	**2.6**	**2.6**	**2.6**	**2.75**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**-**

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

<table>
<tr><td>22EEM07</td><td colspan="2">ELECTRIC VEHICLES 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">Electrical drives and control</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 knowledge on electric vehicle architecture and its configurations</td></tr>
<tr><td>2.</td><td colspan="6">To impart knowledge on vehicle control, use of energy storage systems and energy management in Electric Vehicle</td></tr>
<tr><td>UNIT I</td><td colspan="2">ELECTRIC VEHICLES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT II</td><td colspan="2">PLUG-IN HYBRID ELECTRICVEHICLES (PHEV) AND FUEL CELL ELECTRIC VEHICLES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT III</td><td colspan="2">ELECTRIC PROPULSION SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT IV</td><td colspan="2">ENERGY STORAGE SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT V</td><td colspan="2">ENERGY MANAGEMENT SYSTEM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td colspan="7" align="right">Total (45L+0T)= 45 Periods</td></tr>
<tr><td colspan="7">Text Books:</td></tr>
<tr><td>1.</td><td colspan="6">Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, Taylor & Francis Group, Second Edition ,2011.</td></tr>
<tr><td>2.</td><td colspan="6">Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, AliEmadi,, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles” CRC Press, 2016</td></tr>
<tr><td colspan="7">Reference Books:</td></tr>
<tr><td>1.</td><td colspan="6">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</td></tr>
<tr><td colspan="7">E-Reference:</td></tr>
<tr><td>1</td><td colspan="6">https://archive.nptel.ac.in/courses/108/106/108106170/</td></tr>
</table>

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)

22EEM08	ELECTRICAL ENERGY CONSERVATION AND AUDITING		SEMESTER			
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)															

22EEM09	SMPS AND UPS		SEMESTER			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Power Electronics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge about modern power electronic converters and their applications in power utility.
2.	To impart knowledge about Resonant converters and UPS.

UNIT I	**DC-DC CONVERTERS**	**9**	**0**	**0**	**9**

Introduction to SMPS – Non-isolated DC-DC converters: Cuk, SEPIC topologies, Z-source converter – Zeta converter - Analysis and state space modeling –- Concept of volt-second and charge balance – High gain input-parallel output-series DC-DC converter.

UNIT II	**SWITCHED MODE POWER CONVERTERS**	**9**	**0**	**0**	**9**

Isolated DC-DC converters: Analysis and state space modelling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters- control circuits and PWM techniques – Bidirectional DC-DC converters.

UNIT III	**RESONANT CONVERTERS**	**9**	**0**	**0**	**9**

Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS , Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control.

UNIT IV	**DC-AC CONVERTERS**	**9**	**0**	**0**	**9**

Introduction – Multilevel concept – Types of multilevel inverters – Diode-clamped MLI – Flying capacitors MLI – Cascaded MLI – Cascaded MLI – Applications – Switching device currents – DC link capacitor voltage balancing – Features of MLI – Comparisons of MLI.

UNIT V	**POWER CONDITIONERS, UPS, AND FILTERS**	**9**	**0**	**0**	**9**

Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for power electronic applications – Selection of capacitors.

Total (45L+0T)= 45 Periods

Text Books:

1.	Simon Ang, Alejandro Oliva,” Power-Switching Converters”, Third Edition, CRC Press, 2010.
2.	M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.

Reference Books:

1.	Ned Mohan, Tore.M.Undeland, William.P.Robbins, “Power Electronics Converters, Applications and Design”, 3rd Edition, John Wiley and Sons, 2006.
2.	M.H. Rashid, “Power Electronics circuits, devices and applications”, 3rd Edition, PHI, New Delhi, 2007.

E-References:

1.	NPTEL Course: Power Electronics, IIT-B.
2.	www.cdeep.iitb.ac.in. (Electrical Engineering)

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Analyze the state space model for DC – DC converters.	L4: Analyzing
CO2	:	Acquire knowledge on switched mode power converters.	L2: Understanding
CO3	:	Outline the PWM techniques for DC-AC converters.	L1: Remembering
CO4	:	Discuss about modern power electronic converters and its applications in electric power utility.	L2: Understanding
CO5	:	Identify the filters and UPS.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	2	2			1					2	2	2	1
CO2	1	1	3	2			1					2	3	3	2
CO3	2	2	2	3			1					1	2	2	1
CO4	2	1	1	2			1					2	2	3	2
CO5	1	1	2	1			1					1	2	2	1
Avg.	**1.6**	**1.2**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1.6**	**2.2**	**2.4**	**1.4**

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

22EEM10	UTILIZATION OF ELECTRICAL ENERGY			SEMESTER			
PREREQUISITES		**CATEGORY**		**PE**	**Credit**		**3**
Electrical Machines, Power System, and Power Electronics		**Hours/Week**		**L**	**T**	**P**	**TH**
				3	**0**	**0**	**3**

Course Objectives:

1.	To understand the economics of power generation, tariff and energy conservation methods.
2.	To impart knowledge on principle and design of illumination systems.
3.	To analyze the performance and different methods of electric heating and electric welding.
4.	To impart knowledge on electric traction systems and their performance.
5.	To understand electric drives for various industrial applications.

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

Economics of generation – definitions – load duration curve – number and size of generator units – Cost of electrical energy – tariff –– availability based Tariff- (ABT) – Battery Energy storage system (BESS)- Frequency based energy measurement - need for electrical energy conservation – methods.- Introduction to energy audit

UNIT II	**ILLUMINATION**	**9**	**0**	**0**	**9**

Introduction-nature of radiation – definition – laws of illumination – luminous efficacy-photometry – lighting calculations – design of illumination systems for residential, commercial, street lighting and sports ground– types of lamps –incandescent lamp- mercury vapour –fluorescent lamp-energy efficiency lamps – types of lighting schemes – requirements of good lighting

UNIT III	**HEATING AND WELDING**	**9**	**0**	**0**	**9**

Introduction- classification of methods of heating – requirements of a good heating material – design of heating element – temperature control of resistance furnace – electric arc furnace –induction heating – dielectric heating – electric welding – resistance welding – electric arc welding-electrical properties of arc-applications of electric arc welding.

UNIT IV	**ELECTRIC TRACTION**	**9**	**0**	**0**	**9**

Introduction – requirements of an ideal traction system – supply systems – train movement -mechanism of train movement – traction motors and control –speed control of three phase induction motor- multiple unit control – braking – recent trends in electric traction.

UNIT V	**DRIVES AND THEIR INDUSTRIAL APPLICATIONS**	**9**	**0**	**0**	**9**

Electric drive –advantages of electric drive-individual drive and group drive –factors affecting selection of motor – types of loads – steady state –transient characteristics –size of motor– load equalization – industrial applications – modern methods of speed control of D.C drives-dynamic braking using thyristors-regenerative braking using thyristors.

Total (45L+0T)= 45 Periods

Text Books:

1.	C.L. Wadhwa, “Generation, Distribution and Utilization of Electrical Energy”, New Age International Pvt.Ltd, 2003.
2.	Eric Openshaw Taylor, “Utilisation of Electric Energy”, English Universities Press Limited, 1937
3.	J.B. Gupta, “Utilization of Electric Power and Electric Traction”, S.K.Kataria and Sons, 2002.

Reference Books:

1.	G.C.Garg, S.K.Gridhar&S.M.Dhir, “A Course in Utilization of Electrical Energy”, Khanna Publishers, Delhi, 2003.
2.	H. Partab, “Art and Science of Utilization of Electrical Energy”, Dhanpat Rai and Co, New Delhi, 2004.

E-References:

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

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand the economics of power generation, tariff and energy conservation methods.	L2: Understanding
CO2	:	Interpret the concept behind illumination and design a suitable illumination system for a specific application.	L3: Applying
CO3	:	Design and choose an appropriate heating method for specific application and gain knowledge about electric welding system.	L4: Analyzing
CO4	:	Explain the concepts and recent trends of traction system.	L4: Analyzing
CO5	:	Discuss the concepts of electric drives and their characteristics.	L2: Understanding

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1	1	1	1	2	1	2	2	1	1	1	2	2	3
CO2	2	3	2	3	1	1	2	1	1			1	3	3	2
CO3	3	3	1	3	1	1	2	1					2	2	3
CO4	1	2	2	3	3	1	2	1					2	3	2
CO5	3	1	1	2	1	1	2	1		1		1	2	2	3
CO6	1	3	3	3	3	1	2	2				1	3	3	2
Avg	**2.17**	**2.17**	**1.67**	**2.5**	**1.67**	**1.17**	**1.83**	**1.33**	**1.5**	**1**	**1**	**1**	**2.33**	**2.5**	**2.5**

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

22MEM01	**ENGINEERING THERMODYNAMICS** *(Use of standard thermodynamic tables, Mollier diagram are permitted)*					
PRE-REQUISITE:		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To impart the knowledge on concepts of zeroth and first law of thermodynamics.
2.	To make the learners to understand the third law of thermodynamics and analyze the various work and heat interactions in closed and open systems.
3.	To teach properties of pure substance.
4.	To impart knowledge on the concepts of steam power cycle.
5.	To derive thermodynamic relations for ideal and real gases.

UNIT I	**BASIC CONCEPT AND FIRST LAW**	**9**	**0**	**0**	**9**

Role of Thermodynamics in Engineering and Science - Applications of Thermodynamics. Basic concepts - concept of continuum, macroscopic approach, thermodynamic systems, Property, state, path and processes, quasi-static process, Thermodynamic equilibrium, Displacement work, P-V diagram. Zeroth law of thermodynamics – concept of temperature and heat. First law of thermodynamics – application to closed and open systems, steady flow processes with reference to various thermal equipment.

UNIT II	**SECOND LAW AND ENTROPY**	**9**	**0**	**0**	**9**

Heat engine – Refrigerator – Heat Pump, Second law of thermodynamics – Kelvin's and Clausius statements- Equivalence of these statements their corollaries. Reversibility and irreversibility. Carnot cycle, reversed Carnot cycle. Clausius inequality, Concept of entropy, principle of increase of entropy, T-s diagram, T-ds equations, Entropy.

UNIT III	**PROPERTIES OF PURE SUBSTANCES**	**9**	**0**	**0**	**9**

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

UNIT IV	**STEAM POWER CYCLE**	**9**	**0**	**0**	**9**

Basic Rankine cycle, T-s & h-s diagrams - Performance Improvement - Reheat cycle, regenerative cycle and their combination cycles.

UNIT V	**IDEAL AND REAL GASES AND THERMO DYNAMIC RELATIONS**	**9**	**0**	**0**	**9**

Properties of ideal and real gases, equation of state of ideal and real gases, Avogadro's law, Vander Waal's equation of states, Principle of corresponding states, reduced properties and compressibility chart. Exact differentials, Maxwell relations, Specific heat equations, Tds, relations, Clausius Clapeyron equations and Joule Thomson Coefficient.

Total (45L)= 45 Periods

Text Books:

1.	Nag. P.K, "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2017.
2.	Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.
3.	Arora C.P, "Thermodynamics", Tata McGraw Hill, New Delhi, 2003.
4.	Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987.

Reference Books:

1.	Cengel, "Thermodynamics- An Engineering Approach", 3rd Edition, Tata McGraw Hill, 2015.
2.	Merala C, Pother, Craig W and Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGrawHill, New Delhi, 2004.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the concepts of zeroth, first and second law of thermodynamics.	Remember
CO2	Analyze the various work and heat interactions for different types of processes for closed and open systems	Evaluate
CO3	Evaluate the different properties of pure substances using steam tables and Mollier chart	Evaluate
CO4	Analyze the performance of steam power cycle.	Analyze
CO5	Derive thermodynamic relations for ideal and real gases.	Analyze

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2			1					1	3	1	1
CO2	3	3	2	2			1					1	3	1	1
CO3	3	3	3	2		1	1					1	3	1	1
CO4	2	3	2	2		1	1					1	3	1	1
CO5	3	3	2	2		1						1	3	1	1
Avg	**2.8**	**3**	**2.2**	**2**		**1**	**1**					**1**	**3**	**1**	**1**
3/2/1 – indicates strength of correlation (3 – High, 2- Medium, 1- Low)															

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)

<table>
<tr><td>22MEM09</td><td colspan="2">METROLOGY AND QUALITY CONTROL</td><td colspan="5"></td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>CATEGORY</td><td>PE</td><td colspan="2">Credit</td><td colspan="2">3</td></tr>
<tr><td colspan="2" rowspan="2"></td><td rowspan="2">Horus/Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">3</td></tr>
<tr><td colspan="8">COURSE OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="7">Explaining the importance of measurements in engineering and the factors affecting measurements and to compute measurement uncertainty</td></tr>
<tr><td>2.</td><td colspan="7">Applying the applications of linear and angular measuring instruments</td></tr>
<tr><td>3.</td><td colspan="7">Interpretation of various tolerance symbols.</td></tr>
<tr><td>4.</td><td colspan="7">Applying the SQC methods in manufacturing.</td></tr>
<tr><td>5.</td><td colspan="7">Applying the advances in measurements for quality control.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

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)

<table>
<tr><td>22MTM01</td><td colspan="5">ADVANCED PHYSICAL METALLURGY</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">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 impart knowledge on the crystal structure, diffusion, phase diagrams for various engineering materials.</td></tr>
<tr><td>Unit I</td><td colspan="3">CRYSTAL STRUCTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Unit II</td><td colspan="3">CRYSTALLINE IMPERFECTIONS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit III</td><td colspan="3">ATOMIC DIFFUSION IN SOLIDS AND SOLIDIFICATION OF METAL</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit IV</td><td colspan="3">PHASE DIAGRAMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Unit V</td><td colspan="3">IRON-CARBON PHASE DIAGRAM</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8" align="right">Total (45+0) = 45 Hours</td></tr>
</table>

<table>
<tr><td colspan="2">Text Books:</td></tr>
<tr><td>1</td><td>Donald R. Askeland,”The Science and Engineering of Materials”, Thomson Learning, India Edition, 2007.</td></tr>
<tr><td>2</td><td>William D.Callister, “Materials Science and Engineering – An Introduction”, 4th edition, JohnWiley & Sons, New York, USA, 1997.</td></tr>
</table>

Reference Books:	
1	Avner S H."An Introduction to Physical Metallurgy", McGraw Hill Book Co, New York, USA, 1997.
2	Donald R Askeland," Essentials of Material Science and Engineering ", Thomson Learning, India Edition, 2007
3	Raghavan V., "Physical Metallurgy – Principles and Practice", Prentice Hall of India Ltd., New Delhi, 199.
4	William F.Smith, "Foundations of Materials Science and Engineering", Second Edition, McGraw-Hill Inc, New York, 1993.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Describe the basic crystal structure, orientation and their influence on macroscopic properties.	L2: Understanding
CO2	:	Discuss the role of imperfections in strengthening the materials.	L2: Understanding
CO3	:	Diagonise the diffusion mechanism in solidification of materials under different conditions.	L4:Analysing
CO4	:	Apply the concept of phase diagrams in equilibrium transformation of materials phases.	L3:Applying
CO5	:	Construct the Fe-Fe_3C phase diagram and discuss various properties of steel and cast iron.	L3:Applying

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)

22MTM03	MECHANICAL BEHAVIOUR OF MATERIALS		Semester			
PREREQUISITES			**OE**	**Credit**		**3**
Engineering physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To know the fundamental concepts of deformation behaviour for structural engineering applications.

		L	T	P	TH
Unit I	**DISLOCATIONS AND PLASTIC DEFORMATION**	**9**	**0**	**0**	**9**

Strength of perfect crystal and need for dislocations; Characteristics of dislocations – Edge dislocation, Screw dislocation, Burger's vector, mixed dislocation, dislocation loops; Movement of dislocation – Pierls stress, Cross slip, Climb; Dislocations in FCC, HCP and BCC lattice; Stress fields and energies of dislocations, forces on and between dislocations; Dislocation density; Intersections of dislocations – Jogs and kinks; Dislocation multiplication; Dislocation pile-ups; Deformation by slip and twinning; Critical resolved shear stress; Deformation bands and kink bands.

		L	T	P	TH
Unit II	**STRENGTHENING MECHANISMS**	**9**	**0**	**0**	**9**

Strain hardening; Grain boundary strengthening; Solid solution strengthening - yield-point phenomenon, strain ageing; Precipitation hardening - Conditions for precipitation hardening, Ageing, Formation of precipitates, coarsening of precipitates, Mechanism of strengthening; Dispersion strengthening; Fiber strengthening; Martensite strengthening - examples for above strengthening mechanisms from ferrous and non-ferrous systems, Bauschinger effect; Preferred orientation; Sever plastic deformation.

		L	T	P	TH
Unit III	**FRACTURE AND FRACTURE MECHANICS**	**9**	**0**	**0**	**9**

Types of fracture – ductile and brittle fracture, Ductile to Brittle Transition Temperature (DBTT), Metallurgical factors affecting DBTT, determination of DBTT, Hydrogen embrittlement and other embrittlement, Theoretical cohesive strength of metals, Griffith's theory of brittle fracture, Orowan's modification. Fracture mechanics - introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of KIC, introduction to COD, J integral.

		L	T	P	TH
Unit IV	**FATIGUE BEHAVIOUR AND TESTS**	**9**	**0**	**0**	**9**

Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, HCF / LCF, thermo-mechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.

		L	T	P	TH
Unit V	**CREEP BEHAVIOUR AND TESTS**	**9**	**0**	**0**	**9**

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametetric methods of extrapolation. Deformation Mechanism Maps

Total (45+0) = 45 Hours

Text Books:

1	George. E. Dieter, "Mechanical Metallurgy", 3rd Edition, McGraw-Hill Publications, New York, SI Edition, 2004
2	Marc Andr'e Meyers, Krishan Kumar Chawla, "Mechanical Behavior of Materials", Cambridge University Press, UK, 2009.

Reference Books:	
1	Reed Hill, R.E., "Physical Metallurgy Principles", Affiliated East West Press, New Delhi, 1992.
2	Davis.H.E. Troxell G.E., Hauck.G.E.W. “The Testing of Engineering Materials”, McGraw-Hill, 1982.
3	Wulff et al Vol. III “Mechanical Behavior of Materials”, John Wiley and Sons, New York, USA, 1983.
4	Honeycombe R.W.K., “Plastic Deformation of Materials”, Edward Arnold Publishers, 1984

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom’s Taxonomy Mapped**
CO1	:	Discuss the mechanical behaviour of materials.	L2: Understanding
CO2	:	Discuss the strengthening mechanisms of materials.	L2: Understanding
CO3	:	List the various types of fractures and their mechanisms, fracture mechanics and various theories describing fracture mechanics.	L2: Understanding
CO4	:	Discuss the fatigue behaviour and the mechanism of fatigue, SN curve and fatigue testing machines.	L2: Understanding
CO5	:	Describe the creep behaviour and mechanism, factors affecting creep and creep testing machines.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1	1		
CO2	1	1		1	1								1	1		
CO3	1	1	1		1										1	1
CO4	1	1				1	1								1	1
CO5	1	1		1	1								1	1		
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0

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

<table>
<tr><td>22MTM04</td><td colspan="2">RATE PROCESSES IN METALLURGY</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 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>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: 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>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="7">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>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="7">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>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="7">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>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="7">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="7" 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)																

22MTM05	CORROSION AND SURFACE ENGINEERING		Semester			
PREREQUISITES			OE	Credit		3
Engineering chemistry		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the corrosion and surface engineering, with its application in engineering field.

Unit I	MECHANISMS AND TYPES OF CORROSION	9	0	0	9

Principles of direct and Electro chemical Corrosion, Hydrogen evolution and Oxygen absorption mechanisms – Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitations, Crevice Fretting, Erosion and Stress Corrosion, corrosion fatigue, hydrogen damage –Factors influencing corrosion

Unit II	TESTING AND PREVENTION OF CORROSION	9	0	0	9

Corrosion testing techniques and procedures- Corrosion Testing ASTM Standards, Pitting Corrosion Test, Hydrogen Induced Cracking Test, Sulphide Stress Corrosion Cracking Test- Prevention of Corrosion-Design against corrosion –Modifications of corrosive environment –Inhibitors – Cathodic Protection –Special surfacing processes.

Unit III	CORROSION OF INDUSTRIAL COMPONENTS	9	0	0	9

Corrosion in fossil fuel power plants, Automotive industry, Chemical processing industries, corrosion in petroleum production operations and refining, Corrosion of pipelines- wear of industrial components.

Unit IV	SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE	9	0	0	9

Diffusion coatings –Electro and Electroless Plating –Hot dip coating –Hard facing-Metal spraying, Flame and Arc processes- Conversion coating –Selection of coating for wear and Corrosion resistance.

Unit V	THIN LAYER ENGINEERING PROCESSES	9	0	0	9

Laser and Electron Beam hardening –Effect of process variables such as power and scan speed - Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating-Properties and applications of thin coatings.

Total (45+0) = 45 Hours

Reference Books:

1.	Fontana. G., Corrosion Engineering, McGraw Hill,1985.
2.	Kenneth G. Budinski, Surface Engineering for Wear Resistance, Prenticehall,1992.
3.	ASM Metals Hand Book –Vol. 5, Surface Engineering,1996.
4.	Denny A Jones, “Principles and prevention of corrosion”, 2ndedition, Prentice Hall, New Jersey,1995.
5.	ASM International, Surface Engineering for Corrosion and Wear Resistance,2005.
6.	Schweitzer. P.A., Corrosion Engineering Hand Book, 3rd Edition, Marcel Decker, 1996.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Name the different types of corrosion and their mechanism.	L2: Understanding
CO2	:	Estimate corrosion resistance by different tests.	L4:Analysing
CO3	:	Explain the corrosion behavior of different metals in different industries.	L2: Understanding
CO4	:	Classify the different forms of processing techniques of surface engineering materials.	L1: Remembering
CO5	:	Select the type of deposition and spraying technique.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1	1		
CO2	1	1		1		1							1	1		
CO3	1	1	1	1			1								1	1
CO4	1	1		1	1										1	1
CO5	1	1		1	1								1	1		
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)																

<table>
<tr><td>22MTM06</td><td colspan="2">MATERIALS CHARACTERIZATION</td><td colspan="3">Semester</td><td></td></tr>
<tr><td colspan="2">PREREQUISITES</td><td></td><td>OE</td><td colspan="2">Credit</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2">Engineering physics</td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">Course Learning Objectives</td></tr>
<tr><td>1</td><td colspan="6">To acquire knowledge on various characterizations, chemical and thermal analysis of metallurgical components using its analysis tools.</td></tr>
<tr><td>Unit I</td><td colspan="2">OPTICAL MICROSCOPY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Metallographic specimen preparation. Macro-examination -applications. Metallurgical microscope - principle, construction and working, , Optic properties - magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources, lens aberrations and their remedial measures, Various illumination techniques-bright field , dark field, phase-contrast, polarized light illuminations, interference microscopy, high temperature microscopy; Quantitative metallography – Image analysis.</td></tr>
<tr><td>Unit II</td><td colspan="2">X-RAY DIFFRACTION</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Characteristic X-ray spectrum, Bragg's Law, Diffraction methods - Laue method, rotating crystal method and powder method. Diffraction intensity – structure factor calculation. X-ray diffractometer -general features, filters and counters. Applications of X-ray diffraction in materials characterisation – Determination of crystallite size, crystal structure, precise lattice parameter, measurement of stress.</td></tr>
<tr><td>Unit III</td><td colspan="2">ELECTRON MICROSCOPY</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Electron beam - specimen interactions. Construction and operation of Transmission Electron Microscopy – Diffraction effects and image formation, various imaging modes, selected area diffraction, applications, specimen preparation techniques. Scanning electron microscopy – principle, equipment, various operating modes and applications, Electron probe microanalyser (EPMA)- principle, instrumentation, qualitative and quantitative analysis. Introduction to HRTEM, FESEM, EBSD.</td></tr>
<tr><td>Unit IV</td><td colspan="2">SPECTROSCOPIC TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">X-ray spectroscopy – EDS and WDS. Principle, instrumentation, working and applications of Auger Electron spectroscopy, X-ray photoelectron spectroscopy and Secondary ion mass spectroscopy / ion microprobe. Optical emission spectroscopy, Atomic Absorption spectroscopy and X-ray fluorescence spectroscopy - principle, construction, working and applications. UV-Vis, FTIR and Raman spectroscopy.</td></tr>
<tr><td>Unit V</td><td colspan="2">THERMAL ANALYSIS AND ADVANCED CHARACTERIZATION TECHNIQUES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Thermal Analysis: Principles of differential thermal analysis, differential scanning calorimetry and thermo-graviometric analysis – Instrumentation and applications. Advanced characterization techniques: Scanning probe microscopy - STM and AFM - principle, instrumentation and applications. Field ion microscopy including atom probe - principles, instrumentation and applications.</td></tr>
<tr><td colspan="7" align="right">Total (45+0) = 45 Hours</td></tr>
</table>

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)																

<table>
<tr><td>22MTM07</td><td colspan="2">AUTOMOTIVE, AEROSPACE AND DEFENCE MATERIAL</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 understand the properties and applications various materials suitable for automobile, aircraft and defnce industries and its components.</td></tr>
<tr><td>Unit I</td><td colspan="2">MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.</td></tr>
<tr><td>Unit II</td><td colspan="2">MATERIALS FOR AUTOMOTIVE STRUCTURES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit III</td><td colspan="2">AEROSPACE METALS AND ALLOYS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>Unit IV</td><td colspan="2">CERAMICS AND COMPOSITES</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Unit V</td><td colspan="2">NUCLEAR WASTE AND RADIATION PROTECTION, IRRADIATION EFEFCTS</td><td>9</td><td>0</td><td>0</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7" align="right">Total (45+0) = 45 Hours</td></tr>
</table>

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

<u>COURSE ARTICULATION MATRIX</u>

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1		1	1								1	1		
CO2	1	1	1			1							1	1		
CO3	1			1	1								1		1	
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)