Regulation 2018		Semester III / Semester IV	Total Hours			60
			Hours / Week			C
Category	Course Code	Course Name	L	T	P	
M	18CYM201T	Environmental Science	1	0	0	-

Prerequisite Course (s)

NIL

Course Objective (s):

The purpose of learning this course is to:

- To demonstrate in-depth knowledge within environmental engineering and an awareness of social, economic, political, and environmental impacts of engineering practices.
- To have competence for working with multi-disciplinary teams to arrive at solutions to environmental engineering problems.
- To get solutions which will minimize the negative impact of human activities on the environment and to protect human health

Course Outcome (s) (Cos):

At the end of this course, learners will be able to:

CO1	Improve fundamental knowledge of the inter-relationships between the built environment and natural systems
CO2	Characterize and mitigate man-made hazards like nuclear hazards. Understand the principles involved in the generation of different forms of energy
CO3	Improve the reliability, performance, disaster-management of natural calamities and solid waste and water supplies and treatment processes.
CO4	Understand the source, effects and control measure of various environmental pollution
CO5	Apply information technology in the control of human population and women and child welfare

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	3	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	3	3	-	-	-	-	-	1	-	1
CO3	-	2	-	2	-	3	3	-	-	-	-	-	1	-	1
CO4	-	2	-	-	-	3	3	2	-	-	-	-	1	-	1
CO5	-	2	-	2	-	3	3	-	-	-	-	-	-	-	-
CO (Avg)	-	2.00	-	2.00	-	3.00	3.00	2.00	-	-	-	-	1.00		1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	ENVIRONMENT& BIODIVERSITY	3
Definition-types of environment, components of environment, scope-importance of environmental studies- Bio diversity-definition-value of biodiversity-Threats to biodiversity - India a mega diversity nation-endangered and endemic species of India-conservation of biodiversity.		
UNIT II	ENERGY SOURCES	3
Energy resources- Growing energy needs- Renewable and Nonrenewable energy sources- Use of alternate energy sources - Nuclear Energy- Alternative energy fuels-power alcohol-Bio diesel (preparation, properties &uses)		
UNIT III	SOCIAL ISSUES AND ENVIRONMENT	3
Environment ethics – Climate change – Global warming – Acid rain – Ozone layer depletion –Nuclear accidents-holocaust. Solid waste management - Rain water Harvesting-watershed management-		
UNIT IV	ENVIRONMENTAL POLLUTION & ACTs	3
Source, types, effects & control- Air pollution -Water pollution – Soil pollution – Marine pollution and Plastic Pollution -The Environment (Protection) Act - Air (Prevention and control of pollution) Act - Water (Prevention and control of pollution) Act- Role of individual in prevention of pollution.		
UNIT V	HUMAN POPULATION AND ENVIRONMENT	3
Sustainable development – Urban Population growth and distribution – Population explosion – Family Welfare Program –Women and child welfare- Role of information technology in environment and human health- case studies		

Text / Reference (s) books:

1	Dr.J.P.Sharma, " Environmental studies" , Laxmi Publications(p) Ltd, New Delhi.
2	Miller "Environmental Science" 11th Edition, Cengage Learning India Private Limited, New Delhi, (2006).
3	Master. G.M., "Introduction to Environmental Engineering and Science", Pearson Education Pvt Ltd., (2004)
4	Dr.A.Ravikrishnan " Environmental Science and Engineering " Sri Krishna publications, Chennai(2015)
5	P.Anandan, R.Kumaravelan "Environmental Science and Engineering" Scitech Publication (India) Pvt. Ltd, Chennai, Reprint 2009.

Regulation 2018		Semester III	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PCC	18CEC202T	CONSTRUCTION MATERIALS AND TECHNIQUES	3	0	0	3

Prerequisite Course (s)	
Basic Civil and Mechanical Engineering	
Course Objective (s): The purpose of learning this course is to:	
1	Summarize the knowledge of geology and its engineering considerations
2	Able to describe in details about rocks and its types
3	Acquire knowledge on commonly used construction materials
4	Obtain knowledge about various construction practices
5	Have exposure on sub-structure, super structure construction techniques
Course Outcome (s) (COs): At the end of this course, learners will be able to:	
CO1	Acquire the knowledge of the topographical formation, interior earth, gradational activities and weathering and also the theory of plate tectonics
CO2	Interpret minerals and rocks and assessment of its physical, mechanical and engineering properties.
CO3	Identify the appropriate materials used in construction
CO4	Sequence the various construction practices
CO5	Explore the sub structure and super structure construction techniques

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	2	3	2	-	-	-	1	1	2
CO2	3	1	1	-	-	2	3	2	-	-	-	1	1	2
CO3	2	1	2	1	-	2	-	3	-	2	-	2	3	3
CO4	3	1	2	1	-	2	-	3	-	2	-	2	3	3
CO5	2	1	2	2	-	2	-	3	-	2	-	2	3	3
CO (Avg)	2.60	1.00	1.60	1.33	0.00	2.00	3.00	2.60	0.00	2.00	0.00	1.60	2.20	2.60

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	ENGINEERING GEOLOGY	9
Geology in Civil engineering – branches of geology – scope – earth structures and composition – elementary knowledge on continental drift and plate technologies – earth processes – weathering – types – geological work of river and wind – engineering.considerations.		
UNIT II	**ROCKS AND BUILDING STONES**	**9**
Classification of rocks – distinction between igneous, sedimentary and metamorphic rocks. Igneous rocks – Granite, Gabbro, Dolerite and Basalt. Sedimentary rocks – Sandstone, Limestone, Conglomerate and Breccia. Metamorphic rocks – Quartzite, Marble, Slate and Schist.		
UNIT III	**MATERIALS FOR CONSTRUCTION**	**9**
Timber – market form of timber – veneer – plywood – bricks – steel – TMT and GFRP bars – steel fibre – glass fibre – plastic – types of plastic – PVC – UPVC – paint – distemper – varnish		
UNIT IV	**CONSTRUCTION PRACTICES**	**9**
Stone masonry – brick masonry – load bearing wall – reinforced wall – framed structures – scaffolding and its types – basic of formwork – slip form work – centring – plastering – pointing.		
UNIT V	**CONSTRUCTION TECHNIQUES**	**9**
Sub structures: Trenchless techniques – box jacking – pipe jacking – tunnelling – sheet piling – piling techniques. Superstructures: Launching girders – Bridge decks – Shells – domes – Introduction to prefabricated structures.		

Text Book (s)	
1	Parbin Singh, "Engineering and General Geology", Taylor & Francis, 2009.
2	Arora S.P. and Bindra S.P., "The Text Book of Building Construction", Dhanpat Rai and Sons, 2010.
Reference (s)	
1	F.G. Bell "Engineering Geology", Elsevier, 2nd ed. 2007.
2	Edward Allen and Joseph Iano, "Fundamentals of Building Construction: Materials and Methods", Wiley, 5th Edition, 2008.
3	Rangwala S.C., "Engineering Materials" Charotar Publishing House, Anand, India, 2014.
4	Peurifoy. R. L, "Construction Planning, Equipment and Methods", McGraw Hill Co., New York, 2010.

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Regulation 2018		Semester III	Total Hours			75
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PCC	18CEC204J	ENVIRONMENTAL ENGINEERING I	3	0	2	4

Prerequisite Course (s)

Environmental Science

Course Objective (s): The purpose of learning this course is to:

1	To impart knowledge on the various issues pertaining to quantity of water.
2	To impart knowledge on hydrological cycle and various sources of water
3	To emphasize the quality of water and various system of conveyance of water
4	To learn about Principles and design of water treatment system
5	To emphasize the need for distribution systems and service reservoir

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Analyze quantity of water and needs of public water supply schemes.
CO2	Identify the sources of water and evaluate the storage capacity of the reservoir.
CO3	Relate water quality criteria and standards to public health.
CO4	Construct appropriate treatment schemes to remove certain pollutants present in water
CO5	Design and evaluate water distribution alternatives on basis of chosen criteria.

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	2	2	2	1	1	-	2	2	1
CO2	3	2	3	2	2	2	2	1	1	1	-	1	2	1
CO3	2	2	3	2	2	2	2	1	1	1	-	2	2	1
CO4	3	2	3	2	2	2	2	2	1	1	-	2	3	1
CO5	2	2	2	2	-	2	2	1	1	1	-	1	1	1
CO (Avg)	2.60	2.20	2.60	2.00	2.00	2.00	2.00	1.40	1.00	1.00	0.00	1.60	2.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9

Necessary and objectives of public water supply schemes – planning and financing – report preparation of schemes-quantity of water – water requirements for continuous and intermittent supply – rate of demand – variations in rate of demand – its effect on design –design periods and capacities of different components –population growth and forecast estimating the quantity of water required.

UNIT II	HYDROLOGICAL CONCEPTS AND SOURCES OF WATER	9

Hydrological concepts-hydrological cycle – precipitation – types of precipitation – rain fall measurements – rain fall indices –estimation of surface runoff – Sources of water –types of sources – wells – lakes – ponds – rivers – infiltration galleries - intakes – types – intake tower – storage reservoirs – determination of reservoir storage capacity by analytical and mass curve methods.

UNIT III	QUALITY OF WATER AND CONVEYANCE OF WATER	9

Characteristics of water - sampling –analysis of water – water borne diseases – water quality standards- conveyance of water – types of conduits – hydraulics of pipe flow – pipe corrosion – theories – effect and prevention – laying and testing of pipe lines - pumps – pumping stations.

UNIT IV	TREATMENT OF WATER	9

Treatment of water – working principles, purpose and design – screening – plain sedimentation – coagulation– filtration – disinfection – water softening – ion exchange- membrane processes.

UNIT V	DISTRIBUTION OF WATER AND IMPACT OF WATER SUPPLY SCHEMES	9

Distribution of water – requirements of good distribution system – method of distribution system – layouts of distribution system – distribution reservoirs – purpose – types– preventive methods to reduce wastage of water – impact of water supply schemes- 3R principles of water management.

LIST OF EXPERIMENTS	30

1. Sampling and preservation methods and significance of characterization of water and Wastewater.
2. Determination of pH and turbidity
3. Determination of hardness of water
4. Determination of dissolved oxygen
5. BOD Test
6. COD Test
7. Determination of ammonia nitrogen in water sample
8. Determination of nitrates in water sample
9. Determination of phosphate in water sample
10. Determination of potassium and sodium
11. Heavy metals determination – chromium, lead and zinc. (Demonstration only)

Text Book (s)	
1	Garg, S.K., "Environmental Engineering Vol. I", 24th Edition, New Delhi, Khanna Publishers, 2018.
2	Mark J. Hammer, Mark J. Hammer Jr, "Water and Waste Water Technology", Prenticehall new arrivals 2012.
Reference (s)	
1	"Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
2	Qasim, S.R., Motley, E.M. and Zhu.G. "Water works Engineering – Planning, Design and Operation", Prentice Hall, New Delhi, 2002.
3	Birdie, G.S. and Birdie, J.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and Sons, New Delhi, 2014.
4	Punmia, B.C., Jain, A.K., and Jain.A., "Environmental Engineering, Vol.I," Lakshmi Publications,2015.
5	Poonia, M.P.,Sharma, S.C., "Environmental Engineering",Khanna Publishers, 2018.

Regulation 2018		Semester IV	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PCC	18CEC208T	ENVIRONMENTAL ENGINEERING II	3	0	0	3

Prerequisite Course (s)

Environmental Engineering I

Course Objective (s): The purpose of learning this course is to:

1	To impart knowledge on the various issues pertaining to quantity of waste water.
2	To impart knowledge on characteristics of wastewater.
3	To emphasize the principles and design of wastewater treatment system.
4	To learn about principles and design of sludge management system.
5	To emphasize the need for secure wastewater disposal systems and reuse of used water.

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Analyze quantity of wastewater and needs of sewerage system.
CO2	Identify the characteristics of wastewater and design the primary treatment units of wastewater.
CO3	Construct appropriate treatment schemes to remove certain pollutants present in wastewater
CO4	Adapt the suitable mode of disposal for the residual without endangering the environment.
CO5	Design and evaluate wastewater disposal alternatives on basis of chosen criteria.

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	2	2	2	1	1	1	2	2	1
CO2	3	3	3	2	-	2	2	1	1	1	1	1	2	1
CO3	3	3	3	2	-	2	2	1	1	1	1	2	2	1
CO4	3	2	3	1	-	2	3	2	1	1	1	2	3	1
CO5	3	2	2	1	-	3	3	1	1	1	1	1	1	1
CO (Avg)	3.00	2.60	2.60	1.6	0.00	2.20	2.40	1.40	1.00	1.00	1.00	1.60	2.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	PLANNING AND DESIGN OF SEWERAGE SYSTEM	9
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.		
UNIT II	**CHARACTERISTICS ANDPRIMARY TREATMENT OF WASTEWATER**	**9**
Characteristics and composition of sewage – physical and chemical analysis – DO and BOD and their significances – cycles of decomposition – fundamentals of microbiology of wastewater – primary treatment – screens –principles of grit chambers – principles, types of sedimentation – design of sedimentation tanks – septic tanks and effluent disposal systems.		
UNIT III	**BIOLOGICAL TREATMENT OF WASTEWATER**	**9**
Basic principles of biological treatment – activated sludge process – recirculation – diffuser – mechanical aeration – process modification – oxidation ditch – trickling filter – principles – NRC equation–principles of rotating biological contactor (RBC)– principles of sequencing batch reactor(SBR) – principles of membrane bioreactor – principles of UASB.		
UNIT IV	**SLUDGE MANAGEMENT AND HOUSE DRAINAGE**	**9**
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.		
UNIT V	**SEWAGE DISPOSAL**	**9**
Methods – dilution – self-purification of streams – oxygen sag curve – wastewater reclamation techniques – land disposal – sewage farming - deep well injection – eutrophication – recycle and reuse of wastewater.		

Text Book (s)

1	Garg, S.K., "Environmental Engineering Vol. II", 24th Edition, New Delhi, Khanna Publishers, 2018
2	Punmia, B.C., Jain, A.K., and Jain.A., "Environmental Engineering, Vol.II", Lakshmi Publications, 2015.

Reference (s)

1	Duggal K.N., "Elements of Environmental Engineering" S.Chand and Co. Ltd., New Delhi, 2014.
2	Poonia, M.P.,Sharma, S.C., "Environmental Engineering",Khanna Publishers, 2018.
3	Mark J. Hammer, Mark J. Hammer Jr, "Water and Waste Water Technology", Prenticehall new arrivals 2012.
4	Birdie, G.S. and Birdie, J.S., "Water Supply and Sanitary Engineering", DhanpatRai and Sons, New Delhi, 2014.

Regulation 2018		Semester __	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PEC	18CEE005T	SUSTAINABLE CONSTRUCTION METHODS	3	0	0	3

Prerequisite Course (s)

Construction Materials and Techniques

Course Objective (s): The purpose of learning this course is to:

1	Gaining knowledge of the key aspects of sustainable construction
2	Obtaining knowledge of the basic technologies used in sustainable construction
3	Acquiring the ability to rationally selecting energy-efficient ecological building materials for sustainable Construction
4	Understanding possible uses of different methods and tools for estimating the influence of buildings on the environment

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Know the principles and criteria of sustainable construction
CO2	Basic technologies and basic materials used in sustainable construction
CO3	Identify the suitable building materials for sustainable construction
CO4	Concept of Environment and Environmental Impact Factors considering for various projects
CO5	Get the aware of the energy efficient buildings concept

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	1	-	1	-	-	1	2	1
CO2	3	2	-	-	-	1	1	-	1	-	-	1	2	1
CO3	3	2	-	-	-	1	1	-	1	-	-	1	2	1
CO4	3	2	-	-	-	1	1	-	1	-	-	1	2	1
CO5	3	2	-	-	-	1	1	-	1	-	-	1	2	1
CO (Avg)	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	2.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	INTRODUCTION	9
Fundamentals of Sustainable Construction Engineering –Sustainability and resources, need, present practices at national and international level, The Sustainability Quadrant– challenges and Issues, Government initiatives - Necessity and importance of sustainable construction materials.		
UNIT II	**SUSTAINABLE MATERIALS**	**9**
Recycled and reused products in sustainable construction - Advanced and smart materials and technologies in sustainable construction–Types of building materials for energy-efficient construction: an overview - Building materials for thermal insulation (Mineral and natural based composites, polymers, advanced materials, reflective materials) - Criteria for the selection of building materials for energy-efficient construction.		
UNIT III	**CONSTRUCTION METHODS**	**9**
Construction of conventional framed structure with block work walls - Modular construction methods for repetitive works - Precast concrete construction methods - Identification of cutting edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential.		
UNIT IV	**ENERGY EFFICIENT CONSTRUCTION**	**9**
Concept of Environment and Environmental Impact Factors and area of consideration for Mega Projects such as Airports, Highways, Power Projects, Water Related Projects - 3E's Environmental Economics, Ethics and Ecology of sustainable development -Rules and regulations and Laws governing Energy Conservation in India and developed Nations.		
UNIT V	**SUSTAINABLE MATERIALS APPLICATION**	**9**
Examination of the current LEED for New Construction rating system, and case study analysis of highly successful recent "green construction projects" - Life Cycle Assessment (LCA) of building materials - Case studies of the application of sustainable building materials in energy efficient buildings.		

Text Book (s)

1	Charles J,Kibert "Sustainable Construction: Green building design and delivery", 4th Edition, 2017, Wiley India Pvt. Ltd.,
2	Amirtanshushukla, atul Sharma "Sustainability through Energy efficient buildings", 1st Edition, CRC press publisher, 2018.

Reference (s)

1	Godfrey Boyle, "Renewable Energy:Power for a Sustainable Future",Oxford University Press, 2004.

Regulation 2018		Semester __	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PEC	18CEE012T	SOLID AND HAZARDOUS WASTE MANAGEMENT	3	0	0	3

Prerequisite Course (s)

Environmental Science and Engineering

Course Objective (s): The purpose of learning this course is to:

1	Understand the sources, types and effects of solid waste.
2	Know about the storage containers and processing techniques for municipal solid waste.
3	Ability to identify collection options for municipal solid waste and transfer process.
4	Impart Knowledge on possible solutions to reuse and to develop the disposal alternative methods through case studies
5	Know about the classification of hazardous wastes and its storage and disposal options.

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Summarize the characteristics of solid waste and the effects of solid waste public and economic aspects
CO2	Identify the storage containers and processing techniques for municipal solid waste.
CO3	Explain how to identify collection options for municipal solid waste and transfer process.
CO4	Illustrate the possible solution to reuse and energy management. To Develop the disposal alternative methods through case studies and team-oriented technical presentations.
CO5	Identify and Classify the hazardous waste and know about storage and disposal options for hazardous wastes.

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO2	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO3	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO4	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO5	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO (Avg)	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	FUNDAMENTALS OF SOLID WASTE MANAGEMENT	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 and economic aspects; Public awareness; Role of NGOs; Legislation.		
UNIT II	**ONSITE STORAGE ANDPROCESSING**	**9**
On-site storage methods - Effect of storage, materials used for containers- segregation of solid wastes - Public health and economic aspects of open storage - waste segregation and storage-case studies under Indian conditions- source reduction of waste - Reduction, Reuse and Recycling.		
UNIT III	**COLLECTION ANDTRANSFER**	**9**
Methods of Collection - analysis of collection system (HCS and SCS) - types of vehicles - Manpower requirement - collection routes - route optimization - preparation of master schedule - transfer stations - selection of location, operation and maintenance; options under Indian conditions.		
UNIT IV	**OFFSITE PROCESSING ANDDISPOSAL**	**9**
Processing techniques and Equipment; Resource recovery from solid wastes - sorting and separation - composting, incineration, Pyrolysis - options under Indian conditions- Dumping of solid waste; sanitary landfills - site selection, design and operation of sanitary landfills - Leachate collection and treatment.		
UNIT V	**HAZARDOUS WASTES**	**9**
Identification, classification of Hazardous waste-Source and characterization of hazardous waste – TCLP tests-Storage, labelling and handling of hazardous wastes-Hazardous waste manifests and transport-Waste minimization options-Disposal of Hazardous waste		

Text Book (s)

1	Ganesaguru.S, "Municipal Solid Waste Management" AR publications, 2016.
2	Rao, M. N., et al. Solid and Hazardous waste management. BS Pubications, 2014.

Reference (s)

1	Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
2	George Tchobanoglous and Frank Kreith" Handbook of Solid Waste Management", McGraw Hill, New York, 2002.
3	Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001.

Regulation 2018		Semester __	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PEC	18CEE013T	AIR AND NOISE POLLUTION AND CONTROL	3	0	0	3

Prerequisite Course (s)

Environmental Science and Engineering

Course Objective (s): The purpose of learning this course is to:

1	Impart knowledge on the concepts of air pollution and its effects on human and ecosystem health.
2	Understand the atmospheric process and pollutant transport mechanism.
3	Get Solution to control the major air pollution.
4	Apply modelling techniques and to determine the fate of air pollutant with respect to time and space.
5	Acquire the Knowledge of noise pollution and its control.

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Relate the basic concepts of air pollution and its effects on human and ecosystem health.
CO2	Adopt interpretation of meteorological data for atmospheric stability and sampling of air pollutants
CO3	Find the major air pollution control technologies
CO4	Compute modelling techniques and to determine the fate of air pollutant with respect to time and space
CO5	Analyse the effects of noise pollution and its control.

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO2	3	2	-	-	-	1	1	-	-	-	-	1	1	-
CO3	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO4	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO5	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO (Avg)	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9
Classification of air pollutants - Particulates and gaseous pollutants - Sources of air pollution - Effects of air pollution on human beings, materials, vegetation, animals - Air pollution indices - Indoor Air Pollutants		
UNIT II	**METEOROLOGY**	**9**
Elements of atmosphere - Meteorological factors - Wind roses - Lapse rate - Atmospheric stability and turbulence - Plume rise - Dispersion of pollutants - Gaussian plume Dispersion models - Applications.		
UNIT III	**CONTROL OF PARTICULATE ANDGASEOUS CONTAMINANTS**	**9**
Concepts of control - Principles 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.		
UNIT IV	**AIR QUALITY SAMPLING AND MODELLING**	**9**
Stack sampling- instrumentation and methods of analysis of gases- Analytical methods-Air pollution legislation and regulations- Legal Requirements based on Tamil Nadu – Impact of Novel Corona Virus 2019 - Case Studies.		
UNIT V	**NOISE POLLUTION ANDCONTROL**	**9**
Sources and Effects of Noise Pollution – Measurement – Standards – Control and Preventive measures – Case Studies.		

Text Book (s)	
1	Rao .C.S, Environmental pollution control engineering, New Age International, 2007.
2	Rao M N and Rao H V N., Air Pollution, McGraw Hill Education(India) Private Limited., New Delhi, 2016.
Reference (s)	
1	Lawrence K.Wang, Norman C Pereira, Yung-Tse-Hung, 'Air Pollution Control Engineering', Springer, 2004.
2	De Nevers, Noel. Air pollution control engineering. Waveland press, 2010.

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Regulation 2018		Semester __	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PEC	18CEE014T	INDUSTRIAL WASTE MANAGEMENT	3	0	0	3

Prerequisite Course (s)

Environmental Science and Engineering

Course Objective (s): The purpose of learning this course is to:

1	Know about the Characteristics, Effects and Environmental Legislation of Industrial wastes.
2	Ability to plan minimization of industrial wastes
3	Ability to design facilities for the processing and reclamation of industrial waste water
4	Impart knowledge on the Treatment Technologies in Industrial.
5	Know about the classification of hazardous wastes and its storage and disposal options.

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Infer the characteristics of Industrial Waste and their impact at the surroundings.
CO2	Summarize cleaner production techniques for reuse, recycle and recovery
CO3	Analyse the characteristics of wastewater from major Industries and their reclamation concept
CO4	Recognize the appropriate treatment and disposal method based on the characteristics of Wastewater.
CO5	Specify Hazardous waste and identify suitable treatment techniques

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	1	1	-	-	-	-	1	1	-
CO2	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO3	3	2	-	-	-	1	1	-	-	-	-	1	1	-
CO4	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO5	3	2	-	-	-	1	1	-	-	-	-	1	1	1
CO (Avg)	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9
Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health – Environmental legislations related to prevention and control of industrial effluents and hazardous wastes		
UNIT II	**CLEANER PRODUCTION**	**9**
Waste management Approach – Waste Audit – Volume and strength reduction – Material and process modifications – Recycle, reuse and by-product recovery – Applications.		
UNIT III	**POLLUTION FROM MAJOR INDUSTRIES**	**9**
Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts.		
UNIT IV	**TREATMENT TECHNOLOGIES**	**9**
Equalisation – Neutralisation – Removal of suspended and dissolved organic solids - Chemical oxidation – Adsorption - Removal of dissolved inorganics – Combined treatment of industrial and municipal wastes – Residue management – Dewatering – Disposal.		
UNIT V	**HAZARDOUS WASTE MANAGEMENT**	**9**
Hazardous wastes-Sources and Classification- Collection and Segregation - Physical chemical treatment – solidification – incineration – Secure landfills- Regulatory aspects – Control measures		

Text Book (s)

1	Rao, M. N. Waste water treatment. Oxford and IBH Publishing, 2018.
2	Patwardhan. A.D., Industrial Wastewater Treatment", Prentice Hall of India, New Delhi 2010.
3	Eckenfelder W.W. Jr., "Industrial Water Pollution Control", McGraw Hill Book Company, New Delhi, 2000.

Reference (s)

1	Stephenson, Ralph L., and James B. Blackburn Jr. The industrial wastewater systems handbook. CRC Press, 2018.
2	Freeman H.M., "Industrial Pollution Prevention Hand Book", McGraw Hill Inc., New Delhi, 1995.
3	Bishop, P.L., "Pollution Prevention: Fundamental and Practice", McGraw Hill, 2000.

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Regulation 2018		Semester __	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
PEC	18CEE024T	ENVIRONMENTAL IMPACT AND RISK ASSESSMENT	3	0	0	3

Prerequisite Course (s)

Environmental Science, Environmental Engineering I, Environmental Engineering II

Course Objective (s): The purpose of learning this course is to:

1	Study the current EIA methods, techniques and tools used
2	Make aware the Environmental impact due to various pollutants and their prevention and control Act
3	Understand about environmental management plan and its impact
4	Study the current environmental monitoring systems
5	Understand about environmental and risk assessment

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Carry out scoping and screening of developmental projects for environmental and social assessments
CO2	Prepare terms of reference for environmental impact and socio-economic impact for any development project.
CO3	Prepare the environmental management plan and its various impact mitigation
CO4	Prepare the Environment audit report development projects
CO5	Describe the legal requirements of environment risk assessment and its evaluation measures

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO2	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO3	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO4	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO5	3	2	-	-	-	1	1	-	-	-	-	1	2	1
CO (Avg)	3.00	2.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	2.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9
Environmental Impact Assessment (EIA)- Need for Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS) - Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India - Types and limitations of EIA -Issues in EIA - Social and cultural, Impact of development projects – Sustainable development- EIA capability and limitations – Legal provisions on EIA-Stages of EIA- Types of EIA		
UNIT II	**ENVIRONMENTAL IMPACTS AND ITS ACTS**	**9**
Environmental Impacts– positive and negative environmental impact assessment– steps of doing EIA– methodology adopted –EIA procedure in India –Types of pollutants– The Environment (Protection) Act - Water (Prevention and Control of Pollution) Act , The Air (Prevention and Control of pollution) Act		
UNIT III	**ENVIRONMENTAL MANAGEMENT PLAN**	**9**
Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, flora and fauna–Addressing the issues related to the Project Affected People – ISO 14000		
UNIT IV	**ENVIRONMENTAL AUDIT**	**9**
Objectives of Environmental Audit, Types of environmental Audit, Audit protocol, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report, Post Audit activities - EIA 2020		
UNIT V	**RISK ASSESSMENT**	**9**
Environmental risk assessment frame work – hazard identification – dose responses evaluation – exposure assessment – exposure factors – tools – HAZOP and FEMA methods – Risk characterization – risk communication – emergency preparedness plan		

Text Book (s)

1	A K Srivastava, Environment impact Assessment, APH Publishing, 2014
2	John Glasson, Riki Theriveland S Andrew Chadwick "Introduction to EIA" University College London Press Limited, 2011
3	Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.

Reference (s)

1	Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.
2	J. Petts, Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 1999.
3	John G. Rau and David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.

Regulation 2018		Semester__	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
C	18ECC302T	ANTENNAS AND WAVE PROPAGATION	3	0	0	3

Prerequisite Course (s)

Electromagnetic Fields, Transmission Lines and waveguides

Course Objective (s): The purpose of learning this course is to:

1	Understanding the working principles of antenna and performance of antenna arrays.
2	Describe the application of all types of antennas.
3	Recognize the different types of propagation of radio waves at different frequencies.

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Utilize the concept of antenna parameters in the working principle. (K3)
CO2	Solve the radiation fields of various antennas (K3)
CO3	Categorize the various types of Antennas. (K4)
CO4	Examine the parameters of antenna measurements. (K4)
CO5	Analyze the various types of wave propagation in different layers of atmosphere.(K4)

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	1	1	-	-	-	3	3
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	3
CO3	3	3	2	-	-	-	1	-	-	-	-	-	3	3
CO4	3	2	2	-	-	-	-	-	-	-	-	-	3	3
CO5	3	3	2	-	-	-	-	1	2	1	-	-	3	3
CO (Avg)	3	3	2	-	-	-	1	1	1.5	1	-	-	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	ANTENNA FUNDAMENTALS	9

Basic antenna parameters: Radiation patterns, Beam solid angle, Radiation intensity- Directive gain- Directivity- Power gain- Beam Width-Gain, Effective aperture, Antenna field zones, Reciprocity principle- Relation between Effective length and Effective area. Retarded vector potential, Fields associated with Hertzian dipole- Power radiated and radiation resistance of current element.

UNIT II	WIRE ANTENNAS AND ANTENNA ARRAYS	9

Radiation from half-wave dipole and quarter-wave monopole antennas, Folded dipole. **Antenna Arrays:** Expression for electric field from two and N element arrays linear arrays: Broad-side array and End-Fire array- Method of pattern multiplication-Binomial array- Horizontal and Vertical antennas above the ground plane.

UNIT III	ANTENNA TYPES	9

Loop Antennas: Radiation from small loop and its radiation resistance- Radiation from a loop with circumference equal to a wavelength- Helical antenna: Normal mode and axial mode operation- Log periodic antenna- Horn antenna- Yagi-uda Antenna- Reflector antennas: Parabolic reflectors and their feed systems.

UNIT IV	SPECIAL ANTENNA AND ANTENNA MEASUREMENTS	9

Microstrip antenna: Feeding Methods- Rectangular Patch. **Special Antenna:** Plasma Antenna, GPR, UWB and Wearable antennas. Antenna Measurements: Measurement of different Antenna parameters: Directional pattern, Gain, Phase, Polarization, Impedance, Efficiency.

UNIT V	PROPAGATION OF RADIO WAVES	9

Ground wave propagation: Calculation of field strength at a distance- Flat earth and Curved earth concept. **Space wave propagation:** Reflection from ground for vertically and horizontally polarized waves- Duct propagation. **Sky wave propagation:** Structure of atmosphere - Critical frequency - Skip distance- Virtual height- Maximum usable frequency.

Text Book (s)	
1	Constantine A. Ballanis, "Antenna Theory: Analysis and Design", John Wiley and Sons, Third Edition, 2016.
2	Prasad K.D., "Antennas and Wave Propagation", 3rd Edition, Satya Prakashan Publications, New Delhi 2013.
Reference (s)	
1.	G.N.S. Raju, "Antennas and Wave Propagation", McGraw-Hill, 4th Edition, 2010
2.	Jordan E.C and Balmain, "Electro Magnetic Waves and Radiating Systems", PHI, Reprint 2011
3.	John D. Kraus, Ronald J Marhefka and Ahmad S. Khan, —Antennas and Wave Propagation‖, 4th Edition, McGraw Hill, New Delhi, 2010.

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Regulation 2018		Semester __	Total Hours			60
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18ECE021J	FIBER OPTIC COMMUNICATION	3	0	2	4

Prerequisite Course (s)

Analog communication, Digital communication

Course Objective (s):The purpose of learning this course is to:

1	Study about the various optical fiber modes, configuration of optical fibers
2	Analyze the signal degradation factors coupled with optical fiber
3	Learn the various optical source and photonic crystal in the optical communication system
4	Examine the optical receivers and their uses
5	Discuss about digital transmission and its related parameters on system performance

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Experiment with the basic elements in optical fibers, different modes and configurations. (K3)
CO2	Make use of the signal degradation factors in optical fibers (K3)
CO3	Categorize the characteristics of Optical Sources (K4)
CO4	Identify the error sources in optical detectors (K3)
CO5	Apply the digital transmission system in Optical Communication (K3)

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	2				3				3	2
CO2	3	3	1		2				3				3	2
CO3	3	3	1		2				3				3	2
CO4	3	3	1		2			1	3	1			3	2
CO5	2	3			2			1	3	1			3	2
CO (Avg	2.8	3	1	1	2			1	3	1			3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	INTRODUCTION TO OPTICAL FIBERS	9
Elements of an Optical fiber Transmission link - Ray theory transmission - Total internal reflection, Acceptance angle, Numerical Aperture, Optical Fiber Modes and Configurations- skew rays-Mode theory of circular wave guide - Overview of Modes, Key Modal Concepts-Linearly Polarized Modes -Single Mode Fibers, Graded Index fiber structure		
UNIT II	**SIGNAL DEGRADATION IN OPTICAL FIBERS**	**9**
Attenuation -Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides-Information Capacity determination-Group Delay-Material Dispersion, Wave guide Dispersion, ISI , Signal distortion in SM fibers-Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers-Mode Coupling Design Optimization of SM fibers, RI profile and cut-off wavelength-Mode filed Diameter		
UNIT III	**OPTICAL SOURCES AND PHOTONIC CRYSTAL**	**9**
LED's- Modulation Of LED, Quantum efficiency and LED power, LASER Diodes: Modulation of LASER diodes -Rate equations -External Quantum efficiency -Temperature effects -Power Launching and Coupling: Source to fiber power launching - Lensing Schemes for Coupling improvement - Fiber Optical Sources and Coupling - Fibre- to-Fibre joints - Fibersplicing. Principle of Photonic crystal, Guidance mechanism: Index guiding PCF, Photonic band gap PCF, All solid photonic Bandgap PCF, Hybrid PCF, Applications Of PCF in sensing.		
UNIT IV	**FIBER OPTICAL RECEIVERS**	**9**
PIN Photo detector -Schottky -Barrier Photodiodes -Avalanche Photodiodes - Photo detector noise - Detector response time - Avalanche multiplication of Noise-Temperature effects on Photo Detectors-Phototransistors -Fundamental Receiver operation-preamplifiers-Error Sources-Receiver configuration -Probability of error-Quantum limit		
UNIT V	**DIGITAL TRANSMISSION SYSTEMS**	**9**
Point to point link systems considerations -Link Power budget-Rise time budget-Noise effects on system performance - Operational principles of Wavelength division multiplexing (WDM)–Solitons -Erbium doped fiber Amplifier(EDFA's)-Basic on concepts of SONET/SDH Network-application of OFC-CATV.		

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LIST OF EXPERIMENTS

1. Measurement of Numerical Aperture and Coupling efficiency (Angular and Lateral) in Optical Fiber.

2. Attenuation losses and Bending losses in single mode optical fiber.

3. DC Characteristics of LED Diode.

4. DC Characteristics of LASER Diode.

5. DC Characteristics of PIN Diode.

6. Study of Data Communication using Single Mode Fiber Optic System.

7. Pulse Width Modulation and Demodulation using fiber optic System.

8. Transmission of different wavelengths using WDM and De-Multiplexing.

9. Transmission and Reception of TDM signals using fiber optic System.

10. Eye pattern measurement.

Text Book (s)

1	Gerd Keiser,"Optical Fiber Communication",Fifth Edition, Tata Mc Graw Hill, 2007.
2	John M. Senior,"Introduction to Optical Fiber Communications", Pearson / Prentice Hall

Reference (s)

1	Palais,"Fiber optic communications", Fifth Edition, Pearson, 2005
2	Agarwal.G.P, "Fiber Optic Communication systems", Second Edition, John Wiley & Sons, NY, 1997.
3	Harry J.R Dutton, "Understanding Optical Communications", IBM Corporation, International Technical Support Organization.
4	J.Gower, "Optical Communication System ", Prentice Hall of India, 2001.

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Regulation 2018		Semester V	Total Hours			75
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
C	18MEC303J	AUTOMOBILE ENGINEERING	3	0	2	4

Prerequisite Course (s)

Engineering Thermodynamics , Fluid Mechanics and Machinery

Course Objective (s):

- To impart knowledge on the principles of operation and constructional details of various automobile engine power source.
- To impart knowledge on the working of fuel supply system and combustion technique in various automobiles.
- To provide knowledge on the requirement and function of various components in power transmission and suspension system in vehicle.
- To impart knowledge on the emission in automobile.
- To provide advance automotive driving control.

Course Outcome (s) (COs):

CO1	Explain the operating principles and constructional details of various automobile engine power source.
CO2	Identify the appropriate Fuel supply system for a particular automobile vehicle based on the requirements.
CO3	Analyze the function of various components in transmission and safety driving line of a vehicle.
CO4	Explain the emission control technique and its importance.
CO5	Analyze the advance automotive driving methods.

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	-	1	-	3	2	2	-	3	3	-	2
CO2	3	2	2	2	-	2	-	2	2	2	-	3	3	-	2
CO3	3	2	3	2	-	1	-	2	2	2	-	3	3	-	-
CO4	3	2	3	2	-	3	3	2	2	2	-	3	3	-	1
CO5	3	3	2	2	-	1	2	2	2	2	-	3	3	-	1
CO (Avg)	3	2.2	2.2	2.2	-	1.6	2.5	2.2	2	2	-	3	3	-	1.5

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	**VEHICLESTRUCTUREAND ENGINES**	**9**
Types ofautomobiles, Automotive components, sub systems and their positions, vehicleconstruction and differentlayouts, chassis,frame and body,resistancestovehiclemotion and aerodynamics of vehicles. Introduction to automobile engine power source.		
UNIT II	**ENGINEAUXILIARYSYSTEMS**	**9**
Carburetor-basic type and working principles- Electronic fuel injection system for petrol and diesel engine- supercharging and turbo charging. Review of cooling and lubrication system. Electrical sytem (General electrical circuits. Battery, Starting motor, DC generator, Alternator, Ignition circuit, Dash board instrumentation, Lighting system) and electronics system - Ignition system (Magneto coil and Electronic type). Electronic engine management system.		
UNIT III	**TRANSMISSIONSYSYTEMS**	**9**
Clutch-typesandconstruction, gearboxes- manualandautomatic, Wheel drive components, Wheel and tyres - Steeringgeometry ,PowerSteering, Front and Rear Axle-Suspension Systems.BrakingSystems- ABS and electronic brake force distribution (EBD).Stabilizer, Air Bags		
UNIT IV	**EMISSION CONTROL AND ALTERNATIVEENERGYSOURCES**	**9**
Emission Norms and Bharat standard – Non exhaust and exhaust emission (SCR).Useofalternative fuels in Automobiles -Enginemodificationsrequired–Performance and Combustion CharacteristicsofSIandCIengineswiththesealternatefuels.		
UNIT V	**ADVANCES IN AUTOMOTIVE TECHNOLOGY**	**9**
Electric andHybridVehicles,Fuel Cell. Advanced driving controls – Electronic Stability Program (ESP), Traction control system (TCS), Hill hold control, automatic climate control. Fuel smart engines. Autonomous driving – Google car-GPS Technology.		

Text Book (s)

1	Kirpal Singh, "Automobile Engineering Vol. 1& 2" , Standard Publishers, 7th Edition 2012
2	William. H. Crouse, Donald L Anglin, Automotive Mechanics, 10th Edition, McGraw-Hill, 2017.

Reference (s)

1	Ganesan V.." Internal Combustion Engines" , Third Edition, Tata Mcgraw-Hill ,2007
2	Jain,K.K.,and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers,New Delhi,2002
3	Julian Happian-Smith "Introduction to Modern Vehicle Design", Publisher: Society of Automotive Engineers Inc.2012.
4	Bosch Automotive Hand Book, 8th Edition, Bentley Publishers, 2011.
5	Hand Book - Automotive Research Association of India (ARAI- Pune)

Regulation 2018		Semester V / VI / VII / VIII	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18MEE011T	RENEWABLE SOURCES OF ENERGY	3	0	0	3

Prerequisite Course (s)

Nil

Course Objective (s):

- To understand the solar energy resourse and application
- To identify with Wind energy conversion in to power
- To analyze the Bio energy generation and utilization
- To discover the utilization and environmental merits pattern of renewable energy resources
- To new development of new sustainable energy methodologies / technologies for its utilization

Course Outcome (s) (COs):

CO1	Explain solar radiation, components and applications of PV systems
CO2	Illustrate the wind energy conversion systems, storage systems and applications
CO3	Classify the Bio energy technology and its utilization
CO4	Explain the principle and components of OTEC, Tidal, Geothermal and Hydel Energy sources and environmental issues
CO5	Illustrate the Hydrogen generation, Storage, Transport and applications and Fuel cell technologies

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	2	3	1	-	-	-	1	1	-	-
CO2	3	2	1	-	-	2	3	1	-	-	-	1	1	-	-
CO3	3	2	-	-	-	2	3	1	-	-	-	1	1	-	-
CO4	3	2	-	-	-	2	3	1	-	-	-	1	1	-	-
CO5	3	3	1	-	-	2	3	1	-	-	-	1	1	-	-
CO (Av				-	-	2	3	1	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	**SOLAR ENERGY**	**9**
Solar Radiation – Measurements of solar Radiation and sunshine – Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion – solar Cells – PV Systems – PV Applications		
UNIT II	**WIND ENERGY**	**9**
Wind Data and Energy Estimation – wind Energy Conversion Systems – Wind Energy generators and its performance – Wind Energy Storage – Applications – Hybrid systems.		
UNIT III	**BIO ENERGY**	**9**
Biomass, Biogas, Source, Composition, Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and Economics. Case studies for rural bio gas plant		
UNIT IV	**OTEC, TIDAL, GEOTHERMAL AND HYDEL ENERGY**	**9**
Tidal energy – Wave energy – Data, Technology options – Open and closed OTEC Cycles – Small hydro, turbines – Geothermal energy sources, power plant and environmental issues.		
UNIT V	**NEW ENERGY SOURCES**	**9**
Hydrogen, generation, storage, transport and utilization, Applications : power generation, transport – Fuel cells – technologies, types – economics and the power generation		

Text Book (s)

1	G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 5th Edition, 2010.
2	D. P. Kothari, K. C. Singal and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, Prentice Hall of India, New Delhi, 2nd Edition ,2009.

Reference (s)

1	Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 3rd Edition, 2012.
2	John Twidell, Tony Weir , Renewable Energy Sources, EFN Spon Ltd., UK, 3rd Edition 2015
3	G.N. Tiwari, solar Energy – Fundamentals Design, Modelingand applications, Narosa Publishing House, New Delhi, Revised Edition 2012.
4	S.P. Sukhatme, Solar Energy-Principles of thermal Collection and storage, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition 2009.
5	Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 3rd Edition, 2012.

Regulation 2018		Semester V / VI / VII / VIII	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18MEE014T	SOLAR ENERGY ENGINEERING	3	0	0	3

Prerequisite Course (s)

Nil

Course Objective (s):

- To learn abour Solar energy and techniques to utilize it efficiently and cost effectively.
- To learn about Conversion of sunlight to heat for either direct usage or further conversion to other energy carriers
- To provide Design a solar thermal system for a given criteria.
- To impart the knowledge on Solar energy storage and process to implement.
- To learn about Applications of solar energy

Course Outcome (s) (COs):

CO1	Understand the available solar energy and the current solar energy conversion and utilization processes
CO2	Analyze performance of flat plate collector and develop skills to design, model, analyze and evaluate solar thermal systems.
CO3	Understand the photovoltaic cells operation.
CO4	Estimate the PV array requirement for small residential and industrial applications.
CO5	Solve simple to complex problems of solar thermal energy conversion and storage.

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	2	1	-	-	-	-	2	-	-	-
CO2	3	3	2	2	2	2	1	1	-	-	-	1	2	-	2
CO3	3	2	1	1	-	2	1	-	-	-	-	2	-	-	-
CO4	3	3	2	2	2	2	1	1	-	-	-	2	2	-	1
CO5	3	3	2	3	2	2	1	1	-	-	-	1	2	-	2
CO (Avg)	3	2.8	1.6	1.8	2	2	1	1	-	-	-	1.6	2	-	1.6

2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9
Energy alternatives – New energy technologies – Solar thermal process Solar Radiation – Solar constant – extra terrestrial radiation – clear sky irradiation – solar radiation measurement – estimation of average solar radiation – solar radiation on tilted surface.		
UNIT II	**FLAT PLATE COLLECTORS**	9
Energy balances equation and collectors efficiency – collector performance – collector improvements, effect of incident angle, dust and shading – thermal analysis of flat plate collector and useful heat gained by the fluid - collector design – heat transfer factors.		
UNIT III	**CONCENTRATION COLLECTORS AND REFLECTORS**	9
Parabolic concentrators, non-imaging concentrators, other forms of concentrating collectors. Tracking –receiver shape and orientation – performance analysis – reflectors – reflectors orientation –performance analysis.		
UNIT IV	**SOLAR ENERGY STORAGE**	9
Stratified storage – well mixed storage – comparison – Hot water system – practical consideration –solar ponds – principle of operation and description of Non-convective solar pond – extraction of thermal energy application of solar ponds.		
UNIT V	**APPLICATIONS OF SOLAR ENERGY**	9
Solar electric power generation, photo voltaic cells. Solar furnace, Solar Chimney, heaters – power generation system. Tower concept – solar refrigeration system, thermo electric refrigeration system.		

Text Book (s)

1	Sukhatme.K, Suhas P. Sukhatme, "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th Edition, 2011.
2	Goswami D.Y., Kreith F., Kreider J.F.,"Principles of Solar Engineering", Taylor and Francis,2nd Edition,Indian reprint, 2015.

Reference (s)

1	G.D. Rai, "Solar Energy Utilization", Khanna Publishers, 5th Edition, 2014.
2	Kriender, J.M., 'Principles of Solar Engineering', McGraw Hill, 2000.
3	Mangal, V.S., 'Solar Engineering', Tata McGraw Hill, 2014.
4	Bansal, N.K., 'Renewable Energy Source and Conversion Technology', Tata McGraw Hill, 2011.
5	John.A. Duffie and Willam A.Beckman., 'Solar Engineering of Thermal Processes', Wiley, 2006.

Regulation 2018		Semester V / VI / VII / VIII	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18MEE016T	WASTE MANAGEMENT AND ENERGY RECOVERY	3	0	0	3

Prerequisite Course (s)

Thermal Engineering

Course Objective (s):

- To impart knowledge on sources and characteristics of various wastes and strategies for its prevention and control.
- To learn what is waste and how can it be minimized, what is pollution, how waste is disposed of through natural processes and how to harness those processes to better manage waste Engineering disposal.
- To learn about waste heat recovery systems and its application.
- To understand the waste heat recover system design and particulars.
- To identify the environmental impact.

Course Outcome (s) (COs):

CO1	Explain the operating principles of waste management system.
CO2	Identify the ways of environment pollution.
CO3	Describe the issues in waste management system.
CO4	Analyses the Waste Heat recovery system.
CO5	Illustrate the environmental impact on universal.

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	-	-	3	3	-	-	-	-	1	-	-	-
CO2	3	2	1	-	-	3	3	2	-	-	-	2	1	-	-
CO3	3	1	3	1	-	2	3	2	-	-	-	1	1	-	2
CO4	3	1	3	1	-	2	3	2	-	-	-	-	2	-	2
CO5	3	2	2	2	-	3	3	2	-	-	-	2	2	-	1
CO (Avg)	3	1.4	2.2	1.3	-	2.6	3	2	-	-	-	1.5	1.5	-	1.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	**INTRODUCTION TO WASTE MANAGEMENT**	**9**
Waste management system - Pollution studies - Issues relating to waste management include – Needs of Waste management – Classification of waste - 3R system- 3D system.		
UNIT II	**SOLID WASTE MANAGEMENT**	**9**
Municipal Solid Waste Management: An Introduction.-Generation and Characteristics of Waste.-Waste Collection, Storage and Transport -Waste Disposal-Waste Processing Techniques- Source Reduction, Product Recovery and Recycling-Hazardous Waste: Management and Treatment-Integrated Waste Management (IWM).		
UNIT III	**WASTE HEAT RECOVERY**	**9**
Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Power Plant.		
UNIT IV	**WASTE HEAT RECOVERY SYSTEMS**	**9**
Waste heat recovery systems - Design Considerations - fluidized bed heat exchangers - heat pipe exchangers - heat pumps -thermic fluid heaters - selection of waste heat recovery technologies		
UNIT V	**ENVIRONMENTAL NEEDS**	**9**
Environmental considerations for waste management and waste heat recovery – Pollution-Case studies		

Text Book (s)

1	Dr. Efstratios Kalogirou , " Waste-to-Energy Technologies and Global Applications", CRC Press;1 edition (31 August 2017).
2	John Pichtel , " Waste Management Practices: Municipal, Hazardous, and Industrial ,Second Edition ", CRC Press, 2014.

Reference (s)

1	Tchobanoglous G., Theisen H. and Vigil S. (2003) Integrated Solid Waste Management: Engineering Principles and Management Issues, New York, McGraw
2	Vesilind P.A., Worrell W.A. and Reinhart D.R. (2001) Solid Waste Engineering, Australia, CLEngineering
3	Fuel Economy in furnaces and Waste heat recovery-PCRA.
4	Heat Recovery Systems by D.A.Reay, E & F.N.Span, London, 2012.

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Regulation 2018		Semester V / VI / VII / VIII	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18MEE019T	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3

Prerequisite Course (s)

Thermal Engineering

Course Objective (s):

- Upon completion of this course, the students can able
- To analyze the energy data of industries
- Can carry out energy accounting and balancing
- Can suggest methodologies for energy savings
- To analyze the economics in energy utilization

Course Outcome (s) (COs):

CO1	Describe the importance of energy conservation and its auditing
CO2	Analyze the energy conserve aspects in electrical systems
CO3	Analyze the energy conserve aspects in thermal systems along with case studies
CO4	Study and Calculation of energy conservation in other utilities.
CO5	Demonstrate the economics and its relative terms.

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	-	-	2	-	-	-	-	-	1	-	-	-
CO2	3	3	1	1	-	2	-	1	-	-	-	2	1	-	-
CO3	3	3	1	1	-	2	-	1	-	-	-	2	1	-	-
CO4	3	3	1	1	-	2	-	1	-	-	-	1	1	-	-
CO5	3	3	-	1	-	2	-	1	-	-	2	1	-	-	-
CO (Avg)	2.8	2.6	1	1	-	2	-	1	-	-	2	1.4	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	INTRODUCTION	9
Energy scenario – role of energy manager and auditior in industries: energy monitoring, auditing and targeting – economics of various energy conservation schemes – national energy consumption data – environmental aspects associated with energy utilization – energy auditing: methodology and barriers -Instruments for energy auditing.		
UNIT II	**ELECTRICAL SYSTEMS**	**9**
Components of EB billing – HT and LT supply, transformers, cable sizing, capacitors, power factor improvement, harmonics, electrical motors: motor efficiency computation, energy efficient motors - LED lighting.		
UNIT III	**THERMAL SYSTEMS**	**9**
Boilers: losses in boilers, furnaces and thermal fluid heaters – efficiency computation and case studies of energy conservation measures –Steam: steam traps, condensate recovery, flash steam utilization – insulators and refractories		
UNIT IV	**ENERGY CONSERVATION IN MAJOR UTILITIES**	**9**
Refrigeration and air conditioning – heat load estimation – energy conservation in cooling towers and spray ponds, case studies- electrical energy – energy efficiency in lighting, case studie for energy saving in buildings		
UNIT V	**ECONOMICS**	**9**
Energy economics – discount rate, play back period, internal rate of return, net present value, life cycle costing - ESCO concept		

Text Book (s)

1	D.Yogigoswami, Industrial Energy Conservation, 2nd Edition, CRC Press, 2017.
2	website administered by Bureau Of Energy Efficiency (BEE) a statutory body under ministry of Power, Gov Of India, 2004

Reference (s)

1	Turner. W.C., "Energy Management Hand book", Wiley, New York, 2012
2	Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 2017.
3	Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.

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Regulation 2018		Semester V / VI / VII / VIII	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18MEE030T	INDUSTRIAL SAFETY ENGINEERING	3	0	0	3

Prerequisite Course (s)

Nil

Course Objective (s):

- To anticipate, identify, evaluate, and control workplace hazardous conditions and practices.
- To develop effective safe operating procedures and comprehensive safety and health programs.
- To address identified hazards, conditions, and practices in a cost effective manner.
- To measure and evaluate occupational safety and health performance.
- To understand the provisions contained in the industrial laws.

Course Outcome (s) (COs):

CO1	List out the various safety considerations.
CO2	Monitor and review the safety performance followed in various industries.
CO3	Carryout safety study, undertake appraisal and audit of various industries.
CO4	Understand safety management system of an industry.
CO5	Get familiarize with the acts and rules applicable for industries.

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	-	-	3	2	3	-	-	-	-	-	-	-
CO2	3	2	2	1	-	3	3	3	-	-	-	-	1	-	-
CO3	3	2	2	1	1	3	3	2	-	-	-	-	1	-	-
CO4	3	2	2	1	-	3	3	2	-	-	-	1	-	-	-
CO5	3	2	2	2	-	2	3	3	-	-	-	1	-	-	-
CO (Avg)	2.8	1.8	1.8	1.2	1	2.8	2.8	2.6	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	SAFETY IN PROCESS PLANTS	9
Hazards analysis - Energy source – Release of hazardous materials – Fires – Types of fires – Fire extinguishers – types and handling. Personal protective equipments – Types – Helmets – Respirator – Air purification – Chemical protective clothing – gloves for heat – electricity and chemical – Eye stakes – Ear marks – Industrial Hygiene – Principles – Health and safety Ergonomics.		
UNIT II	**SAFETY IN HIGH PREESURE OPERATIONS AND CHEMICAL INDUSTRIES**	**9**
Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves –Plant commissioning and inspection, pressure vessel, non-destructive testing, vibration, corrosion Plant maintenance and emergency planning, management of maintenance HAZOP study, ALOHA SOFTWARE.		
UNIT III	**HAZARDS IN INDUSTRIES**	**9**
Engineering control of hazards and accidents due to fire explosion and natural causes in the Industries – Thermal power plant – Atomic power plant – mining industries – Fertilizers – petroleum refinery.		
UNIT IV	**SAFETY MANAGEMENT**	**9**
Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Investigation and Reporting - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.Types of organization –Safety committee-Safety councils-Safety education-First aid.		
UNIT V	**THE OCCUPATIONAL SAFETY, HEALTH AND WORKING CONDITIONS CODE**	**9**
Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Motor Vehicle Rules, Explosive Act 1983, Boiler Act, Child labour and women employee Acts		

Text Book (s)

1	Rolland P. Blake, "Industrial safety" , II Edn.., Prentice Hall Inc . New york, Latest Edition.
2	Willaim Handley Mc, "Industrial Safety Hand book" , II Edn.., – Graw Hill Book Co., U. K. (1977).

Reference (s)

1	Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2	National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3	Explosive Act-1884, Eastern Book Company, Lucknow -266 001,1984.
4	Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras.
5	"Occupational Accident Prevention Judson & Brown ", john Wiley , london (1944).

Regulation 2018		Semester VII	Total Hours			30
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
H	18MBH202T	SOCIAL ENGINEERING	2	0	0	2

Prerequisite Course (s)

Nil

Course Objective (s): The purpose of learning this course is to:

1	Learn about fundamental concept of social engineering
2	Know the different elements of ethical hacking and social engineering.
3	Understand the concepts of threats and attack vectors
4	Understand the ethical hacking
5	Learn about the attacks against individuals and organizations

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Understand the concept of social engineering and types of attacks.
CO2	Identify the key security concepts, CIA and IT governance and best practices
CO3	Understand principles of social engineering.
CO4	Exhibit the ethical hacking concepts and scopes, threats and attack vectors and common areas of vulnerability.
CO5	Gain knowledge of attacks against individuals and organizations.

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	1	1	1	1	1	-	1	-	-
CO2	1	1	-	-	-	2	-	2	1	-	-	1	-	-
CO3	-	1	-	-	-	-	1	2	1	-	-	1	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-	1	-	-
CO5	1	1	-	-	-	-	-	-	1	1	-	1	-	-
CO (Avg)	1.33	1.25	-	-	-	1.50	1.00	2.00	1.00	1.00		1.00		-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	**INTRODUCTION TO SOCIAL ENGINEERING**	**6**
Social Engineering Defined - Why Does Social Engineering Work - Identify Communication Style - key aspects of social engineering - Categories of Social Engineering Attacks – human – based attacks and technology - based attacks		
UNIT II	**KEY SECURITY**	**6**
Key security - concepts - Types of key security concepts – Cyber security position. The CIA Triad - the significance of incident response and frameworks around cyber security. IT Governance - Best practices - compliance.		
UNIT III	**PSYCHOLOGY OF SOCIAL ENGINEERING**	**6**
Mind Tricks: Psychological Principle - Four fundamental aspects of human nature that social engineers - the desire to be helpful - the tendency to be trusting - the fear of offending others - the tendency to cut corners		
UNIT IV	**ETHICAL HACKING AND SOCIAL ENGINEERING**	**6**
Ethical Hacking Concepts and Scopes - Threats and Attack Vectors - Information Assurance - Threat Modelling - Enterprise Information Security Architecture - Vulnerability Assessment and Penetration Testing - Types of Social Engineering - Insider Attack - Preventing Insider Threats - Social Engineering Targets and Defence Strategies. Common Areas of Vulnerability - Appropriate access - Assessed resistance - Information availability		
UNIT V	**CASES OF SOCIAL ENGINEERING**	**6**
Notable Cases of Social Engineering - Attacks against Individuals - Attacks against Organizations - Preventing Social Engineering Attacks - Mitigating the Damage of Social Engineering Attacks - Segregation of Access - Maintain Access Logs - Ensure That Backups Occur Regularly - Automatically Revoke User Privileges If Suspicious Activity Is Detected		

Reference (s)

1	Kevin D. Mitnick, William L. Simon, Steve Wozniak, The Art of Deception: Controlling the Human Element of Security, Wiley, October 17th 2003
2	Christopher Hadnagy, Social Engineering: The Science of Human Hacking Paperback- Wiley Publishing Inc.,Edition 2018
3	Lester Evans, Cybersecurity: An Essential Guide to Computer and Cyber Security for Beginners, Including Ethical Hacking, Risk Assessment, Social Engineering, Attack and Defense Strategies, and Cyberwarfare Paperback –2018
4	Dr. Erdal Ozkaya, Learn Social Engineering: Learn the art of human hacking with an internationally renowned expert-2018

Regulation 2018		Professional Elective - Group II	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18EEE007T	WIND ENERGY CONVERSION SYSTEMS	3	0	0	3

Prerequisite Course (s)

Electric Power Generation, Power Electronics and Converters

Course Objective (s): The purpose of learning this course is to:

1	Understand the fundamentals of wind energy and its conversion system
2	Understand the control of Wind turbine rotor for maximum power extraction
3	Understand the concepts of fixed speed systems and Variable speed systems
4	Learn the modern wind turbine control & monitoring.
5	Understand the grid integration issues.

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Acquire knowledge on the basic concepts of Wind energy conversion system.
CO2	Realize the concepts of mathematical modeling and control of Wind turbine for maximum power extraction
CO3	Explain the concept of Fixed speed system, Variable speed system and its modeling.
CO4	Describe the modern wind turbine control and monitoring.
CO5	Interpret the Grid integration issues..

CO-PO Mapping

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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9
Components of WECS - WECS schemes - Power obtained from wind - simple momentum theory - Power coefficient - Sabinin's theory - Aerodynamics of Wind turbine.		
UNIT II	**WIND TURBINES**	**9**
HAWT - VAWT- Power developed - Thrust-Efficiency - Rotor selection - Rotor design considerations - Tip speed ratio - No. of Blades - Blade profile - Power Regulation - yaw control - Pitch angle control stall control - Schemes for maximum power extraction.		
UNIT III	**WIND TURBINE CONTROL & MONITORING SYSTEM**	**9**
Details of Pitch System - Control Algorithms, Protections used - Safety Consideration in Wind turbines - Wind Turbine Monitoring with Error codes - SCADA and Databases: Remote Monitoring and Generation Reports - Operation and Maintenance for Product Life Cycle, Balancing technique (Rotor & Blade), Standards and Grid Codes.		
UNIT IV	**FIXED SPEED AND VARIABLE SPEED SYSTEMS**	**9**
Generating Systems - Constant speed constant frequency systems - Choice of Generators - Deciding factors - Squirrel Cage Induction Generator - Model of Wind Speed - Model wind turbine rotor - Drive Train model - Need of variable speed systems - Power-wind speed characteristics - Variable speed constant Frequency systems synchronous generator – DFIG - Variable speed generators modeling - Variable speed variable frequency schemes.		
UNIT V	**GRID CONNECTED SYSTEMS**	**9**
Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady - state and dynamic performance of the power system including modeling issue.		

Text Book (s)	
1	L.L.Freris, "Wind Energy conversion Systems", Prentice Hall, 1990
2	S.N.Bhadra, D.Kastha,S.Banerjee, "Wind Electrical Sytems",Oxford University Press, 2010.
3	John D Sorensen and Jens N Sorensen, "Wind Energy Systems", Woodhead Publishing Ltd, 2011.
4	Mario Garcia-Sanz, Constantine H. Houpis, "Wind Energy Systems", CRC Press 2012.
Reference (s)	
1	N. Jenkins, " Wind Energy Technology" John Wiley & Sons,1997
2	Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3	E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd.,Trowbridge, 1976.
4	S.Heir "Grid Integration of WECS", Wiley 1998.
5	Spera D.A., "Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering", ASME Press, 1994.
6	Twidell J.W. and Weir A., "Renewable Energy Sources", EFN Spon Ltd., 1983.

Regulation 2018		Professional Elective – Group II	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	18EEE020T	SOLAR ENERGY UTILIZATION	3	0	0	3

Prerequisite Course (s)

Electric Power Generation

Course Objective (s): The purpose of learning this course is to:

1	Enable the students to acquire knowledge of solar radiation data and its measurement.
2	Comprehend the concept of various forms of solar thermal systems.
3	Understand basic knowledge on direct steam generation systems.
4	Learn the maintenance and implementation of solar photovoltaic.
5	Recognize the latest heat energy storages in buildings

Course Outcome (s) (COs): At the end of this course, learners will be able to:

CO1	Infer the concepts of solar radiation data and its measurement.
CO2	Explain the working process of various solar thermal systems
CO3	Describe the principles of solar parabolic concentrators and direct steam generation systems.
CO4	Enumerate the importance of solar photovoltaic maintenance and their implementation.
CO5	Understand the orientation and design of buildings by using latest heat energy storages.

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	2	2	-	-	-	2	1	2	2	2
CO2	3	1	-	-	-	2	2	-	-	-	2	1	2	-	-
CO3	3	1	-	-	-	2	1	-	-	-	2	1	2	-	-
CO4	3	1	-	-	-	2	2	-	-	-	2	1	2	-	-
CO5	3	1	-	-	-	2	1	-	-	-	2	1	2	2	1
CO (Avg)	3	1	-	-	-	2	1.6	-	-	-	2	1	2	2	1.5

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UNIT I	SOLAR RADIATION AND MEASUREMENTS	9
Sun and earth geometry- Solar radiation- Beam and diffuse radiations- Measurement of solar radiation – Pyranometer -Pyrheliometer- Sunshine recorder-Solar collectors and applications.		
UNIT II	**SOLAR THERMAL SYSTEMS**	**9**
Flat plate and evacuated tube collectors- Domestic hot water and process heat systems- Solar cooker- Solar dryer-Solar desalination and solar pond.		
UNIT III	**SOLAR POWER PLANT**	**9**
Principles of solar parabolic concentrators- Trough and dish types- Compound parabolic concentrators- Fresnel lens collectors- Central receiver plant- Direct steam generation systems- Solar furnaces.		
UNIT IV	**SOLAR PHOTOVOLTAICS**	**9**
Solar photovoltaic theory- Mono and polycrystalline silicon technologies- PV modules and integrated systems implementation and maintenance.		
UNIT V	**SOLAR-CONSCIOUS BUILDINGS**	**9**
Orientation and design of buildings- Passive solar heat- Thermal capacity -Insulation- Solar cooling-refrigeration and air-conditioning- Space heating- Sensible and latest heat energy storages in buildings.		

Text Book (s)	
1	Sukhatme.K, Suhas P. Sukhatme, "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th edition, 2008.
2	Soteris A. Kalogiru, "Solar Energy Engineering: Processes and systems", Academic press, 1st edition, 2009.
Reference (s)	
1	Duffie.J.A, & Beckman.W.A, "Solar Engineering of Thermal Processes", John Wiley & Sons, Inc., 3rd edition, 2006.
2	Martin A. Green, "Third generation Photovoltaics: Advanced energy conversion", 1st edition, 2005
3	Garg.H.P, Prakash.J, "Solar energy fundamentals and applications", Tata McGraw Hill publishing Co. Ltd, 2006

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Regulation 2018		Semester III	Total Hours			30
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
M	18MBM201L	COMPETENCIES IN SOCIAL SKILLS	0	0	2	1

Course Objective (s):

The purpose of learning this course is to:

1	Sharpen problem solving skill and to improve thinking capability of the students
2	Hone soft skill and analytical ability of students
3	Engage learners in using language purposefully and cooperatively
4	Expertise the writing and presentation skill to fulfill the corporate expectations

Course Outcome (s) (Cos):

At the end of this course, learners will be able to:

CO1	Solve both analytical and logical problems in an effective manner
CO2	Design and deliver information in a proper manner
CO3	Improve their presentation skills individually as well as a team member

CO-PO Mapping

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-			
CO2	-	-	-	-	-	-	-	-	-	2	-	-			
CO3	-	-	-	-	-	-	-	-	2	-	-	-			
CO4	-	-	-	-	-	-	-	-	-	-	-	-			
CO5	-	-	-	-	-	-	-	-	-	-	-	-			
CO (Avg)	3.00	-	-	-	-	-	-	-	2.00	2.00	-	-			

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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UNIT I	Module - 1	6

Aptitude: Coding & Decoding - Direction Sense Test.

Communication: Self-Introduction and SWOT analysis - Letter writing - types.

UNIT II	Module - 2	6

Aptitude: Venn Diagrams - Data Interpretation.

Communication: Phrasal verbs - Voice of Valluvar.

UNIT III	Module - 3	6

Aptitude: Averages.

Communication: Idioms and Phrases - Skits.

UNIT IV	Module - 4	6

Aptitude: Time and Distance - Problems on Trains.

Communication: Prefix/Suffix - Root words - Adjectives - JAM (Extempore Speech).

UNIT V	Module - 5	6

Aptitude: Clocks & Calendars.

Communication: Homophones - Frame Tales.

Text Book (s)	
1	Dr.R.S.Aggarwal, "Quantitative Aptitude", S. Chand & Company Limited, 2015
2	Dr.R.S.Aggarwal, "A Modern Approach to Verbal & Non - Verbal Reasoning", S. Chand & Company Limited, 2015

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Regulation 2019		SEMESTER II	Total Hours			45
			Hours / Week			C
Category	Course Code	Course Name	L	T	P	
C	19PCMC103T	ANTENNAS AND RADIATING SYSTEMS	3	0	0	3

Prerequisite Course (s)

Antenna and Wave Propagation

Course Objective (s):The purpose of learning this course is to:

1	Enhance the students knowledge in the area of various antenna design
2	Impart knowledge about the state of art in antenna technology.
3	Study the antenna arrays
4	Understand the concepts of aperture antennas
5	Design the patch antennas

Course Outcome (s) (COs):At the end of this course, learners will be able to:

CO1	Compute the far field distance, radiation pattern and gain of an antenna
CO2	Explain about linear wire antennas
CO3	Compute the array factor for an array of identical antennas
CO4	Describe the characteristics of aperture antenna
CO5	Design the Microstrip patch antennas

UNIT I	TYPES OF ANTENNAS	9

Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

UNIT II	LINEAR WIRE ANTENNAS	9

Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non uniform current.

UNIT III	LINEARARRAYS	9

Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration.

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UNIT IV	APERTURE ANTENNAS	9
Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture. Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.		
UNIT V	**MICROSTRIP ANTENNAS**	**9**
Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch. Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.		

Text Book (s)	
1	I.J. Bahl and P. Bhartia," Microstrip Antennas",Artech House,Inc.,1980.
2	W.L.Stutzman and G.A.Thiele,"Antenna Theory and Design", 2nd edition,John Wiley&Sons Inc.,1998.
Reference (s)	
1	Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 1982.
2	Krauss.J.D, "Antennas", II edition, John Wiley and sons, New York, 1997.

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Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC103T	MODERN MANUFACTURING PROCESSES	3	0	0	45	3	50	50	100

Course Objective (s):

- To create awareness on Abrasive aided machining
- To understand electrical and electrochemical machining processes.
- To analyse the principles of high energy aided machining.
- To study the surface and bulk machining processes of silicon wafer.
- To introduce students to the major manufacture steps in electronic circuit boards.

Course Outcomes:

CO1 : Understand and grasp the significance of modern machining process and its applications.
CO2 : Identify the selection of machining process and its parameters.
CO3 : Express and appreciate the cutting edge technologies and apply the same for research purposes.
CO4 : Measure the stages involved in fabrication of micro devices.
CO5 : Create new devices involved in micro fabrication and recent technology.

Unit I	ABRASIVE AIDED MACHINING PROCESSES	9

Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining- Magneto rheological Abrasive flow machining- construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

Unit II	ELECTRICAL AND CHEMICAL AIDED MACHINING PROCESSES	9

Wire cut EDM - Electric discharge machining – Electrochemical machining – chemical machining – Maskants - Electrochemical grinding - construction – principle – types – control - circuits – tool design – merits, demerits and applications. Hybrid Machining.

Unit III	HIGH ENERGY AIDED MACHINING PROCESSES	9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

Unit IV	FABRICATION OF MICRO DEVICES	9

Semiconductors – Si wafer - planarization – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process

Unit V	MICROFABRICATION TECHNOLOGY	9

Moulding – PCB board hybrid and MCM technology – programmable devices and ASIC – electronic material and processing– stereolithography – Solid free form fabrication -SAW devices, Surface Mount Technology.

TOTAL: 45 HOURS

REFERENCES:

1. Brahem T. Smith, Advanced Machining I.F.S. UK 2016.
2. Jaeger R.C., Introduction to Microelectronic Fabrication Addison Wesley, 2nd Edition,1998.
3. Jain V K, Micromanufacturing Processes, CRC Press, 2012.
4. Julian W. Gardner, Vijay K Varadan and Osama O Awadelkarim, Microsensors MEMS and Smart devices, John Willey, 2013.
5. Pandey P.C. and Shan H S Modern Machining Processes, Standard Publishing Co., 1st Edition,1980.
6. Serope Kalpakjian and Steven R. Schmid- Manufacturing Process for Engineering Material – Pearson Education, 6th Edition, 2018

Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC109T	MATERIAL TESTING AND CHARACTERIZATION TECHNIQUES	3	0	0	45	3	50	50	100

Course Objective (s):

On completion of the course the students are expected to be knowledgeable in microstructure evaluation, crystal structure analysis, electron microscopy, Chemical Thermal Analysis, static and dynamic mechanical testing methods.

Course Outcomes:

This course aims to impart knowledge on various techniques of material characterization.

Unit I	MICRO AND CRYSTAL STRUCTURE ANALYSIS	10

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

Unit II	ELECTRON MICROSCOPY	9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

Unit III	CHEMICAL AND THERMAL ANALYSIS	10

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA).

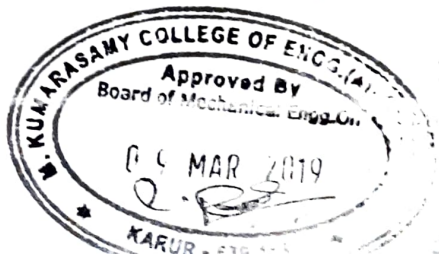
Unit IV	MECHANICAL TESTING – STATIC TESTS	8

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

Unit V	MECHANICAL TESTING – DYNAMIC TESTS	9

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 HOURS



Department	MECHANICAL ENGINEERING					Semester			III
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE020T	NANOTECHNOLOGY	3	0	0	45	3	50	50	100

Course Objective (s):

- To expose the students to the evolution of Nano systems, to the various fabrication techniques.Also to impart knowledge to the students about nano materials and various nano measurements techniques.

Course Outcomes:

- To inspire the students to expect to the trends in development and synthesizing of nano systems and measuring systems to nano scale.

Unit I	OVER VIEW OF NANOTECHNOLOGY	6

Definition – historical development – properties, design and fabrication Nanosystems, , working principle ,applications and advantages of nano system. Nanomaterials – ordered oxides – Nano arrays – potential health effects

Unit II	NANODEFECTS, NANO PARTILES AND NANOLAYERS	8

Nanodefects in crystals – applications – Nuclear Track nano defects. Fabrication of nano particles – LASER ablation – sol gels – precipitation of quantum dots.Nano layers – PVD,CVD ,Epitaxy and ion implantation – formation of Silicon oxide- chemical composition – doping properties – optical properties

Unit III	NANOSTRUCTURING	8

Nanophotolithography – introduction – techniques – optical – electron beam – ion beam – X-ray and Synchrotron – nanolithography for microelectronic industry – nanopolishign of Diamond – Etching of Nano structures – Nano imprinting technology – Focused ion beams - LASER interference Lithography nanoarrays –Near-Field Optics - case studies and Trends

Unit IV	SCIENCE AND SYNTHESIS OF NANO MATERIALS	12

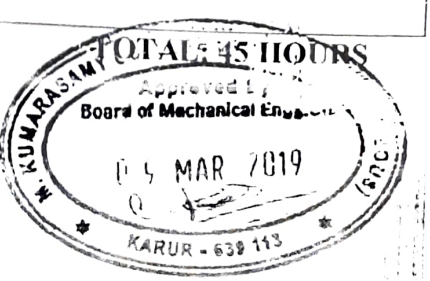
Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture

Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes – Solid carbon source based production techniques – Gaseous carbon source based production techniques – Diamond like carbon coating. Top down and bottom up processes.

Unit V	CHARACTERIZATION OF NANO MATERIALS	11

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL : 45 HOURS



Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE009T	POLYMERS AND COMPOSITE MATERIALS	3	0	0	45	3	50	50	100

Course Objective (s):

- To study matrix material, reinforcements of polymer matrix composites, MMC and ceramic matrix composites.
- To develop knowledge on processing, interfacial properties and application of composites

Course Outcomes:

- To impart knowledge on types, physical properties and processing of polymer matrix composites, metal matrix composites and ceramics matrix composite.

Unit I **PROCESSING OF POLYMERS** **9**

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

Unit II **FIBERS AND MATRIX MATERIALS** **9**

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibers - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

Unit III **PROCESSING OF POLYMER MATRIX COMPOSITES** **9**

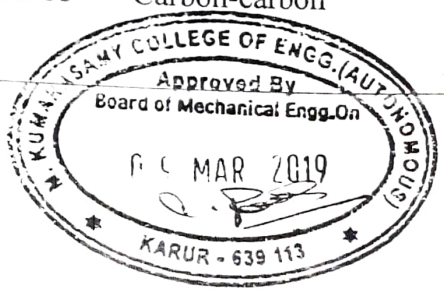
Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

Unit IV **PROCESSING OF METAL MATRIX COMPOSITES** **9**

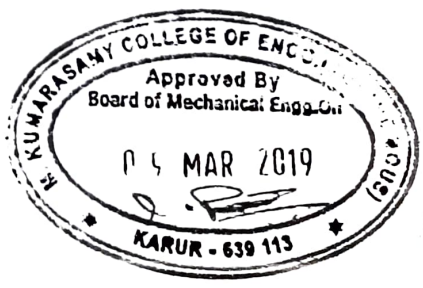
Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

Unit V **PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES** **9**

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites – applications



REFERENCES:	
1.	Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer,2012, ISBN:978-0-387-74364-6.
2.	Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
3.	Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0- 387-35539-9.
4.	Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers, 2003. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
5.	Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002 Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN: 0-8247-0178-x. ASM Handbook – Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.



Department	MECHANICAL ENGINEERING					Semester		III
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE019T	CONCEPTS OF GREEN MANUFACTURING	3	0	0	45	3	50	50	100

Course Objective (s):

- To impart knowledge about air pollution and its effects on the environment.
- To enlighten the students with knowledge about noise and its effects on the environment.
- To enlighten the students with knowledge about water pollution and its effects on the environment.
- To impart the knowledge of fire safety and its production.
- To impart the knowledge about the need, procedure and benefits of Green-Co rating.

Course Outcomes:

CO1 : Understand manufacturing processes towards minimization or prevention of air pollution.
CO2 : Understand manufacturing processes towards minimization or prevention of noise pollution.
CO3 : Understand manufacturing processes towards minimization or prevention of water pollution.
CO4 : Presenting the knowledge of fire safety and its production.
CO5 : Predicting green co-rating and its benefits.

Unit I | **AIR POLLUTION SAMPLING AND MEASUREMENT** | **9**

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behaviour dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants collection of particulate pollutants-stock sampling, analysis of air pollutants-sulphur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone

Unit II | **NOISE POLLUTION AND CONTROL** | **9**

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

Unit III | **WATER DEMAND AND WATER QUALITY** | **9**

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

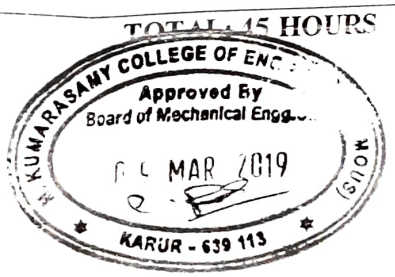
Unit IV | **FIRE SAFETY** | **9**

Basic Elements, Causes, Industrial Fires, Explosions, Effects on Environmental, Property and Human Loss, Prevention technique, Building Design, Fire Protection System, contingency plan, Emergency preparedness, Evacuation.

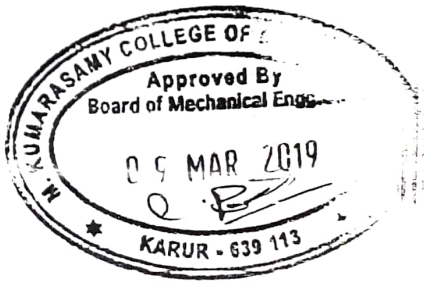
Unit V | **GREEN CO-RATING** | **9**

Ecological footprint, Need for Green Co-rating systems, Intent, System approach, Weightage, Assessment Process, types of ratings, Green Co-Benefits, Case studies of Green Co-Rating.

TOTAL : 45 HOURS



REFERENCES:	
1.	Dornfield David, Green Manufacturing, Springer, 2013
2.	Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013
3	Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
4	World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
5	Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015.
6	Dornfield David, Green Manufacturing, Springer, 2013



Department	MECHANICAL ENGINEERING					Semester		I	
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC101T	ADVANCED MATERIALS TECHNOLOGY	3	0	0	45	3	50	50	100

Course Objective (s):

- To make the students to understand on elastic, plastic and fractured behavior of engineering materials.
- To train the students in selection of metallic and non-metallic materials for the various engineering applications.

Course Outcomes:

- To impart knowledge on the advanced concepts of material technology

Unit I	ELASTIC AND PLASTIC BEHAVIOR	10

Elasticity in metals and polymers Anelastic and visco-elastic behaviour – Mechanism of plastic deformation and non metallic shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Deformation of non crystalline materials.

Unit II	FRACTURE BEHAVIOUR	10

Griffith's theory, stress intensity factor and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law. Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

Unit III	SELECTION OF MATERIALS	10

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

Unit IV	MODERN METALLIC MATERIALS	8

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

Unit V	NON METALLIC MATERIALS	7

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

REFERENCES:

1. Ashby M.F., Material Selection in Mechanical Design, 3rd Edition, Butter Worth 2005.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, (10th Edition), ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Furness, J.A.G., Selection and use of engineering materials, (3rd
4. edition), Butterworth-Heiremann, 2001.
5. Thomas H. Courtney, Mechanical Behaviour of Materials, (2nd edition), McGraw Hill, 2000
6. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988

Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC106T	OPTIMIZATION TECHNIQUES IN MANUFACTURING	3	0	0	45	3	50	50	100

Course Objective (s):

- To make use of the above techniques while modeling and solving the engineering problems of different fields.

Course Outcomes:

- To introduce the various optimization techniques and their advancements.

Unit I	INTRODUCTION	5

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

Unit II	CLASSIC OPTIMIZATION TECHNIQUES	10

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

Unit III	NON-LINEAR PROGRAMMING	9

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming.

Unit IV	INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES	12

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

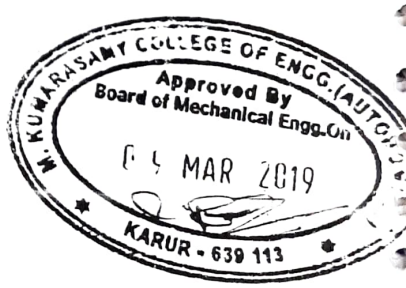
Unit V	ADVANCES IN SIMULATION	9

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 HOURS

REFERENCES:

1	R. Panneerselvam, -Operations Researchl, Prentice Hall of India Private Limited, New Delhi 1 2005.
2	J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
3	Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
4	P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994
5	Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992



Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE005T	MANUFACTURING OF AUTOMOTIVE PARTS	3	0	0	45	3	50	50	100

Course Objective (s):

- To introduce the students about the requirement of materials for automobile components
- To familiarize students on typical materials used in manufacturing of automobile components
- To impart knowledge on material and manufacturing techniques of piston, valves and battery parts
- To impart knowledge on material and manufacturing techniques of engine blocks, cables and locks in automobile.
- To impart knowledge on material and manufacturing techniques of general transmission parts of automobile

Course Outcomes:

CO1 : have the knowledge about material requirements, its recycling and life cycle aspects.
CO2 : gain an insight over the latest materials adopted in automobile manufacture.
CO3 : have the knowledge of methods adopted in manufacture of piston, valves and battery parts.
CO4 : Know the methods of manufacturing engine block, cables and locks in automobile.
CO5 : have the idea of various manufacturing methods of automobile structure, transmission parts.

Unit I	MATERIAL NEEDS IN AUTOMOBILE	9

Requirements of materials in automotive tests – recycling and life cycle consideration. Current materials in use and their future. Advanced in manufacturing and joining techniques. Technical problems and solutions for use of magnesium alloys in automotive industry. Most commonly used composite moulding processes. Renewable materials, barriers and incentives in use of bio-composites - composite materials and their automotive applications

Unit II	MATERIALS AND TECHNOLOGIES FOR AUTOMOBILE	8

Introduction – steel sheets – high strength steel sheet – "Nano-Hilen" – "BHT" – high strength galvannealed steel sheets – development of inorganic type high lubrication galvannealed steel sheets – organic solid lubricant technology – uses of aluminium in automobiles – uses of plastics in automobiles.

Unit III	MANUFACTURING OF PISTON, VALVES AND BATTERY PARTS	10

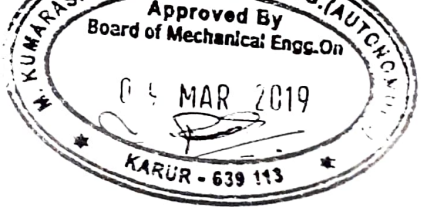
Introduction manufacturing of auto piston – manufacturing of pins for automobiles – manufacturing of piston rings – manufacturing of lead storage battery. Manufacturing of valve and valve set – manufacturing of automobile silencer.

Unit IV	MANUFACTURING OF ENGINE BLOCK, CABLES AND LOCKS	8

Manufacturing of automobile chain – manufacturing of cylindrical block. Manufacturing of cylinder liner – manufacturing of automobile control cable – manufacturing of engine moulding pad – manufacturing of auto locks.

Unit V	MANUFACTURING OF TRANSMISSION PARTS	10

Manufacturing of automobile chassis and other technologies. Manufacturing of automobile body – Manufacturing of disc brake – Manufacturing of brake drum – Manufacturing of gear blank – Manufacturing of gear – casting method – forming method – powder metallurgy – Manufacturing of gear box housing – Manufacturing process of leaf spring – Manufacturing process of automotive tyres –

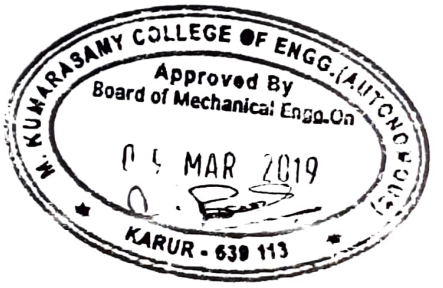


Manufacturing of auto tubes and flaps. Heat treatment of automobile components – forging technologies of automobile parts – Manufacturing of Torque Converters- painting technology of automobiles - Role of Nanotechnology in Automotive Industries.

TOTAL: 45 HOURS

REFERENCES:

1.	Ahmed Elmarkkbi, Advanced Composite Materials for Automotive Applications, Wiley publications, 2014.
2.	Brian Cartor, Patric Grant, Automotive Engineering Light Weight, Functional and Novel materials, Taylor and Francis, CRC Press, 2008.
3.	Gupta K.M, Automobile Engineering Vol.I and II, Umesh Publishers, 2000.
4.	Joao Paulo Carmo, New Advances in Vehicular Technology and Automotive Engineering, JanezaTrdine publisher, 2012.
5.	Kirpal Singh, Automobile Engineering, Vol.I and II, Standard Publishers, New Delhi, 1997.



Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE008T	INDUSTRIAL ERGONOMICS	3	0	0	45	3	50	50	100

Course Objective (s):

- To make the students familiarize with various concepts of Ergonomics, so that students will able to apply the concepts of ergonomics to Design of man – machine system.

Course Outcomes:

- To introduce the concepts of Ergonomics and to indicate the areas of Applications

Unit I	INTRODUCTION	9

Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture – repetitive motion.

Unit II	II ANTHROPOMETRY	9

Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

Unit III	DESIGN OF SYSTEMS	9

Displays – Controls – Workplace – Seating – Work process – Duration and rest periods – Hand tool design – Design of visual displays – Design for shift work.

Unit IV	ENVIRONMENTAL FACTORS IN DESIGN	9

Temperature – Humidity – Noise – Illumination –Vibration – Measurement of illumination and contrast – use of photometers – Recommended illumination levels . The ageing eye – Use of indirect (reflected) lighting – cost efficiency of illumination – special purpose lighting for inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on performance – annoyance of noise and interference with communication – sources of vibration discomfort

Unit V	WORK PHYSIOLOGY	9

Provision of energy for muscular work – Role of oxygen physical exertion – Measurement of energy expenditure Respiration – Pulse rate and blood pressure during physical work Physical work capacity and its evaluation.

TOTAL: 45 HOURS

REFERENCES:

1. 1. Martin Helander, A guide to the ergonomics of manufacturing, East West press, 2007
2. 2. E.J. McCormic & Mark S. Sangers, Human factors in engineering design, McGraw Hill 2007
3. 3. R.S. Bridger Introduction to Ergonomics, McGraw Hill, 1995.

Regulation 2019		Semester II	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	19PPSE008T	ENERGY MANAGEMENT AND AUDITING	3	0	0	3

Prerequisite Course (s)
NIL

Course Objective (s):

The purpose of learning this course is to:

1	Expose the students to study the energy management techniques and auditing process.
2	Analyse the economical value cost and load management techniques.
3	Implement the energy management techniques in electrical equipment's.
4	Learn the concepts of metering for energy management.
5	Acquire the basic knowledge of lighting system and cogeneration.

Course Outcome (s) (COs):

At the end of this course, learners will be able to:

CO1	Apply the designing concepts and starting an energy management program for monitoring energy audit process.
CO2	Determine the Important concepts in an economic analysis, utility rate structures, cost of electricity, loss evaluation and implement load management technique.
CO3	Understanding the energy management technique for electrical equipment's.
CO4	Understanding the concept of various metering techniques for energy managements.
CO5	Understanding the various lighting schemes and cogeneration techniques.

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UNIT I	INTRODUCTION	9
Need for energy management – energy basics – designing and starting an energy management program – energy accounting – energy monitoring, targeting and reporting- energy audit process.		
UNIT II	**ENERGY COST AND LOAD MANAGEMENT**	**9**
Important concepts in an economic analysis – economic models – time value of money –utility rate structures – cost of electricity – loss evaluation. Load management: demand control techniques – utility monitoring and control system-HVAC and energy management – economic justification.		
UNIT III	**ENERGY MANAGEMENT FOR MOTORS, SYSTEMS, AND ELECTRICAL EQUIPMENTS**	**9**
Systems and equipment – electric motors – transformers and reactors – capacitors and synchronous machines.		
UNIT IV	**METERING FOR ENERGY MANAGEMENT**	**9**
Relationships between parameters – Units of measure – typical cost factors – utility meters – timing of meter disc for kilowatt measurement – demand meters – paralleling of current transformers – instrument transformer burdens – multitasking solid-state meters – metering location vs. requirements – metering techniques and practical examples.		
UNIT V	**LIGHTING SYSTEMS AND COGENERATION**	**9**
Concept of lighting systems – the task and the working space – light sources – ballasts –luminaries – lighting controls – optimizing lighting energy – power factor and effect of harmonics on power quality – cost analysis techniques – lighting and energy standards. Cogeneration: forms of cogeneration – feasibility of cogeneration – electrical interconnection.		

Reference (s)

1	Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1996.
2	Reay D.A., "Industrial Energy Conservation", first edition, Pergamon Press, 1979.
3	IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
4	Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.
5	Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", Fifth Edition, The Fairmont Press, Inc., 2011.

Regulation 2019		Semester III	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	19PPSE015T	SOLAR AND ENERGY STORAGE SYSTEMS	3	0	0	3

Prerequisite Course (s)

Power Electronics Converters & Renewable Energy Resources

Course Objective (s):

The purpose of learning this course is to:

1	Acquire knowledge about the behaviour of solar panels for variation in different• parameters.
2	To test and understand the behaviour and applications of solar panels.

Course Outcome (s) (COs):

At the end of this course, learners will be able to:

CO1	To discuss about the basic characteristics of sunlight and solar cells
CO2	An ability to design a solar model in standalone system
CO3	To discuss about the grid connected PV system
CO4	An ability to design a storage system with relevant PV model
CO5	To discuss about the various applications of solar energy system

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UNIT I	**INTRODUCTION**	**9**
Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection		
UNIT II	**STAND ALONE PV SYSTEM**	**9**
Solar modules – storage systems – power conditioning and regulation - protection – stand alone PV systems design – sizing		
UNIT III	**GRID CONNECTED PV SYSTEMS**	**9**
PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance - International PV programs		
UNIT IV	**ENERGY STORAGE SYSTEMS**	**9**
Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage		
UNIT V	**APPLICATIONS**	**9**
Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.		

Reference (s)

1	Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,2003.
2	Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2012,Earthscan, UK.
3	Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
4	Solar & Wind Energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
5	Solar Energy – S.P. Sukhatme, Tata McGraw Hill,1987.

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Regulation 2019		Semester III	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	19PPSE018T	WIND ENERGY CONVERSION SYSTEMS	3	0	0	3

Prerequisite Course (s)	
Power Electronics Application to Power Systems	
Course Objective (s): The purpose of learning this course is to:	
1	Understand Components of WECS-WECS schemes
2	Gain knowledge on wind turbine
3	Gain knowledge on Constant speed constant frequency systems
4	Gain knowledge on Variable speed constant frequency systems
5	Gain knowledge on grid connected systems
Course Outcome (s) (COs): At the end of this course, learners will be able to:	
CO1	Understand the different non conventional sources and the power generation techniques to generate electrical
CO2	Design a prescribed engineering sub-system
CO3	Recognize the need and ability to engage in lifelong learning for further developments in this field
CO4	Apply engineering materials in renewable Energy/ power generation.
CO5	Design grid connected and standalone solar systems.

UNIT I	INTRODUCTION	9
Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine		
UNIT II	**WIND TURBINES**	**9**
HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.		
UNIT III	**FIXED SPEED SYSTEMS**	**9**
Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed-Model wind turbine rotor - Drive Train model-Generator model for Steady state and Transient stability analysis.		
UNIT IV	**VARIABLE SPEED SYSTEMS**	**9**
Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.		
UNIT V	**GRID CONNECTED SYSTEMS**	**9**
Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries		

References:

1	L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2	Ion Boldea, "Variable speed generators", Taylor & Francis group, 2015.
3	E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,2001.
4	S.Heir "Grid Integration of WECS", Wiley 2011.
5	Non-Conventional Sources of Energy by: G.D. Rai, Khanna Publishers.

Regulations 2020		Semester II/III	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	20PCAE115T	WASTE TO ENERGY	3	0	0	3

Prerequisite Course (s)

Nil

Course Objective (s):

The purpose of learning this course is to:

CO1	Enable students to understand of the concept of Waste to Energy
CO2	Link legal, technical and management principles for production of energy form waste
CO3	Learn about the best available technologies for waste to energy
CO4	Analyze of case studies for understanding success and failures
CO5	Facilitate the students in developing skills in the decision-making process.

Course Outcome (s) (Cos):

At the end of this course, learners will be able to:

CO1	Apply the knowledge about the operations of Waste to Energy Plants.
CO2	Analyse the various aspects of Waste to Energy Management Systems
CO3	Carry out Techno-economic feasibility for Waste to Energy Plants
CO4	Apply the knowledge in planning and operations of Waste to Energy plants.
CO5	Take decision regarding the environmental issues

CO PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	2	2	2	1	1	-	2	2	1
CO2	3	2	3	2	2	2	2	1	1	1	-	1	2	1
CO3	2	2	3	2	2	2	2	1	1	1	-	2	2	1
CO4	3	2	3	2	2	2	2	2	1	1	-	2	3	1
CO5	2	2	2	2	-	2	2	1	1	1	-	1	1	1
CO (Avg)	2.60	2.20	2.60	2.00	2.00	2.00	2.00	1.40	1.00	1.00	0.00	1.60	2.00	1.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION	9
The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source.		
UNIT II	**WASTE SOURCES & CHARACTERIZATION**	**9**
Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria.		
UNIT III	**TECHNOLOGIES FOR WASTE TO ENERGY**	**9**
Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.		
UNIT IV	**WASTE TO ENERGY OPTIONS**	**9**
Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes to fuel resources for other useful energy applications.		
UNIT V	**WASTE TO ENERGY & ENVIRONMENTAL IMPLICATIONS**	**9**
Environmental standards for Waste to Energy Plant operations and gas clean-up – Savings on non-renewable fuel resources – Sustainable Materials Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms – Case Studies		

Reference (s)

1	Poonia, M.P.,Sharma, S.C., "Environmental Engineering", Khanna Publishers, 2018.
2	Garg, S.K., "Environmental Engineering Vol. I", 24th Edition, New Delhi, Khanna Publishers, 2018.
3	Garg, S.K., "Environmental Engineering Vol. II", 24th Edition, New Delhi, Khanna Publishers, 2018
4	Punmia, B.C., Jain, A.K., and Jain.A., "Environmental Engineering, Vol.II", Lakshmi Publications, 2015.
5	Duggal K.N., "Elements of Environmental Engineering" S.Chand and Co. Ltd., New Delhi, 2014.
6	M.M. EL-Halwagi, "Biogas Technology- Transfer and diffusion", Elsevier Applied Science Publisher, New York, 2016.
7	D.O Hall and R.P. Overend, "Biomass – Regenerable Energy", John Willy and Sons Ltd. New York. 1987.

Regulations 2020		Semester II/III	Total Hours			45
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
E	20PCAE116T	DISASTER MANAGEMENT	3	0	0	3

Prerequisite Course (s)

Nil

Course Objective (s):

The purpose of learning this course is to:

CO1	Provide students an exposure to disasters, their significance and types.
CO2	Gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
CO3	Ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
CO4	Learn about people involved in disaster management for both sudden-onset natural disasters.
CO5	Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

Course Outcome (s) (Cos):

At the end of this course, learners will be able to:

CO1	Differentiate the types of disasters, causes and their impact on environment and society.
CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation.
CO3	Disaster damage assessment and management.
CO4	Differentiate various Natural Disasters.
CO5	Apply the Case Studies.

CO-PO Mapping

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	1	-	-	-	-	-	1	-	-
CO2	3	2	2	-	-	1	-	-	-	-	-	1	-	-
CO3	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO4	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO5	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO (Avg)	3.00	2.00	2.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

UNIT I	INTRODUCTION TO DISASTERS	9
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters, Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts – Global trends in disasters: urban disasters, pandemics, complex emergencies,		
UNIT II	**NATURAL AND MAN-MADE DISASTERS**	**9**
Climate change: Wind related- Cyclone, Storm, Storm surge, Tidal waves, Heat and cold Waves- Climatic Change- Global warming- Sea Level rise – Ozone Depletion – Man Made Disasters – Do's and Don'ts during various types of disasters – Possible remedies.		
UNIT III	**INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT**	**9**
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India – Relevance of indigenous knowledge, appropriate technology and local resources.		
UNIT IV	**APPROACHES TO DISASTER RISK REDUCTION**	**9**
Disaster cycle – Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- non-structural measures, Roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) - National Disaster Management Authority (NDMA)– Early Warning System – Advisories from Appropriate Agencies.		
UNIT V	**CASE STUDIES AND FIELD WORKS**	**9**
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.		

Reference (s)

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]
3	Gupta Anil K, Sreeja S. Nair. "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011
4	Kapur Anu "Vulnerable India: A Geographical Study of Disasters", IIAS and Sage Publishers, New Delhi.