GALGOTIAS UNIVERSITY

Syllabus of

M. Tech: ENERGY AND ENVIRONMENTAL ENGINEERING

Name of School: School of Engineering

Department: Civil Engineering

Year: 2018-20

Curriculum and Syllabi

M. Tech: ENERGY AND ENVIRONMENTAL ENGINEERING

School of Civil Engineering

(2018-2020)

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Plot No.: 2, Sector: 17 A, Yamuna Expressway, Gautam Budh Nagar, UP (India)203201

www.galgotiasuniversities.edu.in

CURRICULUM

First Semester

Sl. No	Course Code	Name of the Course	L	T	P	C
1	CENG5001	Professional and Communication Skills	0	0	4	2
2	MATH5001	Advanced Numerical and Statistical Methods	3	1	0	4
3	MENE5001	Renewable Energy Technology	3	0	0	3
4	MENE5002	Physico-chemical, Biological Principles and Processes	3	0	0	3
5	MENE5003	Environmental Quality Monitoring	3	0	0	3
6	MENE5004	Energy Auditing, Conservation & Management	3	0	0	3
7	MENE5005	Renewable Energy Technology Lab	0	0	2	1
8	MENE5006	Environmental Quality Monitoring Lab	0	0	4	2
		Total	15	1	10	21

Second Semester

Sl No	Course Code	Name of the Course	L	T	P	C
1	MENE6001	Energy, Instrumentation, Measurement & Control	3	0	0	3
2	MENE6002	Environmental Audit & Impact Assessment	3	0	0	3
3	MENE6003	Design of Water & Wastewater Treatment Systems	3	0	0	3
4	MENE6004	Air Pollution & Its Control	3	0	0	3
5	MENE6019	Elective-I (Energy Environment Climate Change)	3	0	0	3
6	MENE6013	Elective-II (Solar Energy Technologies)	3	0	0	3
7	MENE6005	Seminar	0	0	0	1
8	MENE6006	Energy, Instrumentation, Measurement &Control Lab	0	0	2	1
		Total	18	0	2	20

Third Semester

Sl No	Course Code	Name of the Course	L	T	P	C
1	MENE7001	Comprehensive Examination	0	0	0	2
2	MENE7002	Project (Phase I)	0	0	0	5
3	MENE6029	Energy Efficient Buildings (Elective-III)	3	0	0	3
4	MENE6032	Solid Waste Management (Elective-IV)	3	0	0	3
5	MENE6037	Remote Sensing & GIS Applications (Elective-V)	3	0	0	3
		Total	9	0	0	16

Fourth Semester

Sl No	Course Code	Name of the Course	L	T	P	C
1	MENE8001	Project (Phase II	0	0	0	15
		Total	0	0	0	15

School of Civil Engineering

List of Program Electives

Sl No	Course Code	Name of the Electives	L	T	P	C
1	MENE6013	Solar Energy Technology	3	0	0	3
2	MENE6015	Hydrogen & Fuel Cells	3	0	0	3
3	MENE6019	Energy Environment Climate Change	3	0	0	3
4	MENE6027	Bioenergy Technologies	3	0	0	3
5	MENE6029	Energy Efficient Building	3	0	0	3
6	MENE6032	Solid Waste Management	3	0	0	3
7	MENE6034	Design of Wastewater Treatment & Disposal System	3	0	0	3
8	MENE6035	Urban Environmental Quality Management	3	0	0	3
9	MENE6037	Remote Sensing & GIS Applications	3	0	0	3
10	MENE6038	Application of Bio-technology in Environmental Engineering	3	0	0	3
11	MENE6039	Risk Assessment and Disaster Management	3	0	0	3
12	MENE6040	Mathematical Modelling in Environmental Engineering	3	0	0	3
13	MENE6041	Clean Development Mechanism & Green Technologies	3	0	0	3
14	MENE6042	Environmental Ecology	3	0	0	3
15	MENE6046	Environmental Economics, Legislation and Management	3	0	0	3

MENE5001	Renewable Energy Technology	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

Course Objectives

1. Fundamental knowledge to the student about renewable and non-renewable energy.
2. Brief idea to students about types of energy and conversion technologies, processes, systems and devices.
3. Plasticize students to work with instruments
4. Encourage students to take up projects in those areas.
5. Implementation of renewable energy in project and development.

Course Outcomes

At the end of the course, the student will be able to

1. Explain the basic principles of various renewable energy conversion processes and devices used therein.
2. Understand the relationships between natural resources, consumption, population, economics of consumerism, etc in an environmental context.
3. Identify various parameters that influence the performance of devices/processes.
4. Undertake field projects in these areas.
5. an understanding the problems of energy distribution, design, plan and execute
6. Awareness of the environmental problems faced by the modern man in terms of energy.
7. To make a thought in terms of scientific and technological advancement in the spirit of a sustainable energy.

Catalog Description

Renewable energy sources; Sun-earth relationships; Cell types, manufacture and components; preparation, characteristics and application of Biomass; Gasification; Power in the wind; Power curves and energy estimation; Technologies for harnessing other renewable energy.

Text Books

1. Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy, CRC Press.
2. John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.

Reference Books

1. John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.

COURSE CONTENT

Unit I: Introduction to energy and resources **9 lecture hours**

Introduction to energy and resources – Renewable energy sources - Availability of solar energy – Sun-earth relationships - Estimation of solar radiation using Page-Angstrom method - Solar radiation measurement – Flat plate collectors – Solar water heating systems – Evacuated Tubular Concentrators - Solar air heating systems and applications – Concepts on solar drying, cooking, desalination, solar ponds and solar cooling - Passive heating and cooling of buildings – Basics of solar concentrators and types - Solar thermal power generation.

Unit II: Solar Cells **10 lecture hours**

Physics of solar cells – Cell types and manufacture – PV applications - Characteristics of cells and module – Performance parameters - Estimation of module power output – PV system configurations – System components: Battery, charge controller and inverter.

Unit III: Biomass **10 lecture hours**

Biomass to energy conversion processes – Anaerobic digestion, process parameters, biogas composition, digester types, high rate anaerobic conversion systems – Alcohol from biomass – Biodiesel: preparation, characteristics and application - Biomass combustion and power generation – Briquetting – Gasification: Process, types of gasifiers, applications – Waste to energy technologies.

Unit IV: Wind Power **7 lecture hours**

Power in the wind - Types of wind mills – WEG components - Airfoils: lift and drag – Power curves and energy estimation - Micro siting – Indian wind potential. Small Hydro Power: Types, site identification, head and flow measurement, discharge curve, estimation of power potential and system components.

Unit V: Renewable Energy Technologies **9 lecture hours**

Technologies for harnessing other renewable energy sources like geothermal, wave, tidal and ocean thermal energy.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Explain the basic principles of various renewable energy conversion processes and devices used therein	1,7
2	Identify various parameters that influence the performance of devices/processes	1, 2, 12
3	Undertake field projects in these areas	1, 9, 11
4	An understanding the problems of energy distribution, design, plan and execute	1, 2, 3, 11, 12
5.	Awareness of the environmental problems faced by the modern man in terms of energy.	5, 6,10,12

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 5001	**Renewable Energy Technology**	2	2	1				2		2	1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE5002	Physico-chemical, Biological Principles and Processes	L	T	P	C
Version1.02	Date of Approval:	4	0	0	4
Pre-requisites	--				
Co-requisites	--				

Course Objectives

1. To study about the solid- liquid- gas interactions
2. To understand about process kinetics
3. To deal with the microbial applications in environmental engineering
4. To study microbial activity and its application to treat wastewater
5. To apply microbial kinetics to addressed wastewater treatment problems

Course Outcomes

CO1 Understand the mass transfer and transport of impurities in system
CO2 Apply the concepts of oxidation- reduction equilibrium
CO3 Study and applying practically about microbial kinetics
CO4 Application of micro-organism for wastewater treatment
CO5 Apply microbial principles to environmental engineering

Catalog Description

Structure and Properties of Water ; Chemical Reactions; Ecosystems; biotic and abiotic components; Biochemistry; Biological compounds; Applications of Microbiological principles to environmental engineering

.

Text Books

3. Benefield, L.D. Judkins J.F. and Weand B.L. (1982). Process Chemistry for Water and Wastewater Treatment, End ed., Prentice-Hall, Inc, New Jersey, USA

Reference Books

1. Metcalf and Eddy, M.C., "Wastewater Engineering: Treatment, Disposal and Reuse", Tata McGraw-Hill Pulications, New Delhi, 2003

COURSE CONTENT

Unit I: Structure and Properties of Water	**8 Hours**
Structure and Properties of Water- their significance in environmental engineering, Sources of Water impurities, Abiotic reactions, Biological metabolism. Solid-Liquid-Gas interactions, Mass transfer and transport of impurities in water, diffusion, dispersion. Physical and Chemical interactions due to various forces, suspensions and dispersions.	
Unit II: Chemical Reactions	**8 Hours**
Chemical reactions, Chemical equilibrium and thermodynamics, Acid-baseequilibria, solubility equilibria, oxidation-reduction equilibria. Process kinetics, reaction rates and catalysis, surface and colloidal chemistry, Adsorption. Settling of particles in water stabilization.	

Unit III: Ecosystem **8 Hours**
Ecosystems; biotic and abiotic components, biogeochemical cycles, ecology of population; Ecological niche, Mortality and survivorship, CommModuley Interactions. typical natural and artificial ecosystems
Unit IV: Biochemistry **8 Hours**
Biochemistry; Biological compounds– enzymes, coenzymes and amino acids, Microbiological concepts; Cells, classification and characteristics of living organisms, Characterization techniques, Reproduction, Metabolism, Microbial growth kinetics.
Unit V: Applications of Microbiological principles to environmental engineering 8 Hours
Applications of Microbiological principles to environmental engineering; assimilation of wastes, engineered systems, Concepts and Principles of carbon oxidation, Nitrification, Denitrification, Methanogenasis, etc., Concepts of quantization of degradable pollutants.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Explain Structure and Properties of Waterconversion processes Ecosystems, Microbiological concepts	1,7
2	Solid-Liquid-Gas interactions, Mass transfer and transport of impurities in water, diffusion, dispersion	1, 2, 12
3	Undertake field projects in these areas	1, 9, 11
4	An understanding the problems of Physical and Chemical interactions due to various forces	1, 2, 3, 11, 12
5.	Awareness of the environmental problems faced by engineered systems, Nitrification, Denitrification	5, 6,10,12

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 5002	**Physico-chemical, Biological Principles and Processes**	2	2	1				2		2	1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE5003	Environmental Quality Monitoring	L	T	P	C
Version1.01	Date of Approval:	2	0	0	2
Pre-requisites	--				
Co-requisites	--				

Course Objectives

1. To teach students about various water quality parameters and their effect
2. Explain brief procedure for collection and preservation of samples of water and wastewater
3. Give idea to students about different standard methodologies for sampling and analysis of environment at whole and its constituents like water, wastewater, air and soil
4. To teach advance analytical methods for environmental quality monitoring
5. Conduct small projects on water quality monitoring of polluted and waste water in field condition

Course Outcomes

At the end of the course, the student will be able to

1. Schedule field studies and other data acquisition activities to be considered for compliance
2. Use a tiered monitoring approach consisting of rapid assessment or screening studies at site
3. Supervise monitoring techniques of various environmental parameters
4. Generate monitoring data relevant to decision making process
5. Manage and report environmental quality data in a way that is meaningful and understandable to intended audience

Catalog Description

Data interpretation and analysis; Materials and Methodology for different water quality parameters; analysis of particulates and common chemical air pollutants; Sampling techniques; various analytical methods;

Text Books

1. Metcalf and Eddy, (2003), Wastewater Engineering Treatment and Reuse, 4th edition, Tata McGraw Hill Education Private Limited, ISBN:978-00-704-9539-5.

2. S.K.Garg (2010), Sewage Disposal and Air Pollution Engineering, Khanna Publishers, ISBN:978-81-740-9230-4

3. MN.Rao, H.V.N.Rao, (2007), Air Pollution, Tata McGraw Hill Publishing Company Limited, ISBN: 978-00-745-1871-7

Reference Books

1. Stanley E. Manahan (2005), Environmental Chemistry, 8th Edition, CRC Press, ISBN: 978-15-667-0633-9.

2. Clair N Sawyer, Perry L. McCarty and Gene F. Parkin (2002), Chemistry for Environmental Engineering and Science, McGraw-Hill Science.
3. Gilbert M Master, Wendell P Ela, (2008), Environmental Engineering and Sceince, PHI Learning Pvt. Limited, ISBN:978-81-203-3691-9
4. Howard S.Peavy, Donald R Rowe, George Tchobanoglous, (1985), Environmental Engineering,
5.McGraw Hill Publishing Co.,ISBN:978-0-710-0231-8
C.S.Rao (2006), Environmental Pollution Control Engineering, New Age International, ISBN:978-81-224-1835-4

COURSE CONTENT

Unit I: General Sampling and Analytical Techniques 9 lecture hours

General principles for collection of representative sample, frequency of sampling, validation, interpretation and analysis of data, various statistical techniques, quality control, assessment and management.

Unit II: Methods for Physicochemical Analysis of Water/ Wastewater 10 lecture hours

Gravimetric methods for solids analysis in water and wastewater, determination of acidity, alkalinity and turbidity, analysis of common cations and anions in water/wastewater through various chemical techniques, determination of nitrogen, phosphorus and chemical oxygen demand (COD), acid-base titrations, precipitation titrations, complexometric titrations, oxidation-reduction titrations, working principles of electrodes, different types of electrodes.

Unit III: Biological Methods and Microbiology 10 lecture hours

Biochemical oxygen demand (BOD), MPN test for microbial pollution, plate counts; confirmatory tests for various microbiological agents.

Unit IV: Air Pollution Measurements 7 lecture hours

Sampling techniques for air pollution measurements; analysis of particulates and common chemical air pollutants, analysis of oxides of nitrogen, oxides of sulphur, carbon monoxide, hydrocarbon and poly aromatic hydro carbons.

Unit V: Advanced Analytical Methods 9 lecture hours

Working principles of Spectrophotometric methods; Nephelometric methods; Atomic absorption spectroscopy and its various analytical versions; Ion chromatography, High performance liquid chromatography, CHNO/S Analyzer, TOC analyzer and other advanced analytical instruments.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Schedule field studies and other data acquisition activities to be considered for compliance	1,2, 7
2	Use a tiered monitoring approach consisting of rapid assessment or screening studies at site	1, 2, 9,12
3	Supervise monitoring techniques of various environmental parameters	5, 9, 11
4.	Generate monitoring data relevant to decision making process	1, 2, 3
5.	Manage and report environmental quality data in a way that is meaningful and understandable to intended audience	7, 8, 12

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE5003	**Environmental Quality Monitoring**	2	2	3				2		2	1		1

MENE5004	Energy Auditing Conservation and Management	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

1. To teach the basic concepts of energy audit and management.
2. Give brief knowdge about mathematical calculation and modelling of energy performance
3. Teach students about data collection and analysis
4. The energy auditing procedures, techniques, policy planning, implementation and energy audit instrument
5. To give a broadly knowledge about planning and management for economical growth

Course Outcomes

At the end of the course, the student will be able to

1. Understand the general aspect of energy auditing and management
2. Development of knowledge about the energy auditing procedures, techniques, policy planning and implementation.
3. Understand about energy audit instrument.
4. Mathematical approach of data collection and analysis.
5. Design of energy modelling and optimization

Catalog Description

Energy Management Strategy; Energy performance; energy /fuel and system operations; Heat transfer calculations; Accountability; Information Systems; Materials and Energy Balance diagram; Energy Modelling and Optimization; Instruments for Audit.

Text Books

1. 1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press).
3. Efficient Use of Energy : I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics -A.V.Desai (Wieley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergammon Press)

Reference Books

1. Stanley E. Manahan (2005), Environmental Chemistry, 8th Edition, CRC Press, ISBN: 978-15-667-0633-9.

2. Clair N Sawyer, Perry L. McCarty and Gene F. Parkin (2002), Chemistry for Environmental Engineering and Science, McGraw-Hill Science.

3. Gilbert M Master, Wendell P Ela, (2008), Environmental Engineering and Sceince, PHI Learning Pvt. Limited, ISBN:978-81-203-3691-9

4. Howard S.Peavy, Donald R Rowe, George Tchobanoglous, (1985), Environmental Engineering, McGraw Hill Publishing Co., ISBN:978-0-710-0231-8

5. C.S.Rao (2006), Environmental Pollution Control Engineering, New Age International, ISBN: 978-81-224-1835-4

COURSE CONTENT

Unit I: General Aspects 9 lecture hours

General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. Energy Audit: Need, Types, Methodology and Approach. Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution.

Unit II: Procedures and Techniques 10 lecture hours

Data gathering : Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering.

Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.

Unit III: Energy Policy Planning and Implementation 10 lecture hours

Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability. Motivating – Motivation of employees, Requirements for Energy Action Planning. Information Systems: Designing, Barriers, Strategies, Marketing and Communicating Training and Planning.

Unit IV: Energy Balance & MIS 7 lecture hours

First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses, Improvements. Energy Balance sheet and Management Information System (MIS) Energy Modeling and Optimization.

Unit V: Energy Audit Instruments 9 lecture hours

Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Understand the general aspect of energy auditing and management	1, 2
2	Development of knowledge about the energy auditing procedures, techniques, policy planning and implementation.	2, 9,12
3	Understand about energy audit instrument.	5, 9, 11
4.	Mathematical approach of data collection and analysis.	1, 3,9
5.	Design of energy modelling and optimization	2, 3,11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
MENE 5004	**Energy Auditing, Conservation &Management**	1	2	3	4	5	6	7	8	9	10	11	12

MENE5005	Renewable Energy Technology Lab	L	T	P	C
Version1.02	Date of Approval:	0	0	2	1
Pre-requisites	**Renewable Energy Technology**				
Co-requisites	--				

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

This subject is taught

1. to impart knowledge in the area of biomass to energy
2. working principle knowledge of instruments
3. brief knowledge about various renewable energy parameters
4. knowledge about handling the instruments and how to operate in filed
5. the role of instruments in different engineering applications.

Course Outcomes

At the end of course, the student will be able to:

1. Study the devices used to measure various forms of energy.
2. Understand the basic working principle of energy measuring devices
3. Knowledge of various flow parameters
4. Handling efficiency of instruments and problem solving
5. Technical approach of the instruments in field condition

Catalog Description

Electrical energy meter; various instruments for energy analysis, controllers; air flow meter; Function of odometer; classification and function of flow meters

Text Books

1. Fundamentals of Aerodynamics (McGraw-Hill International Editions: Mechanical Engineering Series) by John David Anderson , Tata Mcgraw-Hill Education.
2. Electrical Measurements and Measuring Instruments by A.K Sawhney**.**
3. Flow measurement: practical guides for measurement and control by David W. Spitzer, Instrument Society of America.

Reference Books

1. Energy Management Handbook by Steve Doty, Wayne C. Turne
2. Handbook of Energy Engineering by Albert Thumann, D. Paul Mehta.
3. Guide to Energy Management by B. L. Capehart, Wayne C. Turner, William J. Kennedy

COURSE CONTENT

1. Determination of proximate analysis (Moisture content, ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids, volatile Solids and calorific value for a given organic

Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
5. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.
6. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.
8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
9. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.
10. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
11. Determination of Crude Protein in a Given Biomass Sample.
12. Study of Gasifier and its performance evaluation with solid and loose biomass.
13. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Practical**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Study the devices used to measure various forms of energy.	1, 2,3
2	Understand the basic working principle of energy measuring devices	1, 9,12
3.	Knowledge of various flow parameters	1, 2
4.	Handling efficiency of instruments and problem solving	5, 11
5.	Technical approach of the instruments in field condition	9, 11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 5005	**Renewable Energy Technology Lab**	2	3	1						1			2

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE5006	Environmental Quality Monitoring Lab	L	T	P	C
Version1.01	Date of Approval:	0	0	4	2
Pre-requisites	**Environmental Quality Monitoring**				
Co-requisites	--				

Course Objectives

This subject is taught

1. to impart knowledge in the area of sampling and statistical analysis
2. working principle knowledge of instruments
3. brief knowledge about various parameters
4. knowledge about handling the instruments and how to operate in field
5. the role of instruments in different engineering applications.

Course Outcomes

At the end of the laboratory experiments, the student will be able to

1. Learn various instruments process and about their features
2. How to handle the instruments
3. Supervise monitoring techniques of various environmental parameters
4. Generate monitoring data and their application in various treatment process
5. Manage and report environmental quality data in a way that is meaningful and understandable to intended project

Catalog Description

Data interpretation and analysis; Materials and Methodology for different water quality parameters; analysis of particulates and common chemical air pollutants; Sampling techniques; various analytical methods;

Text Books

1.Metcalf and Eddy, (2003), Wastewater Engineering Treatment and Reuse, 4th edition, Tata McGraw Hill Education Private Limited, ISBN:978-00-704-9539-5.
2.S.K.Garg (2010), Sewage Disposal and Air Pollution Engineering, Khanna Publishers, ISBN:978-81-740-9230-4
3.MN.Rao, H.V.N.Rao, (2007), Air Pollution, Tata McGraw Hill Publishing Company Limited, ISBN:978-00-745-1871-7

Reference Books

1. Stanley E. Manahan (2005), Environmental Chemistry, 8th Edition, CRC Press, ISBN: 978-15-667-0633-9.
2. Clair N Sawyer, Perry L. McCarty and Gene F. Parkin (2002), Chemistry for Environmental Engineering and Science, McGraw-Hill Science.

3. Gilbert M Master, Wendell P Ela, (2008), Environmental Engineering and Sceince, PHI Learning Pvt. Limited, ISBN:978-81-203-3691-9
4. Howard S.Peavy, Donald R Rowe, George Tchobanoglous, (1985), Environmental Engineering,
5.McGraw Hill Publishing Co.,ISBN:978-0-710-0231-8
C.S.Rao (2006), Environmental Pollution Control Engineering, New Age International, ISBN:978-81-224-1835-4

List of Experiments

1. Estimation of pH
2. Determination of Total, suspended, dissolved volatile & fixed residue in a waste/water sample
3. Determination of Turbidity
4. Determination of the Carbonate, Bicarbonate, and Hydroxide Alkalinity
5. Determination of the type and Extend of Acidity
6. Estimation of the Optimum Dose of Coagulants for Coagulation
7. Estimation of the Hardness of water (EDTA Method)
8. Estimation of the Chloride Concentration.
9. Determination of the Dissolved Oxygen (DO) and percentage saturation
10. Determination of Biochemical Oxygen Demand (BOD) of wastewater
11. Determination of Chemical Oxygen Demand (COD) of wastewater

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Learn various instruments process and about their features	1, 2,3
2	How to handle the instruments	1, 9,12
3.	Supervise monitoring techniques of various environmental parameters	1, 2
4.	Generate monitoring data and their application in various treatment process	5, 11
5.	Manage and report environmental quality data in a way that is meaningful and understandable to intended project	9, 11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE5006	**Environmental Quality Monitoring Lab**	2	3	1						1			2

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6001	Energy, Instrumentation, Measurement & Control	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

Course Objectives

This subject is taught

1. to impart knowledge in the area of numerical integration and Calculus
2. working principle knowledge of energy meter
3. brief knowledge about various flow parameters
4. knowledge about handling the instruments and how to operate in filed
5. the role of instruments in different engineering applications.

Course Outcomes

At the end of course, the student will be able to:

1. Study the devices used to measure various forms of energy.
2.Understand the basic working principle of energy measuring devices
3.Knowledge of various flow parameters
4.Handling efficiency of instruments and problem solving
5.Technical approach of the instruments in field condition

Catalog Description

Electrical energy meter; various instruments for energy analysis, controllers; air flow meter; Function of odometer; classification and function of flow meters

Text Books

1. Fundamentals of Aerodynamics (McGraw-Hill International Editions: Mechanical Engineering Series) by John David Anderson , Tata Mcgraw-Hill Education.
2.Electrical Measurements and Measuring Instruments by A.K Sawhney**.**
3.Flow measurement: practical guides for measurement and control by David W. Spitzer, Instrument Society of America.

Reference Books

1.Energy Management Handbook by Steve Doty, Wayne C. Turne
2.Handbook of Energy Engineering by Albert Thumann, D. Paul Mehta.
3.Guide to Energy Management by B. L. Capehart, Wayne C. Turner, William J. Kennedy

COURSE CONTENT

Unit I: Electrical Energy Metering **9 lecture hours**

Electrical energy meter, One –Phase energy meters, Three Phase Energy meters, working principle, various compensation, Automatic meter reading systems.

Unit II: Thermal Energy Metering **10 lecture hours**

Combustion analyser, Fuel efficiency monitor , Flue gas analyzer, Thermometers, Thermocouples & RTDs, Potentiometric & Paperless Recorders, I/P Converters, Temperature Transmitters, Optical Pyrometer, Digital indicators, PID Controllers, Loop Powered Indicators & Isolators, BTU meters, Thermistors, Heat Flux sensor.

Unit III: Air Flow Metering **10 lecture hours**

Air flow meters: vane (flap) type air flow meters and “hot wire" and "hot film" air mass meters. Anemometer, types and its classification, working principle.

Unit IV: Gas Flow Metering **7 lecture hours**

Types and its basic working principle, Odometer.

Unit V: Fluid Flow Metering **9 lecture hours**

Classification of fluid flow meters based on the operating principle- Differential Pressure Flowmeters, Velocity Flow meters, Positive Displacement Flowmeters, Mass Flowmeters, Open Channel Flowmeters, Types:-Orifices, Venturies, Nozzles, Rotameters, Pitot Tubes, Calorimetrics, Turbine, Vortex, Electromagnetic, Doppler, Ultrasonic, Thermal, Coriolis.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Study the devices used to measure various forms of energy.	1, 2,3
2	Understand the basic working principle of energy measuring devices	1, 9,12
3.	Knowledge of various flow parameters	1, 2
4.	Handling efficiency of instruments and problem solving	5, 11
5.	Technical approach of the instruments in field condition	9, 11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6001	**Energy, Instrumentation, Measurement & Control**	2	3	1						1			2

1=addressed to small extent
2= addressed significantly

MENE6002	Environmental Audit & Impact Assessment	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

3=major part of course

Course Objectives

The course is intended

1. to teach the basic concepts of environmental audit impact assessment and policy.
2. to provide a critical overview of the theory and practice of EIA as operated internationally to those students who need to understand EIA
3. field visit and EIA study of different field cases
4. how to conduct project on sustainability of environment

Course Outcomes

At the end of the course, the student will be able to

1. define EIA, different types of EIAs and benefits of EIA
2. describe the role of EIA in sustainable development
3. Skill development for project planning process
4. take a decision-making process in environmental clearance and public relation
5. Make a plan for International environmental issues and sustainable development

Catalog Description

Relationship between an environmental audit and an EIA; small scale and large scale enterprises; Purpose and aims of EIA; principles and elements of EIA; sustainable development plans; EIA -Treaties

Text Books

1. Fundamentals of Aerodynamics (McGraw-Hill International Editions: Mechanical Engineering Series) by John David Anderson , Tata Mcgraw-Hill Education.
2. Electrical Measurements and Measuring Instruments by A.K Sawhney**.**
3. Flow measurement: practical guides for measurement and control by David W. Spitzer, Instrument Society of America.

Reference Books

1.Energy Management Handbook by Steve Doty, Wayne C. Turne
2.Handbook of Energy Engineering by Albert Thumann, D. Paul Mehta.
3.Guide to Energy Management by B. L. Capehart, Wayne C. Turner, William J. Kennedy

COURSE CONTENT

Unit I: General Aspects **9 lecture hours**

Definition of Environmental Audit (EA). Types of environmental audits. Policies and legislation relating to environmental audits. Conducting an audit. Audit reports. Relationship between an environmental audit and an EIA. The benefits of EA. Guidelines for EAs (General Principles, Criteria, evidence and findings, Reporting). EA objectives, roles and responsibility. EA as environmental management tool for small scale and large scale enterprises. EA and sustainable development. Responsibilities in conducting EAs.
The benefits of database in EAs. Future Direction of EA

Unit II: Environmental Impact Assessment-1 **10 lecture hours**

Economic development, population growth and impact on the environment. Introduction to Environmental Impact assessment. The history of Environmental Impact assessment (EIA). Purpose and aims of EIA. EIA administration and practice Converging opportunities (i.e. development and environmental protection are complimentary), environmental management and sustainable development.

Unit III: Environmental Impact Assessment-2 **10 lecture hours**

EIA in project planning and management. The costs and benefits of EIA. Introduction to the key principles and elements of EIA, core values (sustainability, integrity, utility). EIA guiding principles (e.g. participation, transparency, flexibility, etc). Introduction to the main features of the EIA system. Role of public participation stages that follow EIA Understanding of the strengths and limitations of EIA.

Unit IV: Environmental Policy-1 **7 lecture hours**

Overview of the legislative and institutional characteristics essential for the support of a national EIA system. Factors that help to establish an effective national EIA system. Steps involved in establishing and modifying a national EIA system.

Unit V: Environmental policy-2 **9 lecture hours**

The level of public involvement in EIA and the relative advantages and disadvantages they offer. Techniques for communicating with the public. Consensus building and dispute resolution mechanisms. International environmental issues and sustainable development plans. International environmental laws and policies of relevance to EIA -Treaties, conventions etc.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Define EIA, different types of EIAs and benefits of EIA	1, 2
2	Describe the role of EA in sustainable development	1, 2, 12
3	Skill development for project planning process	1,7,12
4.	take a decision-making process in environmental clearance and public relation	7,12
5.	Make a plan for International environmental issues and sustainable development	1,7

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

MENE6003	Design of Water and Wastewater Treatment Systems	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

MENE 6002	**Environmental Audit and Impact Assessment**	1	2					2			1	1	1

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

Brief knowledge to the student about

1. various water treatment processes and their designing criteria
2. implementation of technologies in wastewater treatment in order to make water safe to drink
3. to teach various options available in treatment of waste water for recycle and safe disposal
4. design of bioreactors for degradation of nutrients
5. application of wastewater treatment in field by research projects

Course Outcomes

At the end of the course, the student will be able to

1. understand various unit operations involved in water treatment and design various water treatment units required.
2. planning and siting of water treatment plant
3. effect of wastes disposal to water
4. design of physical units for waste treatment.
5. design of bioreactors for biodegradation of wastewater treatment

Catalog Description

Philosophy of water treatment; Unit Operations; Design of Advanced Unit Operations; Chemical requirement and residuals management; Design of sewers and sewerage systems; Planning and siting of Wastewater treatment plant.

Text Books

1.Metcalf and Eddy, M.C., “Wastewater Engineering: Treatment, Disposal and Reuse”, Tata McGraw-Hill Publications, New Delhi, 2003
2.Benefield, L.D. Judkins J.F. and Weand B.L. (1982). Process Chemistry for Water and Wastewater Treatment, End ed., Prentice-Hall, Inc, New Jersey, USA

3.Benefield L.D. and Randall, C.W. (1980). Biological process design for wastewater treatment. Prentice-Hall. N.J.
4.Pelczar, M.J., Chan ECS and Krieg NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
5.Talaro K., Talaro A CassidaPelzar and Reid, (1993) Foundations in Microbiology, W.C. Brown Publishers.
6.Sawyer, McCarty, and Parkin, 2003.Chemistry for Environmental Engineers, 5th" McGraw Hill

Reference Books

McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto

COURSE CONTENT

Unit I: Definitions and Concepts — 9 lecture hours

Water sources, Philosophy of water treatment, Review of water quality characteristics and potable water standards, Estimation of water quantity, Theory and design of Conventional Unit Operations used in Water Treatment: Screening, Sedimentation, Floatation, coagulation, flocculation, filtration, softening and disinfection processes.

Unit II: Theory and Design of Advanced Unit Operations used in Water Treatment — 10 lecture hours

Membrane processes, Ion Exchange, Aeration/stripping, Precipitation, Adsorption, Oxidation-reduction and advanced oxidation processes; Water Treatment Plant Design; Selection of raw water source, Planning and siting of water treatment plant, Chemical requirement and residuals management.

Unit III: Philosophy of Wastewater Treatment — 10 lecture hours

Philosophy of wastewater Treatment, Review of Wastewater quality parameters and discharge standards for aquatic and land disposal, Estimation of wastewater quantity; Wastewater Collection; Design of sewers and sewerage systems

Unit IV: Wastewater Disposal — 7 lecture hours

Disposal to inland waters such as lakes reservoirs, rivers and streams, disposal to sea, disposal on Land. Wastewater treatment; Preliminary treatment, Bar-rack, Screens, Grit chamber, Equalization tank, Primary sedimentation

Unit V: Secondary treatments — 9 lecture hours

Aerobic processes, Anaerobic processes. Tertiary treatment, Nutrient removal, Residual management, Design; Planning and siting of Wastewater treatment plant, Chemical requirements and material balance.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	Theory	
	Internal	SEE
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Understand various unit operations involved in water treatment and design various water treatment units required.	1, 2, 3
2	planning and siting of water treatment plant	2, 3, 9
3	effect of wastes disposal to water	1, 11
4	Design waste water treatment units for desire treatment.	2, 3, 12
5.	design of bioreactors for biodegradation of wastewater treatment	2, 3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

MENE6004	Air Pollution and Its Control	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

MENE 6003	**Design of Water and Wastewater Treatment Systems**	3	2	3				2		2		

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

The course is intended to teach
1. the basics concept of air pollution
2. instruments of monitoring of air quality
3. technology required to control air pollution
4. effect of air pollution on environment
5. how to apply study for clean air development

Course Outcomes

At the end of the course, the student will be able to

1. brief knowledge and experience to identify the type the source of pollutant.
2. monitoring of air quality by different instruments.
3. control of air pollution by using different ECS.
4. field project on remediation of air quality
5. use of different methods for air quality improvement

Catalog Description

Effects of Air pollution; Collection of Gaseous pollutants; Stability Conditions of air; Air pollution control technologies.

Text Books

1. M.N.Rao & H V N Rao (2000), Air pollution, Tata McGraw Hill Publishing Ltd

Reference Books

1. Air Pollution Control Technology Handbook, Second Edition" by Karl B Schnelle Jr and Russell F Dunn

COURSE CONTENT

Unit I: Air Pollution & its Classification — 9 lecture hours

Definition, Air Quality, Classification of Air Pollutants.

Unit II: Effects of Air pollution **10 lecture hours**

Effects of Air pollution on human, plant and animal, Air Pollution Episodes.

Unit III: Air Pollution Monitoring **10 lecture hours**

Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_2, Nox, CO, Oxidants and Ozone.

Unit IV: Meteorology & Dispersion of pollutants **7 lecture hours**

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths, Plume Rise and dispersion.

Unit V: Emission Control Systems **9 lecture hours**

Air pollution control technologies for particulates and gaseous contaminants, Gravity settlers, Electrostatic precipitators, Bag Filters, Scrubbers, Cyclone, control for moving sources.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Brief knowledge and experience to identify the type the source of pollutant.	1, 7
2	Monitoring of air quality by different instruments.	2, 3
3	Control air pollution using different ECS	1, 7, 11
4	Field project on remediation of air quality	11
5.	Use of different methods for air quality improvement	2, 7

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

MENE 6005	Seminar	L	T	P	C
Version1.02	Date of Approval:	-	-	-	1
Pre-requisites					
Co-requisites	--				

MENE 6004	**Air Pollution and Its Control**	1	2	1				2		1		

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

1. To prepare students to compete for a successful career in Energy & Environmental Engineering profession through global education standards.
2.To enable the students to aptly apply their acquired knowledge in basic sciences and mathematics in solving Energy & Environmental Engineering problems.
3.To produce skillful graduates to analyze, design and develop a system/component/ process for the required needs under the realistic constraints.
4.To train the students to approach ethically any multidisciplinary engineering challenges with economic, environmental and social contexts
5. To create an awareness among the students about the need for life long learning to succeed in their professional career

Course Outcomes

Student will get the knowledge
1. to demonstrate the ability to identify, formulate and solve engineering problems.
2. to demonstrate the ability to design and conduct experiments, analyze and interpret data.
3. the ability to visualize and work on laboratory and multi-disciplinary tasks.
4. to demonstrate the skills to use modern engineering tools, software's and equipment to analyze problems.
5. to demonstrate the knowledge of professional, ethical responsibilities and in both verbal and written form.
6. to develop confidence for self education and ability for life-long learning.

Catalog Description

Presentation in the weekly class; evaluation; viva voce comprising a comprehensive questions based on presentation.

COURSE CONTENT

Unit I : Student presentations — 9 lecture hours

- Each student will present one paper during the term

Unit II : Class evaluations **10 lecture hours**

- Each week each student is asked to write a short evaluation of one of the papers being presented

Unit III : Class Discussion **10 lecture hours**

- Discuss the papers – expose the flaws, analyse the writing, what was the impact?

Unit IV: Assessment **7 lecture hours**

- Short review submitted each week (you may work in pairs)
- Longer review of the paper you presented

Unit V: Key skills **9 lecture hours**

- Summarise
- Evaluate
- Identify the important questions
- Understand the context

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	to demonstrate the ability to identify, formulate and solve engineering problems.	1
2	to demonstrate the ability to design and conduct experiments, analyze and interpret data.	2, 9
3	the ability to visualize and work on laboratory and multi-disciplinary tasks.	11
4	to demonstrate the skills to use modern engineering tools, software's and equipment to analyze problems.	4,7,11
5	to demonstrate the knowledge of professional, ethical responsibilities and in both verbal and written form.	8, 9
6	to develop confidence for self education and ability for life-long learning.	12

MENE 6006	Energy, Instrumentation, measurement & Control Lab	L	T	P	C
Version1.02	Date of Approval:	0	0	2	1
Pre-requisites	Energy, Instrumentation, Measurement & Control				
Co-requisites	--				

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6005	**Seminar**	2	2	1					`1	2	1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

This subject is taught

1. to impart knowledge in the area of numerical integration and Calculus
2. working principle knowledge of energy meter
3. brief knowledge about various flow parameters
4. knowledge about handling the instruments and how to operate in filed
5. the role of instruments in different engineering applications.

Course Outcomes

At the end of course, the student will be able to:

6. Study the devices used to measure various forms of energy.
7. Understand the basic working principle of energy measuring devices
8. Knowledge of various flow parameters
9. Handling efficiency of instruments and problem solving
10. Technical approach of the instruments in field condition

Catalog Description

Electrical energy meter; various instruments for energy analysis, controllers; air flow meter; Function of odometer; classification and function of flow meters

Text Books

1.Fundamentals of Aerodynamics (McGraw-Hill International Editions: Mechanical Engineering Series) by John David Anderson , Tata Mcgraw-Hill Education.
2.Electrical Measurements and Measuring Instruments by A.K Sawhney**.**
3.Flow measurement: practical guides for measurement and control by David W. Spitzer, Instrument Society of America.

Reference Books

1.Energy Management Handbook by Steve Doty, Wayne C. Turne
2.Handbook of Energy Engineering by Albert Thumann, D. Paul Mehta.
3.Guide to Energy Management by B. L. Capehart, Wayne C. Turner, William J. Kennedy

COURSE CONTENT

1. Determination of electrical Energy in One –Phase & Three Phase energy meters,
2. Fuel efficiency by Flue gas analyzer,
3. Fuel efficiency Thermometers,
4. Determine the difference in potential by Potentiometric
5. Measurement of temperature and converts into current signals by Temperature Transmitters
6. Determination of intensity of light by Optical Pyrometer
7. Measurement of air flow in Air flow meters
8. Determination of speed of airflow in Anemometer
9. Measurement of volumetric flow rate of fluid by Rotameter
10. Determination fluid flow velocity by Pitot Tube
11. Measurement of mass flow rate by Mass Flowmeters
12. Determination of velocity of water by Open Channel Flowmeters

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Study the devices used to measure various forms of energy.	1, 2,3
2	Understand the basic working principle of energy measuring devices	1, 9,12
3.	Knowledge of various flow parameters	1, 2
4.	Handling efficiency of instruments and problem solving	5, 11
5.	Technical approach of the instruments in field condition	9, 11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6006	**Energy, Instrumentation, Measurement & Control lab**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE7002	Research Project	L	T	P	C
Version1.02	Date of Approval:	0	0	0	5
Pre-requisites	Bioenergy Technology/ Energy, Instrumentation, Measurement & Control				
Co-requisites	--				

Course Objectives

1. To provide a comprehensive understanding of the concepts and methodologies for project identification, project preparation, project evaluation and project financing
2. To make the student understand the project cycle and their wide socio-economic and environmental impacts
3. To make the student learn how to evaluate a project in view of global concern about sustainable development of energy and environment projects

Course Outcomes

After taking this course the student will be able to

1. Identify various energy and environmental features of a project
2. Laboratory and field based study
3. Small projects for environmental development and sustainability
4. Develop a project with suitable technology, and environmental impacts
5. Solve complex environmental problems by different tools and techniques
6. Carry out techno-economic evaluation of energy projects with environmental considerations

Catalog Description

Features of Energy Projects, Bioenergy production, wastewater treatment, air pollution remedy, waste management, modelling and simulation

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	Theory	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Identify various energy and environmental features of a project	9
2	Small projects for environmental development and sustainability	2, 3, 7
3	Develop a project with suitable technology, and environmental impacts	9,11
4	Solve complex environmental problems by different tools and techniques	2, 3
5	Carry out techno-economic evaluation of energy projects with environmental considerations	11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
ENE7002	**Research Project**		2	3	2			1		2		2	

MENE8001	Research Project	L	T	P	C
Version1.02	Date of Approval:	0	0	0	15
Pre-requisites	Bioenergy Technology/ Energy, Instrumentation, Measurement & Control				
Co-requisites	--				

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

1. To provide a comprehensive understanding of the concepts and methodologies for project identification, project preparation, project evaluation and project financing
2. To make the student understand the project cycle and their wide socio-economic and environmental impacts
3. To make the student learn how to evaluate a project in view of global concern about sustainable development of energy and environment projects

Course Outcomes

After taking this course the student will be able to
1. Identification various energy and environmental features of a project
2. Laboratory and field based study
3. Small projects for environmental development and sustainability
4. Develop a project with suitable technology, and environmental impacts
5. Solve complex environmental problems by different tools and techniques
6. Carry out techno-economic evaluation of energy projects with environmental considerations

Catalog Description

Features of Energy Projects, Bioenergy production, wastewater treatment, air pollution remedy, waste management, modelling and simulation

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	Theory	
	Internal	SEE
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Identify various energy and environmental features of a project	9
2	Small projects for environmental development and sustainability	2, 3, 7
3	Develop a project with suitable technology, and environmental impacts	9,11
4	Solve complex environmental problems by different tools and techniques	2, 3
5	Carry out techno-economic evaluation of energy projects with environmental considerations	11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

ENE7002	Research Project		2	3	2			1		2		2	

1=addressed to small extent
2= addressed significantly
3=major part of course

PROGRAMME ELECTIVES

MENE6013	**Solar Energy technology**	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

Course Objectives

1. To impart the knowledge in the area of solar energy
2. Solar energy and the effective utilization to improve energy management
3. To understand the importance of economic dispatch and unit commitment problem
4. Solar energy using different technologies.
5. Design of liquid and air heaters

Course Outcomes

Student will get the knowledge of:

1. Atmospheric attenuation
2. Fixing of Solar energy
3. Application of energy into daily life activities
4. Find out heat removal rate
5. Design of active systems for liquid and air heaters

Catalog Description

Sun earth relationship, solar charts, Flat plate collectors, performance analysis focusing solar concentrators, chart method, - tracking-cell arrays, Photo- voltaic cell.

Text Books

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, -1991
2.G.N. Tiwari. "Solar Energy: Fundamentals, Design, Modelling and Applications", Third Reprint, Narosa Publishing House, New Delhi-2006

Reference Books

1.Edward Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pubCO.,1983.
2.FankKreith,,Jan F.Kreider,:Principles of solar Engg", 1978.
3.Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.
4. Kaushik S.C, Tiwari G.N and Nayak J.K, "Thermal control in passive solar buildings" .IBT Publishers & Distributors, 1988.

COURSE CONTENT

Unit I: Solar Radiation — 9 lecture hours

Source of radiation – Sun earth relationship- extra-terrestrial radiation.– Atmospheric attenuation – Terrestrial radiation-radiation on a horizontal surfaces and inclined planes relations between horizontal

radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation-pyrohelio meter, pyrano meter, pyro geo meter, net pyradiometer-sunshine recorder .

Unit II: Solar Collectors – Flat Plate Collectors 10 lecture hours

Design considerations – classification- Flat plate collectors- air heating collectors liquid heating – Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors.

Unit III: Concentric Solar Collectors and Thermal Application 10 lecture hours

Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.

Unit IV: Simulation and Energy Storage 7 lecture hours

Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber'ssaltorganic compounds -solar ponds.

Unit V: Solar PV System 9 lecture hours

Photo- voltaic cell – characteristics-maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	To impart the knowledge of atmospheric attenuation	1
2	Fixing of Solar energy for energy conservation	2, 3
3	Application of energy into daily life activities	9,10
4	Find out heat removal rate	2, 3
5	Design of active systems for liquid and air heaters	3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

MENE6015		Hydrogen Fuel Cells									L	T	P	C
Version1.02		Date of Approval:									3	0	0	3
Pre-requisites		-												
Co-requisites		--												
MENE 6013	**Solar Energy Technologies**	2	2					1			1			1

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

The student will be exposed

1. Importance of hydrogen as a future energy carrier
2. How to storage compressed gas
3. Fuel cell classification
4. Different parameters of fuel cell
5. Design of fuel cell

Course Outcomes

Student will get the knowledge of:

1. knowledge about hydrogen energy
2. able to get techniques to store compressed gas
3. knowledge about various types of fuel cell
4. Find out the energy transferred and effect of various parameters
5. Design of fuel cell

Catalog Description

Thermodynamic and thermo physical properties, Cryogenic liquid storage, state of electrolyte, portable fuel cells

Text Books

1. Aldo V. da Rosa(2005),Fundamentals of Renewable Energy Processes, Elsevier Academic Press.

Reference Books

1. Wolf Vielstich, Arnold Lammand H.A. Gastieger (2003), Handbook of Fuel Cells Vol 1-4, John Wiley.
2. Gregor Hogen Ed. (2003), Fuel Cell Technology Handbook, CRC Press.

COURSE CONTENT

Unit I: 9 lecture hours

Importance of hydrogen as a future energy carrier –Thermodynamic and thermo physical properties- Chemical production of hydrogen–Steam reforming, thermal decomposition etc. - Purification - Desulfurization, removal of CO_2, CO, etc.- Electrolytic hydrogen production– Electrolyzer configurations -Thermolytic hydrogen production – Direct dissociation of water, chemical dissociation of water, photolytic hydrogen production, photobiological hydrogen production

Unit II: **10 lecture hours**

Compressed gas storage-Cryogenic liquid storage-Solid state storage–Adsorption and chemical compounds, Metal hydrides, hydride heat pumps and compressors

Unit III: **10 lecture hours**

Fuel cells classification – operating temperatures, state of electrolyte, type of fuel, chemical nature of electrolyte.

Unit IV: **7 lecture hours**

Polymer Electrolyte Membrane Fuel Cells (PEMFC) – Alkaline Fuel Cells (AFC)-Phosphoric Acid Fuel Cells (PAFC)- Direct Methanol Fuel Cells (DMFC)-Molten Carbonate Fuel Cells (MCFC)-Solid Oxide Fuel Cells (SOFC)

Unit V: **9 lecture hours**

Stationary systems, automotive systems, portable fuel cells, small (less than 1 kW) fuel cells

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	knowledge about hydrogen energy	1
2	able to get techniques to store compressed gas	1
3	knowledge about various types of fuel cell	2, 3
4	Find out the energy transferred and effect of various parameters	2, 3
5	Design of fuel cell	3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6015	**Hydrogen & Fuel Cell**	2	2					1			1		1

1=addressed to small extent

MENE 6019	Energy, Environment and Climate Change	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites					
Co-requisites	--				

2= addressed significantly
3=major part of course

Course Objectives

1. To impart the knowledge of modern energy and climate change
2. Lays the foundation for energy conservation by analyzing various schemes, which is of prime importance in the modern energy crisis
3. To conduct energy audit and hence suggest means to improve energy management
4. To understand the importance of economic dispatch and unit commitment problem
5. This subject is taught to impart knowledge in environmental degradation due to the technical advancement.

Course Outcomes

Student will get the knowledge of:

1. Current emerging technologies
2. conduct energy audit and hence suggest means to improve energy management
3. India's stand in terms of various technologies
4. Environmental impacts due to energy production
5. Measures taken to control the global environmental changes
6. understand the importance of economic dispatch and unit commitment problem
7. understand the climate change policy

Catalog Description

Energy demand and supply, Energy management information, Energy service companies, Solar and Wind energy, Rural conservation energy, Kyoto protocol.

Text Books

1. Adrian Bejan, Peter Vadasz, Detlev G. Kroger (1999), Kluwer Academic Publishers.
2. A K De (2001), Environmental Concerns, New Age Publications Pvt Ltd.

Reference Books

1. O.L. Elgard (1987), Electrical Energy System Theory – An Introduction, Tata McGraw-Hill Publication.
2. Robert H.MillerandJamesH.MalinOwaki(1987), PowerSystemOperation,3rdEdition,Tata McGraw-Hill.
3.P.S.R. Murthy(1994), Power System Operation and Control, Tata McGraw-Hill Publication

COURSE CONTENT

Unit I: Energy Sources **9 lecture hours**

Definition, Modules, Forms of Energy, Power, Origin of Fossil fuels, World and Indian Resources of Coal, Oil, Natural gas, Nuclear, Geothermal, Renewable Energy potential : Solar Energy, Wind Energy, Bio-Energy, Hydro, Tidal, Ocean , Nuclear Energy, Nuclear Fission and Fusion , Geothermal Energy.

Unit II: Energy Scenario **10 lecture hours**

Global Energy Scenario: Energy consumption pattern in various sectors, Impact on economy, India`s Energy Scenario, Urban and Rural energy consumption patterns, Impact of Energy on Development, Energy Infra structure in India

Unit III: Impact of Energy Projects on Environment **10 lecture hours**

Overview of global environmental problems, Environmental degradation due to Energy production and use, Pollution due to thermal power stations , Environmental aspects of Wind Energy Farms ,Environmental aspects of Nuclear power generation, Nuclear waste disposal, Impact of Hydro power generation on Ecology and Environment, Guidelines for Environmental impact assessment (EIA) of Energy Projects

Unit IV: Climate Change Concerns **7 lecture hours**

Green House Gas Emissions, Depletion of Ozone layer, Global Warming, Climate Change Concerns, Climate Change in India, Kyoto protocol, Clean Development Mechanism [CDM], Carbon Fund Concept of Carbon credit

Unit V: Climate Change Policy Issues **9 lecture hours**

Impact of Climate Change on Glaciers, Rivers and Water Resources, Climate Change Policy Issues in Himalayas, International Status of Climate Change Policies, Indian Action Plan on Climate Change

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Current emerging technologies	1
2	conduct energy audit and hence suggest means to improve energy management	2, 9
3	India's stand in terms of various technologies	11
4	Environmental impacts due to energy production	4,7,11
5	Measures taken to control the global environmental changes	1,2
6	understand the importance of economic dispatch and unit commitment problem	1
7	understand the climate change policy	1,9

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

ENE6027	Bio-Energy Technologies	L	T	P	C
Version1.01	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

MENE 6019	**Energy Environment and Climate Change**	2	2	1						2	1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

Student will learn about

1. Bio-energy and its mechanism
2. Different processes for production of bioenergy
3. To under different techniques and tools
4. Bioenergy production from different solid wastes
5. Energy Consumption and Cost - Environmental Aspects

Course Outcomes

Student will get the knowledge of:

1. Solid waste management by bioenergy
2. Different processes used for biodegradation of solid waste and production of bioenergy
3. The industrial applications of Bio-Energy.
4. Environmental aspect of Bio-Energy
5. Energy Consumption and Cost - Environmental Aspects

Catalog Description

Bio Conversion, Biodegradation and Biodegradability of Substrate, Effect of Additives on Biogas Yield, Viability of Energy Production, History of Energy Consumption and Cost Effectiveness

Text Books

1.R.C.Maheswari, Bio Energy for Rural Energisation , Concepts Publication, 1997

Reference Books

1.David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood, Chichester, 1984
2.Khandelwal KC, Mahdi SS, Biogas Technology - A Practical Handbook, Tata McGraw Hill, 1986
3. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York, 1980
4.EL - Halwagi MM, Biogas Technology : Transfer &Diffusio, Elsevier Applied SC, London 1986

COURSE CONTENT

Unit I: **9 lecture hours**

Bio Energy - Bio Conversion Mechanism - Utilization of Photosynthate

Unit II: **10 lecture hours**

Combustion, Pyrolysis, Gasification and Liguefaction - Biological Conversion - Methanol, Ethanol Production - Fermentation - Anaerobic Digestion Biodegradation and Biodegradability of Substrate - Hydrogen Generation from Algae – Biological Pathways

Unit III: **10 lecture hours**

Through Fermentation and Gasification - Biomass Production from different Organic Wastes - Effect of Additives on Biogas Yield - Biogas production from Dry Dung Cakes

Unit IV: **7 lecture hours**

Viability of Energy Production - Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas. Operation and Maintenance

Unit V: **9 lecture hours**

Energy Effectives and Cost Effectiveness - History of Energy Consumption and Cost - Environmental Aspects of Bio-energy Conversion.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Solid waste management by bioenergy	1
2	Different processes used for biodegradation of solid waste and production of bioenergy	2, 3
3	The industrial applications of Bio-Energy	9,10
4	Environmental aspect of Bio-Energy	2, 3
5.	Energy Consumption and Cost - Environmental Aspects	11

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning

MENE6029		Energy Efficient Buildings									L	T	P	C
Version1.02		Date of Approval:									3	0	0	3
Pre-requisites		-												
Co-requisites		--												
		1	2	3	4	5	6	7	8	9	10	11		12
MENE 6027	**Bio-Energy Technologies**	2	1					1			1			

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

The student will be exposed

1. importance of Energy- Efficient Buildings within the context of Energy issues in the 21st century.
2. the concept of Energy efficiency, Renewable sources of energy and their effective adaptation in green buildings
3. understanding of Building Form and Fabric, Infiltration, ventilation, Lighting, cooling and water conservation.
4. the importance of Environmental Management as well as Environmental Impact Assessment methods in Energy efficient buildings.

Course Outcomes

Student will get the knowledge of:

1. Understand why buildings should be made energy efficient.
2. Have a fuller grasp on Renewable Energy mechanisms such as Passive Solar heating and collection, Photovoltaics.
3. Ground source heat pumps, and their adaption to green building concepts.
4. Understand the concepts of Site and Climate, Building Form, Building Fabric, Infiltration and ventilation, Lighting, Heating, Cooling, Energy Management and water conservation.
5. Environmental Impact Assessment study for Energy Efficient Buildings. They shall be equipped with the associated cutting-edge management strategies.

Catalog Description

Building energy; Renewable Energy mechanisms; Ground source heat pumps; Energy Management and water conservation; Environmental Impact Assessment; Lighting, Heating, Cooling

Text Books

1. William T. Meyer., Energy Economics and Building Design., New York: McGraw- Hill, Inc

Reference Books

1.Public Technology, Inc. (1996). Sustainable Building Technical Manual: Green Building Design, Construction, and Operations. Public Technology, Inc., Washington, DC.
2.Sim Van Der Ryn, Stuart Cowan, “Ecological Design”, Island Press (1996).
3.Dianna Lopez Barnett, William D. Browning ,”A Primer on Sustainable Building”, Rocky Mountain Green Development Services,.

4.The HOK Guidebook to Sustainable Design, Sara Mendler and William Odell, John Wiley.
5.David A. Gottfried, Sustainable Building Technical Manual., Public Technology Inc
6.Richard D. Rush, . Building System Integration Handbook., New York: John Wiley & Sons
7.Ben Farmer &HentieLouw., Companion to Contemporary Architectural Thought, London & New York: Routledge
8.Peter Noever (ed)., Architecture in Transition: Between Deconstruction and New Modernism., Munich: Prestel.

COURSE CONTENT

Unit I: Green Buildings, Energy and Environment 9 lecture hours

Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Pollution, Better Buildings, Reducing energy consumption, Low energy design.

Unit II: Renewable Energy, Site and Climate 10 lecture hours

Renewable Energy sources that can be used in Green Buildings – Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy, Photovoltaics, Climate and Energy, Macro and Microclimate. Indian Examples.

Unit III: Building Form and Fabric 10 lecture hours

Building Form – Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, Grouping of buildings. Building Fabrics- Windows and doors, Floors, Walls, Masonry, Ecological walling systems, Thermal Properties of construction material.

Unit IV: Infiltration, Ventilation, Lighting, Cooling and Water Conservation 7 lecture hours

Infiltration and ventilation, Natural ventilation in commercial buildings, passive cooling, modeling air flow and ventilation, Concepts of daylight factors and day lighting, daylight assessment, artificial lighting, New light sources. Cooling buildings, passive cooling, and mechanical cooling. Water conservation- taps, toilets and urinals, novel systems, collection and utilization of rain water.

Unit V: Energy Awareness 9 lecture hours

Energy awareness, monitoring energy consumption, Building Environmental Assessment - environmental criteria - assessment methods - assessment tools (e.g. LEED). Ecohomes, Sustainable architecture and urban design – principles of environmental architecture. Benefits of green buildings – Energy Conservation Building code - NBC

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Understand why buildings should be made energy efficient.	1
2	Have a fuller grasp on Renewable Energy mechanisms such as Passive Solar heating and collection, Photovoltaics.	1
3	Ground source heat pumps, and their adaption to green building concepts.	2, 3
4	Understand the concepts of Site and Climate, Building Form, Building Fabric, Infiltration and ventilation, Lighting, Heating, Cooling, Energy Management and water conservation.	2, 3
5	Environmental Impact Assessment study for Energy Efficient Buildings. They shall be equipped with the associated cutting-edge management strategies.	3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning

MENE6032	Solid Waste Management	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6029	**Energy Efficient Buildings**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

The student will be exposed

1. To gain insight into collection, transfer and transport of municipal solid waste
2. Understand the design and operation of municipal solid waste landfill
3. Understand the design and operation of resource recovery facility
4. Understand the design and operation of waste to energy facility
5. Understand the effect of waste management on environmental sustainability

Course Outcomes

At the end of the course, the student will be able to

1. Understand solid waste and its composition
2. Understant method solid waste collection and transportation
3. Understand various processes involved in solid waste collection, segregation and transportation.
4. Design solid waste disposal facility.
5. Understand the identification of hazardous wastes

Catalog Description

Legal and Organizational foundation; storage and handling of solid waste; analysis of collection system**;** Materials Recovery facilities; TCLP tests and leachate studies; hazardous wastes in Municipal Waste

Text Books

1.GeorgeTechobanoglous et al," IntegratedSolid WasteManagement ", McGraw-HillPublication, 1993

Reference Books

1. HandbookofSolidWasteManagementbyFrankKreith,GeorgeTchobanoglous,McGrawH ill Publication
2. Bagchi, A., Design,Construction, andMonitoring ofLandfills,(2ndEd). WileyInterscience,
3. 1994.ISBN: 0-471-30681-9.
4. Sharma,H.D.,andLewis,S.P.,WasteContainmentSystems,WasteStabilization,andLand fills: DesignandEvaluation.Wiley Interscience,1994.ISBN: 0471575364.
5. GeorgeTechobanoglous et al," IntegratedSolid WasteManagement ", McGraw-HillPublication, 1993.
6. CharlesA.Wentz; "HazardousWaste Management ", McGraw-Hill Publication, 1995.

COURSE CONTENT

Unit I: 9 lecture hours

Legaland Organizational foundation: Definition of solid waste–waste generation–major legislation, monitoring responsibilities, sources and types of solid waste – sampling and characterization – Determination of composition of MSW–storage and handling of solid waste – Future changes in waste composition.

Unit II: 10 lecture hours

Waste collection systems, analysis of collection system–alternative techniques for collection system. Need for transfer operation, transport means and methods, transfer station types and design requirements.

Unit III: Process of Solid Waste and Energy recovery 10 lecture hours

Unit operations for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, anaerobic methods for materials recovery and treatment – Energy recovery – Incinerators

Unit IV: Disposal of Solid Wastes 7 lecture hours

Land farming, deep well injections. Landfills**:** Design and operation including: site selection, Geo-environmentalinvestigations,engineeredsites,linersandcovers,leachatecontrolandtreatment,gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation,,Requirementsandtechnicalsolution,designatedwastelandfillremediation–Integrated waste management facilities. TCLP tests and leachate studies. Economics of the on-site v/s offsite waste management options. Natural attenuation process and its mechanisms.

Unit V: Household Hazardous Waste Management 9 lecture hours

Design practices of solid wastes. Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waster regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection andtransport. Regulatoryrequirementsforidentification,characterizationand disposal of hazardous, nonhazardous and

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Understand solid waste and its composition	1
2	Understant method solid waste collection and transportation	1
3	Collection, segregation and transportation.	2
4	Design solid waste disposal facility.	1,2
5	Understand the identification of hazardous wastes	2, 3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12

MENE6034	Design of Wastewater Treatment & Disposal System	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

MENE 6032	**Solid Waste Management**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

Course Objectives

The student will be exposed

1. Need of advanced wastewater treatment
2. Process for removal nutrients
3. Physical and chemical methods
4. Economic value of environmental resources
5. Economics of biodiversity conservation

Course Outcomes

At the end of the course, the student will be able to

1. Know about the conventional treatment units and processes.
2. Role of microorganisms in wastewater treatment.
3. Biological Nutrients removal.
4. Nutrients removal by chemical process.
5. Sludge treatment, handling and disposal.
6. Wastewater reuse, recycling and disposal of treated effluents

Catalog Description

Development of treatment flow sheets; Sources and forms of nutrients; Air stripping of ammonia; Environmental damage-Concept of Total Economic Value; environmental damage-Concept of Total Economic Value

Text Books

1. R.K.Turner,D.W.PearceandI.Bateman(1994),EnvironmentalEconomics:AnElementary Introduction,HarvesterWheatsheaft,London.
2. D.W.PearceandR.K.Turner(1990),Economicsof NaturalResourcesandtheEnvironment, HarvesterWheatsheaf, London.

Reference Books

1.D.W.Pearce,A.MarkandyaandE.B.Barbier(1989),BlueprintforaGreenEconomy,Earthscan, London.
2.MichaelS.CommonandMichaelStuart(1996),EnvironmentalandResourceEconomics:An Introduction, 2nd Edition,Harlow:Longman.

3.RogerPerman,MichaelCommon,YueMaandJamesMcGilvray(2003),NaturalResourceand Environmental Economics,3rdEdition, Pearson Education.
4.N.Hanley,J.ShogrenandB.White (2001),AnIntroductiontoEnvironmentalEconomics,Oxford University Press.

COURSE CONTENT

Unit I: Chemical Nutrient Removal 9 lecture hours

Effects of chemical constituents in wastewater / Need of advanced wastewater treatment / Basis of process selection and development of treatment flow sheets. Membrane Bio-Reactor (MBR) applications / Removal of residual suspended solids by micro screening.

Unit II: Chemical Nutrient Removal 10 lecture hours

Sources and forms of Nitrogen (N) and Phosphorus (P) / Processes for N and P removals. Conventional biological nitrification/ denitrification processes and its process fundamentals. Sequencing Batch Reactor (SBR) and Simultaneous Nitrification – Denitrification (SND) processes for nitrogen removal. New processes for nitrogen removal: ANAMMOX, SHARON, CANON etc. Biological removal of Phosphorus- Process fundamentals and types of processes. Combined removal of N and P by biological methods.

Unit III: Economic Value of Environmental Resources 10 lecture hours

Nitrogen removal by physical and chemical methods-Air stripping of ammonia/Break point Chlorination/Ion –exchange. Removal of phosphorus by chemical addition

Unit IV: Concept of Total Economic Value 7 lecture hours

Economic value of environmental resources and environmental damage-Concept of Total Economic Value-Alternative approaches to valuation-Cost benefit analysis and discounting

Unit V: Economics of bio-diversity Conservation 9 lecture hours

Economics of biodiversity conservation - Valuing individual environmental damage-Concept of Total Economic Value - Policy responses at national and international levels

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Know about the conventional treatment units and processes.	1
2	Role of microorganisms in wastewater treatment.	1
3	Biological nutrients removal	2, 3
4	Nutrients removal by chemical process.	2, 3
5	Sludge treatment, handling and disposal.	3,11
6	Wastewater reuse, recycling and disposal of treated effluents	1,7

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6034	**Design of Wastewater Treatment & Disposal System**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6035	Urban Environmental Quality Management	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

Course Objectives

The student will be exposed

1. Investigating the causes, consequences and degradation of environmental resources
2. Possible solutions to problems associated with degradation of environmental resources
3. Analyse the potential non-sustainability of certain types
4. Economic activities using economic analysis as a tool
5. to plan and to execute monitoring programmes

Course Outcomes

By the end of the course the student will have knowledge of the following topics:

1. Have knowledge of the nature and effects of environmental pollutants and energies
2. Have a detailed knowledge of the techniques involved in the efficient management of the environment
3. Be able to measure and assess the effects of noise, air, water, terrestrial pollution and noise pollution on human activity and health
4. Have an awareness of the need for integrated pollution control
5. Have the skills to plan and to execute monitoring programmes for the detection and control of environmental pollutants, including water, air and noise terrestrial pollution

Catalog Description

Consequences of urbanization, demand of resources by the public; Nature of air pollution in the Urban environment ; Water Demands and Pollution in Urban areas; Impact of urban soil pollution on quality of living system– prediction of soil pollution indices; solid waste management including disposal; Planning of urbanization

Text Books

1. Varshney, C.K. "Water Pollution andManagement",Wiley Eastern Ltd., New Delhi, 1998

Reference Books

1. Plowden,S., "TheCostof Noise",London, Metra, 1996.
2. Fallion, A.B. &E. Simon,"The UrbanPattern", Van Nistrand, New York.
3. M.J. Suess&S.R. Craxford, "Manualon Urban AirQuality",WHO, Copenhagen.

COURSE CONTENT

Unit I: Urbanization & Pollution **9 lecture hours**

Consequences of urbanization, demand of resources by the public - Sources of Pollution to the urban environment: Status of pollution levels in major cities- Slum formation: Impact of slum on general quality of life on Urban elite – status of slum settlements in major cities

Unit II: Air & Noise Pollution in Urban Environment 10 lecture hours

Air Pollution Sources: Nature of air pollution in theUrban environment due to human activities ofindustrialization,effect ofair pollutiononUrbanEnvironment. AirpollutionIndicesforAssessment of status of Urbanairquality.-Sourcesofnoise pollutioninUrbanareas, effectofnoise pollutiononUrban environment, status ofnoise pollution in major cities.

Unit III: Water and Land pollution in Urban Environment 10 lecture hours

Water Demands and Pollution in Urban areas: Nature of water pollutants and as similative capacity of natural Urban aquatic systems. Urban water quality indices-Sources of land pollution in urban areas: Impact of urban soil pollution on quality of living system– prediction of soil pollution indices.

Unit IV: Management of Urban Environment Quality 7 lecture hours

Land use planning–traffic management. Safe municipal water supply and planning of safe municipal water supply and drainage system–solid waste management including disposal–abatement of noise pollution – Provision of zones – regulation

Unit V: Conservation and Disaster Management 9 lecture hours

Natural Conservation: Planning of urbanization on ecological basis, preservation and development of green recovery areas.- Urban Disaster Management: Management of Industrial explosions, landslides, earthquakes, Floods and Management of epidemics.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Have knowledge of the nature and effects of environmental pollutants and energies	1
2	Have a detailed knowledge of the techniques involved in the efficient management of the environment	1
3	Be able to measure and assess the effects of noise, air, water, terrestrial pollution and noise pollution on human activity and health	2, 3
4	Have an awareness of the need for integrated pollution control	2, 3
5	Have the skills to plan and to execute monitoring programmes for the detection and control of environmental pollutants, including water, air and noise terrestrial pollution	3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6035	**Urban Environmental Quality Management**	2	2					1			1		1

1=addressed to small extent

2= addressed significantly

MENE6037	Remote Sensing & GIS Applications	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

3=major part of course

Course Objectives

This subject explains the basic concepts of

1. basic concept of Remote Sensing
2. knowledge of Geographic Information Systems with its applications.
3. History of development of GIS
4. Concepts of digital image processing
5. Applications of GIS and remote sensing

Course Outcomes

By the end of the course the student will have knowledge of the following topics:

1. the basic remote sensing concepts and its characteristics
2. GIS and its requirements
3. data management with GIS
4. carry out analysis and interpretation of GIS results
5. Modelling through GIS

Catalog Description

Electro magnetic radiation, Concepts of digital image processing, Basic concepts of GIS, Overlay operation

Text Books

6. A.N. Patel and Surendra Singh (1999), Remote Sensing Principles and Applications, Scientific Publisher, Jodpur.
7. A. Burrough(2000), Principle of Geographical Information Systems for Land Resources Assessment,ClarendonPress,Oxford.

Reference Books

1. T.M.Lilles and R.W.Kiefer (1999),Remote Sensing and Image Interpretation, JohnWiley& Sons, New York.
2. KeithC. Clarke,Brad O.Parks, Michael P.Crane (2005),Geographic Information Systems and Environmental Modeling, Prentice-Hall of India.

COURSE CONTENT

Unit I: Basic concepts of remote Sensing **9 lecture hours**

Basic concepts of Remote Sensing - Introduction to remote sensing – Electromagnetic radiation - Characteristic of real remote sensing systems–Plat forms–Satellite-Indian remote sensing satellite-Sensors

Unit II: Image processing **10 lecture hours**

Image processing - Elements of image interpretation –Concepts of digital image processing

Unit III: Basic concepts of GIS **10 lecture hours**

Basic concepts of GIS – Introduction to GIS-History of development of GIS- Elements of GIS-Computer hardware and software

Unit IV: Map Overlay **7 lecture hours**

Map overlay-Vector and raster data model-Mapping concept-Data storage and data base management-Development of map overlay – Overlay operation

Unit V: Applications of GIS and Remote Sensing **9 lecture hours**

Applications of GIS and remote sensing in resource management

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	the basic remote sensing concepts and its characteristics	1
2	GIS and its requirements	1
3	data management with GIS	2, 3
4	carry out analysis and interpretation of GIS results	1,2
5	Modelling through GIS	1,2

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6037	**Remote Sensing and GIS Applications**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6039	Risk Assessment and Disaster Management	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

Course Objectives

To enable a comprehensive understanding of:

1. To provide knowledge related to the broad field of environmental risk assessment
2. Steps involved in the risk assessment process, including statistical characterization of observed data
3. Knowledge about tools that can be used in defining environmental risks, particularly as related to human health.
4. To develop practical skills in disaster mitigation, planning, response and post disaster rehabilitation, particularly related to health and public health.

Course Outcomes

Students will be able

1. To gain knowledge related to the broad field of environmental risk assessment
2. Statistical characterization of field data
3. Use of tools for environmental risks, particularly as related to human health.
4. to apply biotechnological concept and tools for green production technologies
5. gain knowledge on eco-sustainable waste management ensuring sustainable development

Catalog Description

Guidelines: Principles, Code of practice – Appointment of personnel and their responsibilities– Emergency plans: on site and off site; Steps in risk assessment, Occupationally induced illness, non-occupational illness; Operations Management; Organizational Structure for Disaster Management

Text Books

1. Rao V. Kolluru,"Environmental Strategics hand book", Mc-graw Hill Inc., New York, 1994.

Reference Books

1. BrockNeely.W&BlanG.E,"EnvironmentalExposurefromchemicals,VolumeII,Chc PressIunc., Florida,1989.
2. WoodsenW.E.,"Humanfactorsdesignhandbook– informationandguidelinesfordesigntosystems, facilities, equipment and product for human use", McGraw Hill, New York, 1981.

COURSE CONTENT

Unit I: Risk Assessment 9 lecture hours

Introduction- Methodologies and Guidelines: Principles, Code of practice – Appointment of personnel and their responsibilities–Emergency plans: onsite and offsite. Steps in risk assessment: Identification of risk, Extent of risk and disaster, Risk-Based Decisions for Corrective Action –Timely updation. Developing a Site Conceptual Model -Focusing on Risk-Based Decisions in Corrective Action –Risk Assessment: Dose Response and Target Level Calculations-Experiences in Environmental Risk Assessment.

Unit II: Occupational Health and Safety 10 lecture hours

Occupational risk analysis survey and health evaluation, behavioral studies, occupational injury, disease reporting, investigation: monitoring and control of environmental hazards. Occupationally induced

illness, non-occupational illness, and discomfort at work, the epidemiological approach, occupational health practice: investigation, monitoring, control, examples of occupational health hazards: nasal cancer, asbestosis, bronchitis, heart disease. Occupational health services.

Unit III: Methodologies and Management Techniques 10 lecture hours

Risk assessment techniques for accidental release of toxic and inflammable materials, hazard analysis, potential risk, conceivable release mechanisms and release rates, fire and explosion hazards and simplified models for their assessment. Operations Management(OM),Risk Assessment and Disaster Response, Quantification Techniques, NGO Management, SWOT Analysis based on Design &Formulation Strategies, Insurance & Risk Management.

.

Unit IV: Disaster Management 7 lecture hours

Introduction & Dimensions of Natural & Anthropogenic Disasters, Principles/Components of Disaster Management, Organizational Structure for Disaster Management, Disaster Management Schemes/SOPs, Natural Disasters and Mitigation Efforts, Flood Control, Drought Management, Cyclones, Avalanches, Mangroves, Land Use Planning, Inter-Linking of Rivers, Role of Union/States, Role of Armed Forces/Other Agencies in Disasters, Role of Financial Institutions in Mitigation Effort, Group Dynamics, Concept of Team Building, Motivation Theories and Applications, School Awareness and Safety Programs, Psychological and Social Dimensions in Disasters, Trauma and Stress, Emotional Intelligence, Electronic Warning Systems.

Unit V: Use of Information systems, Experiences and case studies 9 lecture hours

Recent Trends in Disaster Information Provider, GeoInformatics in Disaster Studies, Cyber Terrorism, Remote Sensing & GIS Technology, Laser Scanning Applications in Disaster Management, Statistical Seismology, Quick Reconstruction Technologies, Role of Media in Disasters, Management of Epidemics, Bio-Terrorism, Forecasting / Management of Casualties. Important Statutes/ Legal Provisions, IEDs/Bomb Threat Planning, NBC Threat and Safety Measures, Forest Fires.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	To gain knowledge related to the broad field of environmental risk assessment	1
2	Statistical characterization of field data	1
3	To apply biotechnological concept and tools for green production technologies	2, 3
4	Find out the energy transferred and effect of various parameters	1,2
5	Gain knowledge on eco-sustainable waste management ensuring sustainable development	1,2

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6039	**Risk assessment and Disaster Management**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6040	Mathematical Modelling in Environmental Engg.	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

Course Objectives

To enable a comprehensive understanding of:

1. The scope and extent of mathematical modelling
2. The basic tenets of mathematical modelling and its application to environmental Processes
3. Mathematical modelling techniques
4. Plume Rise estimation Emissions inventories
5. Mathematical modelling methods applied to Global Environmental Problems

Course Outcomes

Student will get the knowledge of:

1. Basic understanding of how mathematical models can be used to solve environmental problems
2. Set up material balance models for conservative and non-conservative systems
3. Formulate and solve Boundary value problems.
4. Plume Rise estimation Emissions inventories
5. Formulate, Set-up, and solve complex environmental Problems.

Catalog Description

states of stability of the atmosphere , Necessity of mathematical models, importance of Air Pollution modelling, Homogeneous and Heterogeneous Pathways for Ozone depletion

Text Books

1.Gilbert M., Master,'Introduction to Environmental Engineering and Science' Prentice-Hall ofIndia,New Delhi,1998

Reference Books

1. Howard S.Peavy, Donald R. Rowe, and George Tchobanoglous.'Environmental Engineering'. McGraw-Hill BookCompany, New York.1985
2. Roland b. Stull : Introduction to Boundary Layer Meteorology. John Wiley 1988.
3. Plus, Journal Articles from J.Geophys. Res.,Geophysical Research Letters, Quarterly Journal of the Royal Meteorological Society.

COURSE CONTENT

Unit I: 9 lecture hours

The origins: Formation of the Physical Environment. The evolution of the Earth's atmosphere. Quantification of the Lapse Rate. The states of stability of the atmosphere Quantification of Wind circulation : Geo-strophic winds. Necessity of mathematical models. Concentration calculationsand conversions in liquids and gases. Converting ppm into micro grammes/m3 and vice-versa. Material Balance–Steady-stateconservativesystems-non-conservativepollutants.Mass-nergyflowsandbalances–specific examples in real-life environmental problems: Thermal pollution of a River

Unit II: 10 lecture hours

The importance of Air Pollution modelling. Modelling the Atmospheric Boundary Layer–mixing length, and eddy diffusion. The formulation and solution of the Gaussian Plume Model. Gaussian Dispersion Coefficients. Plume Rise estimation Emissions inventories. Point, Line and Area Sources. Simple noise quality models : Models for Road way Noise

Unit III: **10 lecture hours**

Modelling the mass transport of Sulphur Dioxide into falling raindrops. Reaction Pathways. Mass and Charge Balance.The convective diffusion equation. Normalisation of the CDE with reaction kinetics. Modelling the Homogeneous and Heterogeneous Pathways for Ozone depletion.

Unit IV: **7 lecture hours**

Solar and Terrestrial Radiation. Quantifying the Green House Effect. A model for estimating the Equilibrium temperature of the Earth. Aerosol and cloud processes. The Basic tenets of Global Circulation Models for Weather Forecasting

Unit V: **9 lecture hours**

The unusual qualities of water. Modelling Biochemical Oxygen demand (BOD). Estimating the BOD Reaction Rate Constant. The effect of Oxygen-demanding wastes on rivers. A model for De-oxygenation. The Oxygen- sag curve. Solid waste modelling: Waste to Energy. Modelling the methane potential of discards.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Basic understanding of how mathematical models can be used to solve environmental problems	1
2	Set up material balance models for conservative and non-conservative systems	1, 2, 3
3	Set up material balance models for conservative and non-conservative systems	2, 3, 4
4	Plume Rise estimation Emissions inventories	2,
5	Formulate, Set-up, and solve complex environmental Problems.	2, 3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE6040	**Mathematical Modelling in Environmental Engg**	2	3	3				1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6042	Environmental Ecology	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

Course Objectives

The main aim is

1. to establish Ecology's credibility in high environmental, ethical and quality standards of goods and services.
2. Access the market opportunity presented by the 'greenmarket'.
3. Raise consumer awareness and concern for environmental issues, and encourage their support for ecological values in consumer practices.
4. Also to develop affair and equitable means to link economic and environmental values
5. the development of mutually beneficial relationships with all segments of the community.

Course Outcomes

By the end of course student will get the knowledge of:

1. Develop legal and economic structures
2. Able to provide reasonable return on investment, financial or personal effort, dividends, wages and so forth.
3. Develop ecologically sustainable production and industry through developing the potential of all fibres.
4. Develop environmentally and socially friendly alternatives
5. Many of the deleterious practices, processes and products currently in use

Catalog Description

Natural ecosystems and their food chains, reduction in biological diversity by human activities, classes and general effects of physical and Biological interaction with pollutants,

Text Books

Odum. E. P, "Fundamentals of ecology",W.B. Sanders, Philadelphia, 2002

Reference Books

1.White. I.D., Mottershead. D.N., Harrison .S.J, "Environmental Systems – an introductory text", Chapmanand ahll ,London,1998.
2.Colinvaux.P.,"Introduction toEcology", JohnWiley & sons,Newyork,1973.

COURSE CONTENT

Unit I: Concepts of Ecology 9 lecture hours

Fundamentals of ecology, Natural ecosystems and their food chains, food webs, bioenergetics, biochemical cycles and ecological succession**,** deoxygeneation nutrient enrichment

Unit II: Bio Diversity 10 lecture hours

Biological diversity and its importance, reduction in biological diversity by human activities, classes and general effects of physical and Biological interaction with pollutants, lethal and sub-lethal effects.

Unit III: Ecosystem Ecology 10 lecture hours

Ecosystems responses to deoxygeneation nutrient enrichment, pesticides, hydrocarbons, metal and salts, thermal pollution, suspended solids andsilt.

Unit IV: CommunityEcology 7 lecture hours

Principles of population and community ecology–concepts of systems and models–building and analysis Of models–environmental systems, structures and interaction between coastalaeolian, glacial, fluvial, weathering, soil and detrital systems.

Unit V: Integration Ecological Principles 9 lecture hours

Integration of classical, agro and restoration ecological principle sand methods, Biomonitoring and its role in the evaluation of aquatic ecosystem, rehabilitation of ecosystem through ecological engineering principles.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Develop legal and economic structures	1
2	Able to provide reasonable return on investment, financial or personal effort, dividends, wages and so forth.	1
3	Develop ecologically sustainable production and industry through developing the potential of all fibres.	2, 3
4	Develop environmentally and socially friendly alternatives	2, 3
5	Many of the deleterious practices, processes and products currently in use	3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6042	**Environmental Ecology**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6046	Environmental Economics, Legislation and Management	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

Course Objectives

The student will be exposed

1. To make the student investigating the causes, consequences
2. possible solutions to problems associated with degradation of environmental resources
3. analyse the potential non-sustainability of certain types of economic activities using economic analysis as a tool.
4. The economic implications of alternative to pollution
5. Alternative methods for valuing environmental resources and environmental damage

Course Outcomes

At the end of the course, the student will be able to

1. The economic significance and the economic causes of environmental degradation, including loss of diversity
2. The extent to which market based mechanisms might provide a solution to the environmental degradation problem in the absence of overt intervention
3. The economic implications of alternative 'intervention' approaches to pollution management, including the use of charges, subsidies and market permits.
4. Alternative methods for valuing environmental resources and environmental damage
5. The economic consequences of policy instrument for biodiversity conservation

Catalog Description

Economic significance and causes of environmental degradation ; Economics of optimal pollution, regulation, monitoring and enforcement - Managing pollution using existing markets; Economic value of environmental resources and environmental damage

Text Books

1. R.K.Turner, D.W.Pearce and I.Bateman (1994), Environmental Economics:AnElementary Introduction, Harvester Wheatsheaft, London.
2. D.W. Pearce and R.K. Turner (1990), Economics of Natural Resources and the Environment, Harvester Wheatsheaf, London.

Reference Books

1. D.W.Pearce, A.Mark and ya and E.B.Barbier (1989),Blue print for a Green Economy, Earthsc an, London.
2. Michael S.Common and Michael Stuart(1996),Environmental and Resource Economics: An Introduction, 2nd Edition, Harlow: Longman.
3. RogerPerman, Michael Common,Yue Maand James Mc Gilvray (2003),Natural Resource and Environmental Economics,3rd Edition, Pearson Education.

4. N.Hanley,J. Shogren and B.White (2001), An Introduction to Environmental Economics, Oxford University Press..

COURSE CONTENT

Unit I: Introduction to Sustainable Development **9 lecture hours**

Introduction to sustainable development -Economy-Environment inter-linkages -Meaning of sustainable development- Limits to growth and the environmental Kuznets curve –The sustainability debate- Issues of energy and the economics of energy – Non-renewable energy, scarcity, optimal resources, back stop technology, property research, externalities, and the conversion of uncertainty

Unit II: Economic Significance **10 lecture hours**

Economic significance and causes of environmental degradation - The concepts of policy failure, externality and market failure - Economic analysis of environmental degradation - Equi-marginal principle.

Unit III: Economics of Pollution **10 lecture hours**

Economics of Pollution - Economics of optimal pollution, regulation, monitoring and enforcement - Managing pollution using existing markets: Bargaining solutions - Managing pollution through market intervention: Taxes, subsidies and permits.

Unit IV: Economic Value of Environmental Resources **7 lecture hours**

Economic value of environmental resources and environmental damage-Concept of Total Economic Value-Alternative approaches to valuation-Cost benefit analysis and discounting

Unit V: Economics of bio-diversity Conservation **9 lecture hours**

Economics of biodiversity conservation - Valuing individual species and diversity of species - Policy responses at national and international levels

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	The economic significance and the economic causes of environmental degradation, including loss of diversity	1
2	The extent to which market based mechanisms might provide a solution to the environmental degradation problem in the absence of overt intervention	1
3	The economic implications of alternative 'intervention' approaches to pollution management, including the use of charges, subsidies and market permits.	2, 3
4	Alternative methods for valuing environmental resources and environmental damage	2, 3
5	The economic consequences of policy instrument for biodiversity conservation	3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE 6046	**Environmental Economics, Legislation and Management**	2	2					1			1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6038	Application of Bio-technology in Environmental Engineering	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

Course Objectives

1. To introduce microbial and biotechnological concepts and theories.
2. To understand the biotechnological tools and their applications for environmental management.
3. To become familiar with the effective use of biotechnology in eco-sustainable waste management.
4. To understand various toxic chemicals
5. To understand various biotechnological technologies for environmental damages

Course Outcomes

CO1	To gain knowledge related to biology of microorganism
CO2	Environmental Management Strategies for Sustainable Development
CO3	Application of Microorganism in green technology
CO4	To address problems of toxic chemicals in environment
CO5	Gain knowledge on Biotechnological remedies for environmental damages

Catalog Description

microbial and biotechnological concepts and theories ; biotechnological tools and their applications for environmental management ; use of biotechnology in eco-sustainable waste management ; toxic chemicals ; various biotechnological technologies for environmental damages ;

.

Text Books

1. Benefield L.D. and Randall, C.W. (1980). Biological process design for wastewater treatment. Prentice-Hall. N.J.

Reference Books

1.Pelczar, M.J., Chan ECS and Krieg NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.

COURSE CONTENT

Unit I: Ecosystem **9 hours**

Principles of biology-Cell structure, types, functions and communication during developments; Genes and development-gene expression and their regulation, regulation of cell and animal body development; Environment and Ecosystem and its components; Energy and bio-geo-chemical cycles; Microorganisms and Environment- microbes as functionary part of ecosystem, terrestrial and non-terrestrial environments, marine and freshwater environments; Ecological Niche;

Unit II: Human Development and Environment **10 hours**
Historical Overview of Development and Pollution, Environmental Sustainability and Biodiversity; Biotechnology, Human and environment-concepts of biotechnology, its usefulness to humankind and global environment theories and philosophy; Contradiction between economic and environment; Environmental Management Strategies for Sustainable Development
Unit III: Biotechnogy Principles **10 hours**
Microbial cell and enzyme technology-adapted microorganisms, bio-removal of nutrients, micro-algal biotechnology; Interaction of mixed microbial population and its applications in bio-processing of wastes, role of extracellular polymers, bioremediation of environmental problems; Concept of DNA technology, plasmid, mutation, genetically engineered microbial strains and applications of genetic engineering in environmental management.
Unit IV: Toxic Chemicals **8 hours**
Problems of toxic chemicals-sources and categories, halogenated and non-halogenated chemicals, petroleum hydrocarbons, metals, human health effects caused by toxic chemical pollutions; Biodegradation of toxic pollutants, mechanisms of detoxification- oxidation reactions, dehalogenation, biotransformation of metals; Xenobiotic Compounds- types, sources and its hazards; Recalcitrance of xenobiotic compounds and leading factors; Biodegradation of xenobiotic compounds
Unit V: Biotechnological remediation **9 hours**
Biotechnological remedies for environmental damages- decontamination of ground water systems, subsurface environment, reclamation concepts-bioremediation; Production of proteins, Biotransformation of waste into biofertilizers, biogas and electrical energy, affecting physical, chemical and microbiological factors, health risk, odor management, technological advances; Environmental effects and ethics of microbial technology; Biosafety; Clean Technology- concepts and applications in industrial process, clean synthesis; Farming as an engineering process.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Explain biology-Cell structure, Sustainable Development, Problems of toxic chemicals	1,7
2	Biodegradation of toxic pollutants, mechanisms of detoxification- oxidation reactions, dehalogenation,	1, 2, 12
3	Undertake field projects in these areas	1, 9, 11
4	An understanding the problems of Human and environment-concepts of biotechnology, its usefulness to humankind	1, 2, 3, 11, 12
5.	Awareness of detoxification- oxidation reactions, dehalogenation, biotransformation of metals	5,10,12

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE6038	**Application of Bio-technology in Environmental Engineering**	2	2	1				2		2	1		1

1=addressed to small extent
2= addressed significantly
3=major part of course

MENE6041	Clean Development Mechanism & Green Technologies	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

Course Objectives

1. The course is intended to teach the basics of CDM.
2. To become familiar with CDM processes.
3. To study CDM to address environmental problems
4. To study use of CDM in sustainable development
5. Case studies of various CDM of major projects

Course Outcomes

CO1	Well aware of developments in Clean Development Mechanism.
CO2	Understanding of Global Warming and Climatic changes.
CO3	Develop ecologically sustainable production and industry throughdeveloping the potential of all fibres.
CO4	Develop environmentally and socially friendly alternatives
CO5	Many of the deleterious practices, processes and products currently in use

Catalog Description

developments in Clean Development Mechanism.; Global Warming and Climatic changes ; ecologically sustainable production ; environmentally and socially friendly alternatives ; deleterious practices, processes and products currently in use

.

Text Books

1.White. I.D., Mottershead. D.N., Harrison .S.J, "Environmental Systems – an introductory text", Chapman and hall ,London,1998

Reference Books

1.David A. Gottfried, Sustainable Building Technical Manual., Public Technology Inc

COURSE CONTENT

Unit I: Principle of Clean Development Mechanism **9 Hours**
Introduction to Climate Change and Global Warming, International response to Climate Change & Global Warming
Unit II: Kyoto Protocol **10 Hours**

Kyoto Protocol and its mechanism, objectives of Kyoto protocol and details of the agreement, Amendments of Kyoto Protocol.
Unit III: Clean Development Mechanism Process 10 Hours
Overview of Clean Development Mechanism, Administration and Participation, CDM, Project Cycle and Financing, Post Kyoto Negotiations and India.
Unit IV: Sustainable Development in CD 7 Hours
CDM, Sustainable Development and its Assessment, The CDM Market, Types of Major CDM Projects, Small Sectors and CDM, preparing CDM project design document (PDD) Course Project
Unit V: Case Studies on CDM Projects 9 Hours
Types of Major CDM Projects, Small Sectors and CDM, Detailed studies of CDM approved projects.

Mode of Evaluation: Quiz/Assignment/ Seminar/Written Examination

Components	**Theory**	
	Internal	**SEE**
Marks	50	50
Total Marks	100	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
Sl. No.	**Course Outcomes (COs)**	**Mapped Programme Outcomes**
1	Explain Climate Change and Global Warming, International response to Climate Change & Global Warming	1,7
2	Kyoto Protocol and its mechanism, objectives of Kyoto protocol and details of the agreement, Amendments of Kyoto Protocol	1, 2, 12
3	Undertake field projects in these areas	1, 9, 11
4	An understanding the problems of Clean Development Mechanism, Administration and Participation, CDM, Project	1, 2, 3, 11, 12
5.	Awareness of the environmental problems faced by CDM, Sustainable Development and its Assessment, CDM	5,10,12

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning
		1	2	3	4	5	6	7	8	9	10	11	12
MENE6041	**Clean Development Mechanism & Green Technologies**	2	2	1				2		2	1		1

1=addressed to small extent
2= addressed significantly
3=major part of course