CENTER OF EXCELLENCE FOR ENERGY AND ENVIRONMENTAL STUDIES

DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE AND TECHNOLOGY

MURTHAL: 131 039(SONEPAT)

SCHEME OF STUDIES & EXAMINATIONS

M. Tech Programme in ENERGY AND ENVIRONMENTAL MANAGEMENT (EEM)

1st YEAR (I - SEMESTER)

S. No.	Course No.	Course Name	L	T	P	Total Credit	Class Work	Theory Marks	Practical Marks	Total	Duration of exam(Hours)
1	EEM/RE 101	Renewable Energy Systems-I	3	0	0	3	25	75	-	100	3
2	EEM-103	Physio-chemical and Ecological Processes in Environment	3	0	0	3	25	75	-	100	3
3	PE-1		3	0	0	3	25	75	-	100	3
4	PE-2		3	0	0	3	25	75	-	100	3
5	EEM/RE-117	Research Methodology and IPR	2	0	0	2	25	75	-	100	3
6	EEM-105	Environment Research Lab-I	0	0	4	2	25	-	75	100	3
7	EEM-107	Energy Research	0	0	4	2	25	-	75	100	3
		Laboratory-I									
8	Audit-I	Audit-I	2	0	0	0	25	75	-	100	
Grand Total										800	

List of PE-1

1	EEM/RE-109	Solar Energy: Fundamentals, Devices and Systems
2	EEM/RE-113	Direct Energy Conversion

List of PE-2

1	EEM-111	Environmental Pollution and Control
2	EEM-115	Solid and Hazardous Waste Management

Audit course

1 & 2

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skill

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SCHEME OF STUDIES & EXAMINATIONS

M. Tech Programme in ENERGY AND ENVIRONMENTAL MANAGEMENT (EEM)

1st YEAR (II - SEMESTER)

S.No.	Course No.	Course Name	L	T	P	Total Credit	Class Work	Theory Marks	Practical Marks	Total	Duration of Exam (Hours
1.	EEM /RE-102	Renewable Energy Systems-II	3	0	0	3	25	75	-	100	3
2.	EEM-104	Analytical Techniques in Environment	3	0	0	3	25	75	-	100	3
3.	PE-3		3	0	0	3	25	75	-	100	3
4.	PE-4		3	0	0	3	25	75	-	100	3
5.	EEM-106	Environment Research Laboratory-II	0	0	4	2	25	-	75	100	3
6.	EEM-108	Energy Research Laboratory-II	0	0	4	2	25	-	75	100	3
7.	EEM-110	Mini Project with seminar	2	0	0	2	25	75	-	100	3
8.	Audit-II	Audit-II	2	0	0	0	25	75	-	100	
Grand Total						18				800	

List of PE-3

1	EEM/RE-112	Solar Photovoltaic Technology
2	EEMRE-116	Solar passive heating and cooling

List of PE-4

1	EEM-114	Water and Waste Water Management
2	EEM-118	Environment Auditing and Impact Assessment

Audit course 1 & 2

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
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SCHEME OF STUDIES & EXAMINATIONS

M. Tech Programme in ENERGY AND ENVIRONMENTAL MANAGEMENT(EEM)

IInd YEAR (III - SEMESTER)

S.No.	Course No.	Course Name	L	T	P	Total	Class Work	Theory Marks	Practical Marks	Total	Duration of Exam (Hours)
1	PE-5		3	0	0	3	25	75	-	100	3
2	OE		3	0	0	3	25	75	-	100	3
3	EEM-209	Phase-I Dissertation	0	0	20	10	50	__	100	150	-
Grand Total						16	100	150	100	350	

List of PE-5

1	EEM/RE-201	Solar Energy Utilization
2	EEM-203	Materials and Devices for Energy Applications
3	EEM- 205	Basics of Toxicology and environmental Risk
4	EEM-207	Society and Environment

List of OE

1	EEM/RE-205	Waste to Energy

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SCHEME OF STUDIES & EXAMINATIONS

M. Tech Programme in ENERGY AND ENVIRONMENTAL MANAGEMENT (EEM)

IInd YEAR (IV - SEMESTER)

S.No.	Course No.	Course Name	L	T	P	Total	Class Work	Theory Marks	Practical Marks	Total	Duration of Exam (Hours)
1	EEM-202	Phase-II Dissertation	0	0	32	16	100	-	200	300	-
Grand Total						16	100	-	200	300	

TOTAL CREDITS: 18+18+16+16 =68

EEM-101: RENEWABLE ENERGY SYSTEMS-I

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (I - Semester)

Z	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

To provide knowledge, understanding and application oriented skills on all renewable energy sources and relevant technologies towards their effective utilization for meeting energy demand. To introduce the various renewable sources of energy and modern applications. It includes solar thermal power, power from wind, biomass power and fuel cell. To provide the concepts of Interrelationship between energy and utilization of various resources of energy. The course will include latest technologies related to different power resources.

Unit I:

Solar Energy: Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Unit II:

Biomass: Origin of Biomass: Resources: Classification and characteristics; Techniques for biomass assessment; Biomass estimation, Thermochemical Conversion Different processes: Direct combustion, incineration, pyrolysis, gasification and liquefaction; Economics of thermochemical conversion.

Unit III:

Wind Energy: Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind machine types, classification, parameters. Wind, its structure, statistics, measurements, data presentation, power in the wind. Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, various aspects of wind turbine design. Horizontal Axis Wind Turbine (HAWT), Vertical Axis Wind Turbine (VAWT) aerodynamics.

Unit IV:

Fuel Cell: Thermodynamics of fuel cells; free energy change and cell potentials; effects of temperature and pressure on cell potential; energy conversion efficiency; factors affecting conversion efficiency; polarization losses; important types of fuel cells, Principle of working, construction, electrode types; electrolytes for fuel cells; applications.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Course Outcomes:

The Course will create awareness among students about Non-Conventional sources of energy technologies and provide adequate inputs on a variety of issues. After completion of this course, the students will know about all renewable energy sources like solar thermal power, power from wind, biomass power and fuel cell and relevant technologies. Now they have the ability to plan and perform a short scientific study and present the results in writing and orally.

Reference Books :

1. Biomass Renegerable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, New york, 1987)
2. Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss (Pergamon Press Ltd. 1982)
3. Thermo chemical processing of Biomass, Bridgurater A V.
4. Biomass as Fuel – L.P.White (Academic press1981)
5. Biomass Gasification Principles and Technology, Energy technology review No. 67, T.B. Read (Noyes Data Corp., 1981)
6. Wind energy Conversion Systems – Freris L.L. (Prentice Hall1990)
7. Wind Turbine Technology: Fundamental concepts of wind turbine technology Spera D.A. (ASME Press, NY, 1994)
8. Wind Energy Systems – G.L. Johnson (Prentice Hall, 1985)
9. Wind Energy Explained – J.F.Manwell, J.G. McGowan and A.L. Rogers (John Wiley &Sons Ltd.)

EEM-103 : PHYSIOCHEMICAL AND ECOLOGICAL PROCESSES IN ENVIRONMENT

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) 1st Year (I - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The students are expected to understand basic knowledge of ecological principles and ecosystems. They will know about different levels of the living world starting with the biology of organisms, then populations and finally the communities. The students will work on case studies related to each level of organization. The course will also provide the understanding of the principles of biodiversity in an ecological and social context. Students learn detailed understating of various aspects of air and soil chemistry.

UNIT-I

Aims and Scope of Ecology, Ecosystem: Structural components, Food chains, Food web, Trophic levels, Ecological pyramids, Geochemical Cycles- Carbon cycle, Nitrogen cycle, Sulphur cycle and Phosphorus cycle, Responses of Ecosystem(Land, Water, Marine) to deforestation, Fire and Pollution, Ecological Succession, Life history strategies, Characteristics of Population, Community Interactions.

UNIT-II

Definition, levels of biodiversity, measurements of biodiversity, values of biodiversity. Hot spots of biodiversity, Biodiversity hotspots of India, threats to biodiversity. Biological Invasion: concept; pathways, process, mechanism, impacts, examples of major invasive species in India. Causes of species extinction. Endangered and threatened species, IUCN Categories of threatened species, Red data book, Biodiversity conservation; Convention on Biodiversity.,

UNIT-III

Soil and Atmospheric Chemistry: Chemical composition and structure of atmosphere, Changing global atmosphere, Lapse rate, Physio-Chemical composition of soil, Humus, Inorganic and organic components of soil, nutrients(NPK) in soil, Significance of C:N ratio, Cation exchange capacity, Reactions in soil solution, Ion exchange, Ligand exchange , Complexation, Chelation, Precipitation/dissolution

UNIT-IV

Physio-chemical properties of soil, soil organic matter, microorganisms of soil, decomposition of organic matter in soil, soil formation and distribution, mobility of nutrients and trace elements during soil genesis, effects of modern agriculture on soil geochemistry, soil erosion and reclamation.

Course outcomes:

Upon completion of this course, a fully-engaged student will be able to:
· Describe important ecological processes.
· Demonstrate knowledge of the important ecological principles operating at different levels of organization.
· Develop concepts of basic chemistry associated with toxicology of environmental pollutants.
· Outline fundamental and applied aspects of environmental analytical chemistry.
· Apply analytical tools to determine and measure pollutants in various environmental samples.
Understand various means of soil contamination, their possible effects and control.
· Discuss the method for reducing soil erosion and soil management.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Recommended books:

1. Terrestrial Ecosystem Ecology: Principles and Applications, Swedish University of Agricultural Sciences, 2012.
2. Day, John W., Kemp W. M., Alejandro Yáñez-Arancibia and Byron C. Crump. Estuarine Ecology (2nd Ed), Wiley-Blackwell Publishers, 2012.
3. Fatik B. Mandal. and Nepal C. Nandi. Biodiversity: Concepts, Conservation and Biofuture, Asian Books, 2013.

4. Jorgensen, Sven Erik. Encylopedia of Ecology. Vol 1-5. Elsevier Publishers. Netherlands, 2008.
5. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management. APH, New Delhi, 2009.
6. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co-operation, New Delhi, 2009.
7. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R. Invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis, 2009.
8. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. and Brown, J.H. Biogeography (4th Ed). Sinauer Associates, 2010.
9. Odum, E.P., Barrick, M. and Barret, G.W. Fundamentals of Ecology (5th Ed).Thomson Brooks/Cole Publisher, California, 2005.

EEM-105 : ENVIRONMENTAL ENGINEERING LABORATORY I

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) 1st Year (I - Semester)

L	T	P/D	Credits			
				Class Work	:	20 Marks
-	-	4	2	Examination (Theory/Practical)	:	30 Marks
-	-					
				Total	:	50 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The course has been designed to train the students in the laboratory for quantitative analysis of various physical, chemical and biological pollutants in water and wastewater and to provide firsthand experience on various instruments.

1. Analysis of water for physical parameters Turbidity and pH.
2. Analysis of water chemical parameters using neutralization methods: acidity, Alkalinity, and free carbon dioxide.
3. Analysis of bioavailable fractions of heavy metals using mild and strong chemicals in soil.
4. Analysis of water for chemical and biological parameters like Dissolve Oxygen, Biochemical oxygen demand, chemical oxygen demand.
5. Analysis of heavy metals in water/ waste water/ industrial water.
6. Analysis of water for chemical parameters chlorides and nitrates.
7. Analysis of water for chemical parameters sulphates and phosphate.
8. Gravimetric analysis of water/wastewater quality parameters TSS and TDS
9. To calculate the lambda max of the given compound by UV-Vis spectrophotometer
10. Determination of chromium using spectrophotometric / colorimetric method.

Note: At least six (6) out of ten (10) experiments will be carried out in one semester. Addition and deletion in the list of experiments may be made from time to time by the department depending on the requirement of course.

Course outcome:

The students will be able to

1. Analyse and quantify various environmental parameters/pollutants present in environment.
2. Perform environmental quality measurements.

Design various experiments for reducing the pollution load from water and wastewater streams.

EEM-107: ENERGY RESEARCH LABORATORY –I

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (I - Semester)

L	T	P/D	Credits			
-	--	4	2	Class Work	:	20 Marks
				Examination (Theory/Practical)	:	30 Marks
				Total	:	50 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

In order to supplement various topics related to energy aspects in class-room lectures, some laboratory experiments are needed as a part of curriculum development of energy studies programme for better understanding of the subjects. The experiments based on science/engineering principles are so designed so as to provide students enough stimulation for further investigation.

1. To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.
2. To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
3. To show the effect of variation in tilt angle on PV module power.
4. To demonstrate the effect of shading on module output power.
5. To demonstrate the working of diode as Bypass diode and blocking diode.
6. To observe the open circuit voltage decay graph of a crystalline silicon solar cell.
7. To calculate the lifetime of the solar cell.
8. Understanding the concept of lifetime in solar cells.
9. Ability to calculate the lifetime of the solar cell.
10. To compare and analyse the performance of charge controllers.
11. To understand the different voltage rating applications.
12. Measurement of IV characteristics with change in illumination to analyse the deviation of operating points from Maximum power point.
13. To understand the PV system design and installation with tracking techniques and mechanisms.
14. Plot the Torque v/s Speed and Power v/s Speed characteristics of the turbine at different wind speed and load configuration.
15. Plot the torque v/s speed and power v/s speed characteristics of the turbine at different pitch angle and load configuration.

Course outcomes:

The students will be able to perform above mentioned experimental. The students are expected to learn the art and science of carrying out experimental research. At the end of the course a student should be able to design and carry out an experiment on his/her own. This is an important skill which anybody wanting to do experimental research is expected to possess.

EEM/RE-109: SOLAR ENERGY: FUNDAMENTAL, DEVICES AND SYSTEMS

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (I - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

This course has objectives to elaborate PG students regarding current trends in solar architecture and following key concepts: Solar Radiation, Sun Angles, and Importance of Sun Angles for Building Fenestration/day lighting, Solar Passive Architecture, heat transfer in buildings, Natural Heating/Cooling concepts for Building, Refrigeration systems.

Unit I

Earth & Sun Relationship:

Earth & Sun Relation: Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram. Available Solar Radiation: Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface, Solar Radiations Characteristics.

Unit II

Thermal Energy Storage: Sensible Storage (Water, pebble bed and ground storage), Latent Heat Storage.

Thermal Energy Systems

Solar Water Heating System: Components, Natural Flow, Forced Flow and Load
Solar Air Heating Systems: Space Heating, Solar Drying, Load Estimation.
Solar desalination system: Design and type, Solar still, performance analysis.

Unit III

Solar Refrigeration and Desiccant

Cooling : Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling .

Unit IV

Solar Power Generator

Solar Thermal Power Generation : Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.

Course outcomes:

This will enable them to understand the solar architecture and following key concepts: Solar Radiation, Sun Angles, and Importance of Sun Angles for Building Fenestration/day lighting, thermal energy storage and devices, Solar Passive Architecture, Solar Refrigeration and Desiccant and Solar Power Generator.

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. W H Blass, F. Pfisterer – Advance in Solar Energy Technology.
13. Mathur and Methaf - Solar Energy.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

EEM - 111 : ENVIRONMENTAL POLLUTION AND CONTROL

M. Tech. - ESEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (I - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

This course aims to provide the students with a variety of perspectives on the air, water, soil and noise pollution issues. The students will get an insight into sources of various types of pollution, their effects and dispersion in the environment. The students will be acquainted with pollution control devices, their constructional features and working principles

UNIT-I

Air pollution: Definition, Air Quality and Standards: Classification of air pollutants, their sources, criteria pollutants, characteristics and effects, Air quality standards.

Dispersion of pollutants – Wind velocity, Lapse rate, atmospheric stability, inversion, atmospheric dispersion, maximum mixing depth and plume rise.

Control of Particulates and gaseous pollutants- Characteristics of particulates - Filters, gravitational, centrifugal-multiple type cyclones, wet collectors, Electrostatic Precipitation, bag filter Scrubbers.

UNIT-II

Noise Pollution and Control:

The decibel Scale, Sound intensity level, Classification of noise, noise standards, effects of noise, Noise control methods, Role of vegetation in noise control, Environmental problems associated with noise pollution.

UNIT-III

Water pollution and control: Definition, Classification, Sources, Water quality standards, Characterisation of water, Principle forms of water pollutants and their sources, suspended, colloidal and dissolved solids (TSS, TDS, Volatile and fixed solid).

Water pollution and control: Indicators, Hardness and determination of DO, BOD, COD of water, and water pollution due to heavy metals and organic pollutants, bio indicators of water pollution.

UNIT-IV

Soil pollution and control: Inorganic and Organic-Definition of pollution and contamination, sources of soil pollution, Effects of chemical residues on soil, (pesticides, fertilizers, heavy metals etc.), Soil pollution from nitrogen, phosphorus, sulfur, micronutrients or trace elements, Heavy metal pollution of soils, heavy metal remediation of soil. Introduction to, Marine pollution (Sources, classification and effects).

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Recommended Books

1. Environmental Pollution – Peavy and Rowe.
2. Environmental Pollution and Solution – Asthana and Asthana.
3. Environmental radioactivity - M Eisendbud.
4. Environmental Science – A study of Inter relationships – E D Enger and B E Smith.
5. Environmental pollution and control Engineering – C.S. Rao.
6. Air Pollution A K Srivastava.
7. Environmental Chemistry - Sharma and Kaur.
8. Environmental Chemistry - A K De.
9. Air Pollution Control Engineering., de Nevers, H, McGraw-Hill, New York, 1995.
10. Air Pollution Its Origin and Control, Wark K, Warner C F and Davis W. 3rd edition, Harper and Row, New York, 1997.

Course outcomes:

On completion of the course, the students will be able to:

1. Understand the type and nature of pollutants, the behaviour of plumes and relevant meteorological determinants influencing the dispersion of air pollutants.
2. Discuss the pollution emission standards.
3. Suggest suitable pollution prevention equipments and techniques for various pollutants to industries.
4. Understand the technical aspects of regulating and controlling air and noise pollution.

EEM/RE-113: DIRECT ENERGY CONVERSION

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (I - Semester)

L	T	P/D	Credits			
				Class Work	**:**	**25 Marks**
3	**--**	**--**	**3**	**Examination (Theory/Practical)**	**:**	**75 Marks**
				Total	**:**	**100 Marks**
				Duration of Examination	**:**	**3 Hours**

Unit I

Survey of energy conversion problem. Basic science of energy conversion, Energy conversion process, indirect and direct energy conversion. Preview of semiconductor physics: Basic ideas of quantum physics, Fermi Energy, band diagram, Intrinsic and extrinsic semiconductors, p-n junction, Physics of semiconductor junctions for photovoltaic

UNIT II

Fabrication and evaluation of various solar cells. Application of solar cells in photo voltaic power generation systems. Batteries: Thermodynamic analysis, design and analysis of batteries, Other modes of direct energy conversion.

Unit III

Technology and physics of thermo-electric generators. Thermo-electric materials and optimization studies, Basic concepts and design consideration of MHD generators. Cycle analysis of MHD systems. Thermionic power conversion and plasma.

Unit IV

Introduction to the principles and operation of fuel cells, stack configurations and fuel cell systems. Fuel cell system design, optimization and economics. Overview of fuel cell technology. Thermodynamics of fuel cells, introduction to electrochemical kinetics, transport-related phenomena and conservation equations for reacting multicomponent systems. Environmental effect.

Reference Books:

1. Direct Energy Conversion : W.R.Corliss
2. Aspects of Energy Conversion : I.M.Blair and B.O.Jones
3. Principles of Energy Conversion : A.W.Culp (McGrawHill International)
4. Energy conversion principles : Begamudre , Rakoshdas
5. Semiconductor Devices by Nauro Zamluto, Mc Graw Hill 1989 (Int. Ed.)

6. Solid State Electronic Devices. III ed. By B. G. Streetman, Prentice Hall India Pvt. Ltd., N.D, 1991.
7. Solar Cells by Martin Green, Pergamon press.
8. Solar Energy Thermal processes: Duffie & Buckman, Wiley & Sons, New York.
9.Solar Energy by S.P. Sukhatme, Tata Mc Graw Hill, New Delhi.
10.Solar Energy: H P Garg & J P Prakash.
11. Non-Conventional Sources of Energy- G D Rai
12. Energy Technology- S. Rao (Khanna Publications)

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

EEM- 115 : SOLID AND HAZARDOUS WASTE MANAGEMENT

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) 1st Year (I - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The course will provide the basic knowledge of solid waste in terms of characteristics and composition. The students will become aware of environmental and health impacts of solid waste management. Further, the course will provide the understanding of engineering, financial and technical options for waste management. Student will get aware about problems of municipal waste, biomedical waste, hazardous waste, e-waste, and radioactive waste. This course provides an in-depth understanding of solid and hazardous waste characteristics and management.

UNIT-I

Solid Waste: Definition, history, types, sources, composition and properties of solid waste, need for management, solid waste generation: Solid waste handling, storage, processing, collection, transfer and transport.

UNIT-II

Solid waste management: Material flow in society, Reduction in raw material usage, reduction in solid waste quantities, reuse of solid waste material, material recovery, energy recovery (biological and thermal), materials and energy recovery system, day to day management of solid waste.

UNIT-III

Hazardous waste: Definition, history, Sources and Characterization of waste, Transport processes of hazardous wastes, Handling and management of Biomedical, Agriculture and E-waste and radioactive waste management.

UNIT-IV

Hazardous waste management: Transport processes of hazardous wastes, Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes), physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation), Composting, bioreactors, incineration, landfill disposal.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Course outcomes:

On completion of the course, the students will be able to:

1. Do sampling and characterization of solid waste.
2. Understand health and environmental issues related to solid waste management.
3. Distinguish among different streams of solid wastes and understand factors affecting variations.
4. Apply steps in solid and hazardous waste management - waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques.

Recommended books:

1. Soild waste engineering by P. Aarne Vesilind, W. Worrell and Debra Reinhart.
2. Environmental Engineering by H.S. Peavy, D.R. Rowe and George Techobanoglous
3. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
4. LaGrega, M.D. Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill
   International Editions, New York, 1994.
5. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.
6. Environmental Management 2nd ed. By Bala Krishnamoorthy.

EEM/RE-117: RESEARCH METHODOLOGY AND IPR

M. Tech. –ENERGY AND ENVIRONMENTAL STUDIES 1st Year (I – Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Course Objectives:

1. To understand some basic concepts of research and its methodologies
2. To identify appropriate research topics
3. To select and define appropriate research problem and parameters
4. To prepare a project proposal (to undertake a project)
5. To organize and conduct research (advanced project) in a more appropriate manner
6. To write a research report and thesis
7. To write a research proposal (grants)
8. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.
9. To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work and for this they must have knowledge of patents, copy right, trademarks, designs and information Technology Act.
10. Further teacher will have to demonstrate with products and ask the student to identify the different types of IPR's.

Unit 1:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2:

Effective literature studies approaches, analysis, Plagiarism, Research ethics, Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 3:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 4:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications, New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Course Outcomes:

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Reference Books :

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

EEM-102: RENEWABLE ENERGY SYSTEMS-II

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

To provide knowledge, understanding and application oriented skills on all renewable energy sources and relevant technologies towards their effective utilization for meeting energy demand. The Course will create awareness among students about Non-Conventional sources of energy technologies and provide adequate inputs on a variety of issues. The objective of this course is to study the potential of power generation from renewable and quantify its impact on carbon dioxide mitigation. It includes geothermal, tidal Energy, hydrogen energy, hydel energy and nuclear power. Some of the advanced countries around the world are harnessing this power. The course will include latest technologies related to different power resources.

Unit I:

Geothermal, Tide and Wave Energy: Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.

Unit II:

Hydrogen Energy: Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles. Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production. Storage of Hydrogen: different methods and metal hydrides etc.

Unit III:

Hydel Energy: Hydro power: Potential, Hydropower Generation and Distribution, Mini and Microhydel Power (MHP) Generation: Classification of hydel plants, Concept of micro hydel, merits, MHP plants: Components, design and layout, Turbines, efficiency, Status in India. Integrated Energy systems and their cost benefit analysis.

Unit IV:

Nuclear Energy: Potential of Nuclear Energy, Nuclear Energy Technologies – Fuel enrichment, Different Types of Nuclear Reactors, Nuclear Waste Disposal, and Nuclear Fusion.

Course Outcomes:

The Course will create awareness among students about Non-Conventional sources of energy technologies and provide adequate inputs on a variety of issues. After completion of this course, the students will know about all renewable energy sources like geothermal, tidal Energy, hydrogen energy, hydel energy and nuclear power and relevant technologies. Now they have the ability to plan and perform a short scientific study and present the results in writing and orally.

Reference Books :

1. Renewable Sources of Energy and Conversion Systems: N.K.Bansal and M.K.Kleeman.
2. Principles of Thermal Process : Duffie Beckman.
3. Solar Energy Handbook: Kreith and Kreider (McGrawHill)
4. Solar Cell : Marteen A. Green
5. Solar Hydrogen Energy Systems T. Ohta (Ed.) (Pergamon Press)
6. Hydrogen Technology for Energy – D.A.Maths (Noyes Data Corp.)
7. Handbook : Batteries and Fuel cell – Linden (Mc.Graw Hill)

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

EEM – 104 : ANALYTICAL TECHNIQUES IN ENVIRONMENT

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
				Class Work	**:**	**25 Marks**
3	**--**	**--**	**3**	**Examination (Theory/Practical)**	**:**	**75 Marks**
				Total	**:**	**100 Marks**
				Duration of Examination	**:**	**3 Hours**

COURSE OBJECTIVES:

The objective of the course is to develop sampling and analytical skills of the students which are required in environmental monitoring. The students will be able to perform quantitative analysis of various physical, chemical and biological pollutants in environment with reference to air, water and soil. The students will acquire knowledge about various standard protocols used in environmental monitoring. The course will also help the students to learn the theory and concepts and develop their practical skills to use the contemporary tools and various techniques required.

UNIT-I

Basic concepts of quantitative analytical chemistry: The law of mass action, Chemical equilibrium, Ionic product, Buffer solution, solubility product, common ion effect, electrode potential, oxidation reduction reactions, preparation of standard solution, primary standard and secondary standard, normality, morality, molality, mole fraction.

UNIT II

Titrimetric methods: Acid base titration, precipitation titration, complexometric titration, oxidation-reduction titration. Chemical speciation – Alkali metal, Cu subgroup, Zn subgroup, Chromium subgroup

UNIT-III

Chromatography- Thin Layer chromatography, Liquid Chromatography, High Pressure Liquid Chromatography, Gas Chromatography, ion chromatography.

UNIT IV

Spectroscopy- General Principle, Atomic Absorption spectroscopy- Theory, Instrumentation, graphite furnance techniques, hydride generation, monochromators, Detectors, Atomic emission spectroscopy- Flame emission spectroscopy, Plasma emission spectrometry, Inductively coupled plasma, ICP instrumentation. Spectrophotometer, X – ray diffraction-principles, unit cell and space group, Bragg's equation, Flame photometry.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

COURSE OUTCOMES:

1. On completion of the course, the students will be:
2. Trained in analytical and conceptual skills required for environmental chemistry research.
3. Able to design and carry out a method of environmental chemical analysis, including instrumental analysis.

Recommended Books:

1. Environmental chemistry by Mannahan.
2. Environmental chemistry by A K De.
3. Introduction to environmental science and engineering by Gilbert M. Masters
4. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication III rd Edition.1986
5. Vogel's Textbook of quantitative chemical analysis, J. Mendham, R c Denney, J D Barnes, M J Thomas, Pearson, Education.
6. Environmental Soil Chemistry by Donald L. Sparks.
7. Fundamentals of Analytical chemistry by Skoog, West & Holler.
8. Environmental Pollution – principles, Analysis and control, by P. Narayanan.

EEM-106: ENVIRONMENTAL ENGINEERING LABORATORY II

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) 1st Year (II - Semester)

L	T	P/D	Credits			
--	-	4	2	**Class Work**	:	**20 Marks**
				Examination (Theory/Practical)	:	**30 Marks**
				Total	:	**50 Marks**
				Duration of Examination	:	**3 Hours**

COURSE OBJECTIVES:

The course has been designed to train the students in the laboratory for quantitative analysis of various physical and chemical pollutants in air and soil, and to provide firsthand experience on various instruments.

1. To determine moisture content, pH and conductivity of soil sample.
2. Analysis of heavy metals in different types of soil.
3. Working, standardization of flame photometer and plotting calibration curve for metal ions.
4. Conductivity of water and wastewater samples using conductivity and TDS meter.
5. Removal of pollutants from wastewater by Adsorption methods.
6. Sampling and analysis of SPM in stationary sources.
7. Study of TSPM, PM10 and PM2.5 in ambient air.
8. Analysis of ash contents of coal.
9. A visit to normal and secured landfill site, biological composting/vermicomposting units in the city.
10. Chemical speciation of heavy metal in soil (Any one heavy metal).

Note: At least six (6) out of ten (10) experiments will be carried out in one semester. Addition and deletion in the list of experiments may be made from time to time by the department depending on the requirement of course.

Course outcome:

The students will be able to
Analyse and quantify various environmental parameters/pollutants present in environment. Perform environmental quality measurements. Design various experiments for reducing the pollution load from water and wastewater streams.

EEM-108: ENERGY RESEARCH LABORATORY-II

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
-	--	4	2	Class Work	:	20 Marks
				Examination (Theory/Practical)	:	30 Marks
				Total	:	50 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

In order to supplement various topics related to energy aspects in class-room lectures, some laboratory experiments are needed as a part of curriculum development of energy studies programme for better understanding of the subjects. The experiments based on science/engineering principles are so designed so as to provide students enough stimulation for further investigation. Acquainting the students on the SOP adopted for quantification of various parameters. To inculcate the habit of analyzing the numbers resulting from experimentation. To create awareness on actual performance limits of renewable energy gadgets/ industrial utilities

1. To draw the charging and discharging characteristics of battery.
2. Workout power flow calculations of standalone PV system of DC load with battery.
3. Workout power flow calculations of standalone PV system of AC load with battery.
4. Workout power flow calculations of standalone PV system of DC and AC load with battery.
5. Performance analysis of PWM and MPPT type charge controllers.
   (a) Change in operating point of modules with and without MPPT with variation in load.
   (b) Comparison between charging points of battery with and without MPPT.
6. To convert and observe various DC voltages 17.5, 35, 70 V to 24, 48 & 96 V respectively using DC step up converters.
7. To convert and observe various DC voltages 17.5, 35, 70 V to 6, 12, 24 V respectively using DC step down converters.
8. To convert various DC voltages to 230 V single phase AC.
9. To analyse the efficiency of step up and step down converter and DC to AC converter at different power.
10. Measurement of IV characteristics at different temperature levels to extract temperature parameters of the modules(without fans)
11. Measurement of IV characteristics with change in illumination to analyse the deviation of operating points from Maximum power point.

12. Measurement of Quantum efficiency of solar cell for different wavelengths of light and obtain quantum efficiency curve. User can also measure Internal and external quantum efficiency measurements.
13. Measurement and comparison of spectral response for different wave lengths of light and obtain spectral response curve.
14. Determine the Performance (UL, FR, η) of the Parabolic Trough collector with varying flow rate of fluid (Water).
15. Determine the Performance (UL, FR, η) of the Parabolic Trough collector with different inlet water temperature.

Course outcomes:

Students will be knowledgeable on the:

Procedure to be adopted for performance analysis and optimization of energy utilities

Methodology to be adopted for the quantification of performance governing parameters

EEM-110: ENERGY RESEARCH LABORATORY-II

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
-	--	4	2	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

EEM-112: SOLAR PHOTOVOLTAIC TECHNOLOGY
M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

The Course will be introducing the students to all the aspects of PV technology. To develop basic understanding related to fabrication ad characterization of different types of solar cells. To know state of art in the field of solar cells materials and solar cells. To provide the introduction of solar photovoltaic system design and solar photovoltaic system testing.

Unit I
Solar Cells
Conversion of Solar energy into Electricity - Photovoltaic Effect, Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, Effect of temperature on Cell performance, Thermo photovoltaic effect, Types of solar cells, Recent developments in Solar Cells.

Unit II
Fabrication Technology for Solar Cells
Si solar cells, CdTe solar cells, Cu(In,Ga)Se2, GaAs solar cells, Organic solar Cells, Perovskite solar cells, High efficiency multi-junction solar cell. Technologies for the fabrication of thin film cells: Thermal evaporation, CVD, CSS etc.

Unit III
Solar Photovoltaic System Design
Solar cell array system analysis and performance prediction, Shadow analysis: Reliability, Solar cell array design concepts, PV system design, Design process and optimization: Detailed array design, Voltage regulation, Maximum tracking, Quick sizing method, Array protection.

Unit IV

Solar Photo Voltaic System Testing

Sun Simulator, Testing and performance assessment of Solar PV generator, Electronic Control and Regulation, Power Conditioning, Converters and inverter, Concentrating system, System design and configuration.

Course outcome:

This course will enable student to understand solar cells, fabrication technologies for solar cells, solar photovoltaic system design and solar photovoltaic system testing. This will enable students to understand the requirements for PV materials and PV systems for different applications. After completing this course student will have theoretical knowledge about fabrication of solar cells, device physics of solar cells, design and development of PV modules, arrays etc.

Text Books/ References:

1. AL Fahrenbruch and RH Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, New York, 1983

2. T Bhattacharya, Terrestrial Solar Photovoltaic, Narosa Publishers Ltd, New Delhi LD Partain (ed), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995

3. RH Bube, Photovoltaic Materials, Imperial College Press, 1998

4. HS Rauschenbach, Solar Cell Array Design Handbook, Van Nostrand Reinfold Company, New York, 1980

5. R Messenger and J Vnetre, Photovoltaic Systems Engineering, CRC Press Stand Alone PV Systems: A Handbook of Recommended Design Practices, Report No SAND 87-7023, Sandia National Lab USA

6. F Kreith and JF Kreider, Principles of Solar Engineering, McGraw-Hill (1978)

7. J Twidell and T Weir, Renewable Energy Resources, Taylor and Francis (Ed), New York, USA, 2006

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

EEM-114 : WATER AND WASTE WATER MANAGEMENT

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The objective of the course is to develop understanding of water quality criteria, standards, impacts of water pollutants and treatment methods. It focuses on causes and effects of water pollution and water quality degradation from different sources. The students will be educated on the principles, designs and functions of the unit processes in water or wastewater treatment and basic equipments that each process uses.

UNIT-1

Water-Global water scenario, Structure and basic properties of water, water sources-Surface and ground water, hydrological cycle, Physical and Chemical Characteristics of water – color, taste , odour, temperature, pH, Electrical Conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates, Total solids, Suspended Solids, Volatile Solids, Non Volatile Solids- Dissolved Oxygen, BOD and COD, Heavy metals in water, Disinfection of water

UNIT-II

Water Treatment: Introduction :Quality standard of domestic and industrial water,

Preliminary and Primary treatment: Screening, sedimentation: Principle of Sedimentation, Coagulation: Coagulation Process, Flocculation process, methods for determining Optimum coagulation dose.

Filtration: Slow sand filter, Rapid sand filter, Pressure filter, filter media, components, cleaning & backwashing process the under drain system and filter control.

UNIT-III

Biological Treatment: Attached Growth Biological Treatment Systems-Trickling Filters-Rotating Biological Contactors-Water stabilization ponds and Lagoons- aerobic pond, Facultative Pond, Anaerobic Ponds- Polishing Ponds, Aerated Lagoons , Up flow Anaerobic Sludge Blanket Reactors-Sludge Digestion, Sludge Disposal.

UNIT-IV

Tertiary treatment: Removal of dissolved inorganic, ion exchange, membrane processes, reverse osmosis, ultra filtration, electro-dialysis, removal of nitrogen and phosphorus (all process in brief) Sludge Treatment & Disposal: digestion process, composting, thickening, Dewatering, Drying beds, Management and disposal of residues.

Course Outcomes:

- After completion of this course, the students will be able to:
- Acquire the knowledge of basic rationale of water quality management.
- Suggest the suitable technologies for the treatment of drinking water and wastewater.
- They will be able to operate and manage troubleshoot problems of municipal and industrial water and wastewater treatment plants.
- Know the various methods for water resource management.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Recommended books:

1. Environmental Pollution – Peavy and Rowe.
2. Environmental Pollution and Solution – Asthana and Asthana.
3. Environmental pollution and control Engineering – C.S. Rao.
4. Waste water engineering: Treatment, Disposal and reuse by Metcalf and Eddy.
5. Water supply and sewage by Terence J.Mc. Ghee
6. Industrial Water Pollution Control by W. Wesley and Eckenfelder, Jr
7. Water and Wastewater Engineering by Mackenzie L. Davis
8. Edzwald, James K. (ed.) Water quality & treatment: A handbook on drinking water
9. Ujang, Zaini (Ed.) Municipal wastewater management in developing countries: Principles and Engineering.

EEM-116: SOLAR PASSIVE HEATING AND COOLING
M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1st Year (II - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

This course has objectives to elaborate PG students regarding current trends in solar architecture and following key concepts: Solar Radiation, Sun Angles, and Importance of Sun Angles for Building Fenestration/day lighting, Solar Passive Architecture, Natural Heating/Cooling concepts for Building, Earth to Air Heat Exchanger, passive heating, passive cooling and solar ventilation.

Unit I
Heating and cooling load of buildings: elements of heating and cooling load, load reduction approaches, building energy codes, thermal mass.

Unit II
Solar geometry and exposure: sun path diagram, shading analysis, graphical design tools, solar control issues.

Unit III
Passive heating: Direct and indirect solar passive heating systems; solarium, trombe wall, trans-wall.
Passive cooling systems: thermal mass, courtyard effect, wind tower design, earth air tunnel system, evaporative cooling, radiative cooling.

Unit IV
Solar ventilation: stack effect, solar chimney for ventilation, absorber design, stack design, issues in opening design.

Course outcome:

This will enable them to understand the solar architecture and following key concepts: Solar geometry, sun path diagram, heat transfer in buildings, Solar Passive Architecture, Flat plate collectors, Earth to Air Heat Exchanger, passive heating, passive cooling and green buildings.

Recommended Books:

1. M.S.Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Instructions to Energy Auditors, Vol. - I & Vol. - II –National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
6. BEE Volume I –Second Edition 2005
7. G.G. Ranjan: Optimizing Energy Efficiencies in Industry, Edition-2003 McGraw Hill

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

EEM-118 : ENVIRONMENTAL AUDITING AND IMPACT ASSESSMENT

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) 1st Year (II - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The students will acquire a better understanding of theoretical ideas of social impact, cultural and environmental impact due to development. This course will provide the basic knowledge to the students with an insight into environmental impact assessment (EIA) methodologies, environmental settings, prediction, evaluation of impacts and their mitigation plan. The students will also get idea to interpret environmental management plans and EIA documents. A comprehensive understanding of the need and procedures for environmental auditing will be provided to the students.

UNIT-I

National environmental policy act, and its implementation, Framework for environmental assessment, Environmental settings, Environmental impact assessment: definition, types, purpose, and evolution, Environmental impact assessment documentation and procedure.

UNIT-II

Environmental impact assessment: preliminary, impact prediction, evaluation, mitigation, decision, public participation, review, Monitoring and auditing, EIA techniques: Checklist, matrices, overlay map, network, and GIS, Practical consideration in writing impact statements.

UNIT-III

Types of Impacts, Prediction and assessment of impacts on the air environment, water environment, noise environment, biological, cultural, human health and socio-economic environment, Problems of EIA in developing countries.

UNIT-IV

Environmental auditing: Introduction, benefits, Guidelines and need for environmental audit, elements. Waste audit and pollution prevention assessment, Environmental audit in Industrial projects, Future of Environmental Impact Assessment, LCA, Environmental management system.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Course outcomes:

On completion of the course, the candidate will be able to:

1. Appreciate the importance of EIA as an integral part of planning process
2. Understand the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects.
3. Understand the legal requirements for getting environmental clearance for new projects.
4. Know the requirements to become EIA consultant.
5. To be a part of EIA team to conduct EIA study for various projects.
6. Acquire basic skills to take up environmental auditing and lifecycle analysis at specific industries.

Recommended books:

1. Environmental Impact Assessment by W. Canter
2. Environmental Audit by Mhastear, A.K.
3. EIA for developing countries by Biswas Asit, K.
4. Environmental Management by Vijay Kulkarni and T.V. Ramachandra
5. Environmental Impact Assessment Methodologies by Y. Anjaneyulu and Valli Manickam
6. Environmental Impact Assessment by, Clark D. Brain, Biesel Donald
7. Handbook of Environmental engineering assessment (Strategy, planning, and management) by Ravi Jain, Lloyd Urban, Harold Balbach and M. Diana Webb.

EEM- 201: SOLAR ENERGY UTILIZATION

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1Ind Year (III - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Objectives of the Paper:

This course has objectives to elaborate PG students regarding current trends in solar architecture and following key concepts: Solar Radiation, Sun Angles, and Importance of Sun Angles for Building Fenestration/day lighting, heat transfer in buildings, Solar Passive Architecture, Flat plate collectors, Earth to Air Heat Exchanger, passive heating, passive cooling and green buildings.

Unit I

Thermal comfort, Sun's motion, Building orientation and design, Thumb rules.

Unit II

Heat transfer in buildings, Thermal storage, Conversion of heat into mechanical energy, Active heating and cooling of buildings, Passive heating and cooling of buildings.

Unit III

Flat plate collectors: liquid and air type. Theory of flat plate collectors, advanced collectors, Solar water heating, solar dryers, solar stills, solar cooling and refrigeration.

Unit IV

Adoption to sustainable resources, process and Technologies. Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture. Eco-housing concepts and National and International norms. Illustrative passive buildings.

Course outcome:

After doing this course students will be familiar with state of art and up to date knowledge in the field of solar architecture and following key concepts: Solar Radiation, Sun Angles, and Importance of Sun Angles for Building Fenestration/day lighting. Students will be familiar with sustainable aspects related to green building technology.

Recommended References:1. Tiwari G.N. Solar Energy. CRC Press, New York (2002).

2. M.S. Sodha, N.K. Bansal, P.K. Bansal, A. Kumar, and M.A.S.Malik, *Solar Passive Building,* Science and Design, Pergamon Press, New York (1986).
3. Solar Energy of Thermal Processes, Second Edition, 1991, by JA Duffie and WA Beckman, John Wiley & Sons Inc.
4. Solar Energy, First Edition, 2002, by GN Tiwari, Narosa Publishing House.
5. Principals of Solar Engineering, Second Edition, 2000, by DY Goswami, F Krieth & JF Krieder, Taylor and Francis Inc.

Note: Eight (8) questions are to be set – uniformly distributed over the entire content of the course syllabus. Students shall have to attempt any five (5) of those questions

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EEM-203: MATERIALS AND DEVICES FOR ENERGY APPLICATIONS

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)1Ind Year (III - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

Unit I

Hydrogen Energy: Need and Relevance in relation to depletion of fossil fuels and environmental considerations.

Hydrogen Production: Photo-electrolysis, Fossil, Biological Process & Bio Fuels, Benefits and barriers of different production methods.

Unit II

Hydrogen Storage technologies: compressed storage, liquid state storage, solid state storage, different materials for storage – metal hydrides, high surface area materials, complex and chemical hydrides, hydrogen storage system – design and materials aspects. Advantages and disadvantage of different storage methods.

Metal Hydrides: Benefits, PC isotherms, Hydrogen storage methods.

Unit III

Fundamentals of Hydrogen storage in different materials: Carbon nanostructures, Magnesium hydrides, Intermetallics and other materials.

Unit IV

Hydrogen Fuel Cells: Principle and workings systems, Applications, Safety & Standards. Application of Hydrogen/Hydrides as fuel in Engines, Socio-Economic Aspects. Comparative future viability analysis, Hydrogen economics, Public acceptability of hydrogen, Policy implications and Current status.

Books/References:

1. Energy Technology- S. Rao (Khanna Publications)
2. Renewable Energy Sources and Emerging Technologies- D. P. Kothari (PHI Publisher)
3. Metal Hydrides-MVC Sastri (Narosa Publisher)
4. Solar Hydrogen Energy Systems T. Ohta (Ed.) (Pergamon Press) 1979

5. Hydrogen Technology for Energy – D.A.Maths (Noyes Data Corp.) 1976
6. Handbook : Batteries and Fuel cell – linden (McGraw Hill) 1984
7. Solid State Hydrogen Storage- Edited by Gavin Walker(CRC Publication)

Note: Eight (8) questions are to be set – uniformly distributed over the entire content of the course syllabus. Students shall have to attempt any five (5) of those questions.

EEM- 205 : BASICS OF TOXICOLOGY AND ENVIRONMENTAL RISK ASSESSMENT

M. Tech.-EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) I1nd Year (III - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The objective of the present course is to acquaint the students with various aspects of ecological toxicology. The students will be taught about the properties, origin, fate and behavior of environmental toxicants in the environment and in food. They will get to know about toxicological test methods, exposure measurements, calculations and risk valuation methods,

UNIT-I

Introduction to toxicity and its effects, fate of chemical toxicants in body (absorption, distribution and storage, biotransformation and elimination), basic of pharmacokinetics or toxicokinetic, toxic effects, structural affinity of toxicants, mechanism of toxic action and manifestation of toxic effects, classification of toxic action and effects, types and limitations of epidemiological studies.

UNIT-II

Basics of contaminants, contaminants release in environment, transport of contaminants in sub-surface, fate of contaminants in sub-surface, dispersion and transport of contaminants in atmosphere, contaminants as toxicants, toxicity reduction, bio-concentration and bio-magnification, brief introduction to contaminants degradation.

UNIT-III

Carcinogens and non-carcinogens, concepts of threshold, NOAEL (no observed adverse effect level), ADI (Acceptable daily intake) and RfD (reference dose) Toxicological database, calculation procedure for assessment of non-carcinogenic risk, initiation, promotion and progression of cancer, classification and types of carcinogens, role of carcinogenic chemicals,

concept of affinity of carcinogens and receptors, brief introduction to testing of carcinogenicity.

UNIT-IV

Quantitative risk assessment: definition, risk, purpose of risk assessment, hazard identification, dose response assessment, curve for carcinogens and non-carcinogens, exposure assessment, toxicity assessment, risk characterization and risk communication, Ecological risk assessment, ecological toxicity, exposure assessment and risk characterization.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Course Outcomes:

After completion of this course, the students will:

1. Know about the environmental toxicants, contaminants, their effects and fate environment and in human body;
2. Know various means to ensure the protection, promotion and maintenance of the health;
3. Be able to quantify the risks to human health of exposure to chemicals;
4. Increase skill to perform a scientifically based risk assessment of chemicals;
5. Have some idea about carcinogens and carcinogenicity;
6. Have ability to plan and perform a short scientific study and present the results in writing and orally.

Recommended books:

1. Environmental Impact Assessment Methodologies by Y. Anjaneyulu and Valli Manickam
2. Safety, occupational health and environmental management in construction by S.C. Sharma and Vineet Kumar Ist ed.
3. Industrial safety: health environment management system by R.K. Jain and Sunil S. Rao.
4. Hazardous waste management IInd ed. By Michael D. LaGrega, Phillip L. Bukingham and Jeffrey C. Evans
5. Lu basic toxicology: fundamentals, target organs, and risk assessment by Byung-Mu Lee, Sam Kacew Hyung Sik Kim, 7th ed.
6. Environmental pollutants and their bioremediation approaches edited by Ram Naresh Bharagava, CRC Press.
7. Environmental Management 2nd ed. By Bala Krishnamoorthy
8. Introduction to environmental engg. And Science 3rd ed. By Gilbert M. Masters and Wendell P. ELA.

EEM – 207 : SOCIETY AND ENVIRONMENT

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT) IInd Year (III - Semester)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	25 Marks
				Examination (Theory/Practical)	:	75 Marks
				Total	:	100 Marks
				Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The course intends to introduce the students to the vast field of ethics and Policies both at the national and international level relating to environment. The course also fosters an understanding of fundamental environmental issues with a focus on resource conservation and management for future use. To sensitize students towards environmental concerns and issues, and make them able to apply their knowledge for sustainable development

UNIT – I

Introduction to Environmental ethics, ethical theories, Environmental ethics and population, environmental ethics and pollution, animal ethics, biocentrism, ecocentrism.

UNIT-II

Concept of Sustainable development, threats to sustainability, guiding principles of sustainable development, sustainability indicators, sustainable development goals, national sustainable development strategies, environmental performance index, sustainable development in India: perspectives and strategies.

UNIT-III

Global Environmental Change - Stratospheric ozone layer: Causes of depletion and consequences; Global efforts for mitigation ozone layer depletion. Ozone hole, Climate change: Greenhouse effects; Chlorofluoro carbons, Drivers of climate change; Greenhouse gases and their sources; Implications on climate, oceans, agriculture, natural vegetation, wildlife and humans; Effects of increased CO2 on plants.

UNIT-IV

Global warming, El-Nino, Asian Brown Cloud, Photo-chemical smog, Acid rain and its effect on plants, animals, microbes and ecosystems. Pollution disaster- past, present and future (Bhopal gas tragedy, Cherobyl nuclear accident, Minamata accident, Leaded gasoline, Sukinda Valley, Space waste.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

Course outcomes:

On completion of the course, the students will be able to:

1. To sensitize students towards environmental concerns and issues, and make them able to
   apply their knowledge for sustainable development
2. To orient the students towards efficient environmental decision-making and management.
3. To develop understanding about the impacts of climate change and related mitigation strategies.

Recommended Books:

1. Environmental Management 2nd ed. By Bala Krishnamoorthy.
2. Environmental science and technology by M Anji reddy
3. Ecology, environmental science and conservation by J.S. Singh, S.P. Singh and S.R. Gupta
4. Environmental ethics by Joseph R. DesJardins
5. Sustainable Development by Kumar Das
6. The Age of Sustainable Development by Jeffrey D. Sachs.
7. Global Environmental Change: Understanding the Human Dimensions. N. Adger , K. Brown , D. Conway. (Vol. 22). 2012. The National Academic Press. 2. Karl K. Turekian. 1996.
8. Global Environmental Change-Past, Present, and Future. Prentice-Hall. 3. Richard Anthony Matthew. 2009.
9. Global Environmental Change and Human Security . Jon Barnett, Bryan McDonald, MIT Press., USA.
10. Global Environmental Change. Hester, R.E. and Harrison, R.M. 2002 Royal Society of Chemistry.

EEM-209: Phase-I Dissertation

M. Tech. - EEM (ENERGY AND ENVIRONMENTAL MANAGEMENT)IIND YEAR(III-SEM)

L	T	P/D	Credits			
3	--	--	3	Class Work	:	50 Marks
				Examination (Theory/Practical)	:	100Marks
				Total	:	150 Marks

Course Objectives:

1. To prepare student for specialized training on IC Engines, Thermal Engineering, Solar Energy, Hydrogen Energy, Gas Sensing and Photocatalytic Activity, Renewable Energy etc.

2. To make familiar with basic concepts of research and its methodologies

Outcome of Course:

After completion of the Phase-I Dissertation student will be able to:

1. To identify appropriate research topics

2. To understand research problem and parameters

3. To understand a project proposal

4. To understand how to conduct research

5. To understand basics of research report

COURSE OBJECTIVES:

The objective of the course is to develop understanding of water quality criteria, standards, impacts of water pollutants and treatment methods. It focuses on causes and effects of water pollution and water quality degradation from different sources. The students will be educated on the principles, designs and functions of the unit processes in water or wastewater treatment and basic equipments that each process uses.

UNIT-1

Water-Global water scenario, Structure and basic properties of water, water sources-Surface and ground water, hydrological cycle, Physical and Chemical Characteristics of water – color, taste , odour, temperature , pH, Electrical Conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates, Total solids, Suspended Solids, Volatile Solids, Non Volatile Solids- Dissolved Oxygen, BOD and COD, Heavy metals in water, Disinfection of water

UNIT-2

Water Treatment: Introduction :Quality standard of domestic and industrial water,

Preliminary and Primary treatment: Screening, sedimentation: Principle of Sedimentation, Coagulation: Coagulation Process, Flocculation process, methods for determining Optimum coagulation dose.

Filtration: Slow sand filter, Rapid sand filter, Pressure filter, filter media, components, cleaning & backwashing process the under drain system and filter control.

UNIT-3

Biological Treatment: Attached Growth Biological Treatment Systems-Trickling Filters-Rotating Biological Contactors-Water stabilization ponds and Lagoons- aerobic pond, Facultative Pond, Anaerobic Ponds- Polishing Ponds, Aerated Lagoons , Up flow Anaerobic Sludge Blanket Reactors-Sludge Digestion, Sludge Disposal.

UNIT-4

Tertiary treatment: Removal of dissolved inorganic, ion exchange, membrane processes, reverse osmosis, ultra filtration, electro-dialysis, removal of nitrogen and phosphorus (all process in brief) Sludge Treatment & Disposal: digestion process, composting, thickening, Dewatering, Drying beds, Management and disposal of residues.

Course Outcomes

- After completion of this course, the students will be able to:
- Acquire the knowledge of basic rationale of water quality management.
- Suggest the suitable technologies for the treatment of drinking water and wastewater.
- They will be able to operate and manage troubleshoot problems of municipal and industrial water and wastewater treatment plants.
- Know the various methods for water resource management.

Note: Eight (8) questions are to be set selecting two from each unit. Students shall have to attempt any five (5) selecting at least one from each unit.

RECOMMENDED BOOKS:

1. Water supply and sewage by Terence J.Mc. Ghee
2. Industrial Water Pollution Control by W. Wesley and Eckenfelder, Jr
3. Water and Wastewater Engineering by Mackenzie L. Davis
4. Edzwald, James K. (ed.) Water quality & treatment: A handbook on drinking water
5. Ujang, Zaini (Ed.) Municipal wastewater management in developing countries: Principles and Engineering.
6. Environmental Pollution and Solution – Asthana and Asthana.
7. Water supply and sewage by Terence J.Mc. Ghee
8. Industrial Water Pollution Control by W. Wesley and Eckenfelder, Jr
9. Water and Wastewater Engineering by Mackenzie L. Davis
10. Edzwald, James K. (ed.) Water quality & treatment: A handbook on drinking water

EEM-202: Phase-II Dissertation

M. Tech. –(ENERGY AND ENVIRONMENTAL MANAGEMENT) 2nd Year (IV – Semester)

L	T	P/D	Credits			
				Class Work	**:**	**100 Marks**
3	**--**	**--**	**3**	**Examination (Theory/Practical)**	**:**	**200 Marks**
				Total	**:**	**300 Marks**

Course Objectives:

1. To provide specialized training on IC Engines, Thermal Engineering, Solar Energy, Hydrogen Energy, Gas Sensing and Photocatalytic Activity, Renewable Energy etc.
2. To understand some basic concepts of research and its methodologies

Outcome of Course:

After completion of the Phase-II Dissertation student will be able to:

1. To identify appropriate research topics
2. To select and define appropriate research problem and parameters
3. To prepare a project proposal (to undertake a project)
4. To organize and conduct research (advanced project) in a more appropriate manner
5. To write a research report and thesis
6. To write a research proposal (grants)