



GALGOTIAS UNIVERSITY

Syllabus of

M. Tech: ENERGY AND ENVIRONMENTAL ENGINEERING

Name of School: _____ **School of Engineering**

Department: _____ **Civil Engineering**

Year: _____ **2016-18**

Curriculum and Syllabi

M. Tech: ENERGY AND ENVIRONMENTAL ENGINEERING

School of Civil Engineering

(2016-2018)



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

S.No	Course Code	Course Title	L	T	P	C
1	ENG584P	Professional and Communication Skills	0	0	4	2
2	MAT502	Advance Numerical & Statistical Methods	3	1	0	4
3	ENE512	Renewable Energy Technology	3	0	0	4
4	ENE513	Physico-chemical, Biological Principles and Processes	4	0	0	4
5	ENE514	Environmental Quality Monitoring	2	0	0	4
6	ENE515	Energy Auditing, Conservation & Management	3	0	0	3
		Total Credits				21

Second semester

S.No	Course Code	Course Title	L	T	P	C
1	ENE521	Energy, Instrumentation, Measurement & Control	2	0	2	3
2	ENE522	Environmental Audit & Impact Assessment	3	0	0	3
3	ENE523	Design of Water & Wastewater Treatment Systems	2	0	4	4
4	ENE524	Air Pollution & Its Control	3	0	0	3
5		Elective-I	3	0	0	3
6		Elective-II	3	0	0	3

7	GUC501	Seminar	-	-	-	1
		Total Credits				20

Third semester

S.No	Course Code	Course Title	L	T	P	C
1		Elective-III	3	0	0	3
2		Elective-IV	3	0	0	3
3		Elective-V	3	0	0	3
4	ENE633	Comprehensive Examination	-	-	-	2
5	ENE699	Research Project	-	-	-	4
		Total Credits				15

Fourth semester

S.No	Course Code	Course Title	L	T	P	C
1	ENE699	Research Project	-	-	-	16

Programme Electives- (Credits to be earned: 15)

S.No.	Course Code	Course Title	L	T	P	C
1	ENE532	Electrical Energy Management	3	0	0	3
2	ENE533	Small Hydro-power Systems	3	0	0	3
3	ENE534	Solar Energy Technologies	3	0	0	3
4	ENE536	Hydrogen & Fuel Cells	3	0	0	3
5	ENE537	Nuclear Power Engineering	3	0	0	3
6	ENE539	Power Plant Engineering	3	0	0	3
7	ENE562	Solid Waste Management	3	0	0	3
8	ENE591	Energy, Environment Climate Change	3	0	0	3
9	ENE592	Energy in Built Environment	3	0	0	3
10	ENE677	Bio-Energy Technologies	3	0	0	3
11	ENE679	Energy Efficient Buildings	3	0	0	3
12	ENE681	Mathematical Modeling in Environmental Engg.	3	0	0	3
13	ENE682	Clean Development Mechanism & Green Technologies	3	0	0	3
14	ENE683	Environmental Ecology	3	0	0	3
15	ENE684	Design of Water Supply Treatment and Treatment Systems	3	0	0	3

ENE512	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 Unit – Performance parameters - Estimation of Unit 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
ENE512	Renewable Energy Technology	2	2	1				2		2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE513	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 Publications, 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-base equilibria, 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, Community 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, Methanogenesis, 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
ENE513	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

ENE514	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 Science, 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
ENE514	Environmental Quality Monitoring	2	2	3				2		2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE515	Energy Auditing Conservation and Management	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

Course Objectives

1. To teach the basic concepts of energy audit and management.
2. Give brief knowledge 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 (Wiley 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 Science, 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
ENE 515	Energy Auditing, Conservation & Management	1	2	3	4	5	6	7	8	9	10	11	12

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE551	Renewable Energy Technology Lab	L	T	P	C
Version1.02	Date of Approval:	0	0	2	1
Pre-requisites	Renewable Energy Technology				
Co-requisites	--				

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 field
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
ENE551	Renewable Energy Technology Lab	2	3	1						1			2

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE552	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 Science, 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
ENE552	Environmental Quality Monitoring Lab	2	3	1						1			2

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE521	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 field
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
ENE521	Energy, Instrumentation, Measurement & Control	2	3	1						1			2

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE522	Environmental Audit & Impact Assessment	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

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
ENE522	Environmental Audit and Impact Assessment	1	2					2			1	1	1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE523	Design of Water and Wastewater Treatment Systems	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

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, Flootation, 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
ENE523	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

ENE524	Air Pollution and Its Control	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites	--				
Co-requisites	--				

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 SO₂, 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
ENE 524	Air Pollution and Its Control	1	2	1				2		1			

1=addressed to small extent

2= addressed significantly

3=major part of course

GUC501	Seminar	L	T	P	C
Version1.02	Date of Approval:	-	-	-	1
Pre-requisites					
Co-requisites	--				

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

		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	
GUC501	Seminar	2	2	1					1	2	1		1	

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

ENE699	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
ENE699	Research Project		2	3	2			1		2		2	

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE699	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	--				

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
ENE699	Research Project		2	3	2			1		2		2	

1=addressed to small extent

2= addressed significantly

3=major part of course

PROGRAMME ELECTIVES

ENE534	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. Duffie J.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. Fank Kreith, 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- pyroheliometer, pyranometer, 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’s salt organic 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
ENE 534	Solar Energy Technologies	2	2					1			1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE536	Hydrogen Fuel Cells	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. 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 CO₂, 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
ENE536	Hydrogen & Fuel Cell	2	2					1			1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE 691	Energy, Environment and Climate Change	L	T	P	C
Version1.02	Date of Approval:	3	0	0	3
Pre-requisites					
Co-requisites	--				

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, Units, 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
ENE 691	Energy Environment and Climate Change	2	2	1						2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE677	Bio-Energy Technologies	L	T	P	C
Version1.01	Date of Approval:	3	0	0	3
Pre-requisites	-				
Co-requisites	--				

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 Liquefaction - 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
		1	2	3	4	5	6	7	8	9	10	11	12
ENE677	Bio-Energy Technologies	2	1					1			1		

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE679	Energy Efficient Buildings	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. 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
		1	2	3	4	5	6	7	8	9	10	11	12
ENE679	Energy Efficient Buildings	2	2					1			1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE562	Solid Waste 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 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. Understand 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. George Tchobanoglous et al, "Integrated Solid Waste Management", McGraw-Hill Publication, 1993

Reference Books

1. Handbook of Solid Waste Management by Frank Kreith, George Tchobanoglous, McGraw Hill Publication
2. Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience,
3. 1994. ISBN: 0-471-30681-9.
4. Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.
5. George Tchobanoglous et al, "Integrated Solid Waste Management", McGraw-Hill Publication, 1993.
6. Charles A. Wentz; "Hazardous Waste Management", McGraw-Hill Publication, 1995.

COURSE CONTENT

Unit I:

9 lecture hours

Legal and 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-environmental investigations, 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	Understand 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
ENE562	Solid Waste Management	2	2					1			1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE683	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 fair 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", Chapman and ahll ,London,1998.
2. Colinvaux.P., "Introduction to Ecology", John Wiley & 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, deoxygenation 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 deoxygenation nutrient enrichment, pesticides, hydrocarbons, metal and salts, thermal pollution, suspended solids and silt.

Unit IV: Community Ecology

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 coastal/aeolian, glacial, fluvial, weathering, soil and detrital systems.

Unit V: Integration Ecological Principles

9 lecture hours

Integration of classical, agro and restoration ecological principle and 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
ENE683	Environmental Ecology	2	2					1			1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE682	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 through developing 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	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
ENE682	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

ENE532	Wind Energy 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 through developing 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. Meteorological Aspects of the Utilization of Wind as an Energy Source, Technical Note No 175, World Meteorological Organization
2. EH Lysen, Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983
- 3.

References

1. T Burton, Handbook of Wind Energy, John Wiley and Sons
2. GL Johnson, Wind Energy Systems, Printice Hall Inc, New Jersey, 1985
www.windpower.dk
3. EH Lysen, Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983
4. E Hau, Wind Turbines- Fundamentals: Technologies, Application, Economics, Springer -Verlag Berlin -Heidelberg, 2000
5. DNV- Riso Guidelines for Design of Wind Turbines, 2nd Edition, RisoNationalLaboratory, Denmark, 2002

COURSE CONTENT

Unit I	Wind Energy Basics
	Global circulation, Forces influencing Wind - Pressure gradient force and Coriolis force, Local and Regional Wind systems, Atmospheric Boundary Layer, Atmospheric Stability, Surface Wind, Characteristic variables of wind and other related atmospheric parameters, Wind Data
Unit II	Power in the wind
	Power extracted from wind – stream tube model, linear momentum theory, power coefficient, Betz limit. Extreme winds calculation of theoretical power developed by the wind turbine
Unit III	Wind Energy Atlas
	Use of Wind Energy Data, Wind Speed Statistics, Weibull, Rayleigh and Normal distributions, Topographic Maps, Wind data of India
Unit IV	Measurement and Instrumentation
	Concept of Measurement System, Anemometers, Wind sensing systems, Recording systems, Global Positioning System
Unit V	Wind Turbines
	Types, Rotor elements, Horizontal and vertical axis wind turbines, slip stream theory. Calculation of axial thrust and efficiency, Pitch and stall regulation, Lift and drag coefficients, thrust and torque calculations, Tip losses, Characteristics of horizontal axis wind turbines and power curve. Concepts of blade design, Wind pumps. Matching of pump and turbine characteristics, Wind Turbine Siting

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	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
ENE532	Wind Energy Technologies	2	2	1				2		2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE533	Small Hydropower System	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

This subject is taught to impart knowledge in the area of hydropower and the effective utilization of the hydro power using different technologies.

Text Books

1. L.Monition,M.Lenir and J.Roux, Micro Hydro Electric Power Station(1984)

References

1. AlenR. Inversin, Micro Hydro Power Source Book(1986)
2. Tyler G.Hicks(1988), Power Plant Evaluation and Design

COURSE CONTENT

Unit I	Introduction
	Overview of Hydropower systems-Preliminary Investigation-Determination of Requirements-preparation of Reports and Estimates-Review of World Resources-Cost of Hydroelectric Power-Basic Factors in Economic Analysis of Hydropower projects-Project Feasibility-Load Prediction and Planned Development

Unit II	Development Of Prototype Systems
Advances in Planning, Design and Construction of Hydroelectric Power Stations-Trends in Development of Generating Plant and Machinery-Plant Equipment for pumped Storage Schemes-Some aspects of Management and Operations-Up rating and Refurbishing of Turbines	
Unit III	Power Station Operation and Maintenance
Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability-Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future	
Unit IV	Reservoirs
Problem of management-Maintenance of Civil Engineering works-Maintenance of Electrical Engineering works	
Unit V	Development of Software
Computer aided Hydropower System Analysis-Design-Execution-Testing-Operation and control of Monitoring of Hydropower Services	

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	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
ENE533	Small Hydropower System	2	2	1				2		2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE537	Nuclear Power Engineering	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

This subject is taught to impart knowledge in the area of hydropower and the effective utilization of the hydro power using different technologies.

Text Books

1. S.Glasstoneand A. Sesonske (1981), Nuclear Reactor Engineering,3rdEdition,von Nostrand.
2. M.M. El-Wakil (1962),NuclearPowerEngineering, McGraw-Hill.

References

1. J.R. Lamarsh(1966), Introduction toNuclear ReactorTheory,Wesley.
2. J.J.DuderstadtandL.J.Hamiition(1976),Nuclear ReactorAnalysis,JohnWiley
3. A.E.WalterandA.B. Reynolds(1981),FastBreederReactor, PergamonPress.
4. R.H.S.Winterton (1981), Thermal Design of NuclearReactors,PergamonPress.
5. M.M. El-Wakil(1971),NuclearEnergy Conversion,IntextEducationalPublish.

COURSE CONTENT

Unit I	
	Mechanism of nuclear fission–Nuclides–Radioactivity–Decay chains– Neutron reactions–Fission process–Reactors–Types of reactors– Design and construction of nuclear reactors–Heat transfer techniques in nuclear reactors- Reactor shielding
Unit II	
	Nuclear fuel cycles–Characteristic of nuclear fuels–Uranium– Production and purification of uranium– Conversion to UF ₄ and UF ₆ – Other fuels like Zirconium, Thorium, Beryllium
Unit III	
	Nuclear fuel cycles–Spent fuel characteristics– Role of solvent extraction in reprocessing–Solvent extraction equipment
Unit IV	
	Processes to be considered–Fuel element dissolution–Precipitation process– Ion exchange–Redox– Purex–TTA–Chelation–U235–Hexone – TBP and Thorax processes–Oxidative slagging and electro- refining – Isotopes– Principles of isotope separation
Unit V	
	Types of nuclear wastes–Safety control and pollution control and abatement– International convention on safety aspects–Radiation hazards prevention

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	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
ENE537	Nuclear Power Engineering	2	2	1				2		2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE684	Design of Wastewater Treatment and Disposal Systems	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 | Knowabout theconventional treatment unitsandprocesses. |
| CO2 | Role of microorganisms in wastewater treatment. |
| CO3 | BiologicalNutrients removal. |
| CO4 | Nutrients removal by chemical process. |
| CO5 | Sludgetreatment,handlinganddisposal. |

Catalog Description

The main aimofintroducingthissubjectistoimpartknowledgeaboutthecompletefundamentalconceptabout treatment of the industrialwastewaterand its recycle

Text Books:

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

References:

1. D.W.Pearce,A.MarkandyaandE.B.Barbier(1989),BlueprintforaGreenEconomy,Earthscan, London.
2. MichaelS.CommonandMichaelStuart(1996),EnvironmentalandResourceEconomics:An Introduction, 2ndEdition,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	Importance of Advanced Wastewater Treatment
	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	Biological Nutrient Removal
	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	Chemical Nutrient Removal
	Nitrogenremovalbyphysicalandchemicalmethods- Airstrippingofammonia/BreakpointChlorination/Ion –exchange.Removal of phosphorus by chemical addition.
Unit IV	Economic Value of Environmental Resources
	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
	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	

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	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
ENE684	Design of Wastewater Treatment and Disposal Systems	2	2	1				2		2	1		1

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

ENE539	Power Plant Engineering	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 | Knowabout theconventional treatment unitsandprocesses. |
| CO2 | Role of microorganisms in wastewater treatment. |
| CO3 | BiologicalNutrients removal. |
| CO4 | Nutrients removal by chemical process. |
| CO5 | Sludgetreatment,handlinganddisposal. |

Catalog Description

The main aimofintroducingthissubjectistoimpartknowledgeaboutthecompletefundamentalconceptabout treatment of the industrialwastewaterand its recycle

Text Books

1. S.C. Arora and S. Domkundwar, "A Course in Power Plant Engineering", DhanpatRai and Sons, Tata McGraw Hill, 1998.
2. P.K.Nag, "Power Plant Engineering ", Tata McGraw Hill Publishing Co. Ltd., 1998.
3. G.R. Nagpal, "Power Plant Engineerig ", Khanna Publishers, 1998.

References

1. Joel Weisman and Roy Eckart, "Modern Power Plant Engineering ", Prentice Hall, International Inc., 1985.
2. Bernhardt G. Askrotzki& William A. Vopat, "Power Station Engineering and Economy ", Tata McGraw Hill Publishing Co. Ltd., 1972.
3. Frederick T. Mores, " Power Plant Engineering ", Affiliated East-West Press Private Ltd.,

COURSE CONTENT

Unit I	Layout of power plant	
	Layouts of Steam, Hydel, diesel, MHD, nuclear and gas turbine power plants - Combined power cycles -Comparison and selection.	
Unit II	Steam Boiler and Cycles	
	Modern high pressure and supercritical boilers - Analysis of power plant cycles - modern trends in cycle improvement - Waste heat recovery, Fluidized bed boilers.	
Unit III	Fuel and Ash Handling, Combustion Chamber, Draught, Air Pollution	
	Preparation and handling of coal - Pulveriser - Dust collector - Ash removal; Stokers - Different types -Pulverised fuel burn; Draught - Different types, Chimney design - Selection of blowers, Cooling towers - Different types - Analysis of pollution from thermal power plants - Pollution controls.	
Unit IV	Instrumentation, Testing Of Boilers, Power Plant Economics	
	CO2 recorders - Automatic controls for feed water, steam, fuel, air supply and combustion, Boiler testing and trials - Inspection and safety regulations. Economics of power plant - Actual load curves, fixed costs – Operating costs - Variable load operation.	
Unit V	Nuclear And MHD Power Generation	
	Elementary treatment - Nuclear fission, chain reaction - Pressurized water reactors, boiling water reactors, gas cooled reactors - Fast breeder reactors, MHD power cycle principles.	

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	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
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		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
ENE539	Power Plant Engineering	2	2	1				2		2	1		1

1=addressed to small extent

2= addressed significantly

3=major part of course

ENE591	Energy in Built Environment	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 understandthevariousenergyuseandenergyprocessesinbuilding
- CO2 knowinteractionofvariousexternalparametersinfluencingbuildingenergyrequirements
- CO3 knowtheenergyrequirementsforlighting,air-conditioning,etc.
- CO4 takeenergyauditandenergyconservation measuresinbuildings
- CO5 understandthe managementofindoorenvironmentalrequirements

Catalog Description

The main aimofintroducingthissubjectistoimpartknowledgeaboutthecompletefundamentalconceptabout treatment of the industrialwastewaterand its recycle

Text Books

1. J.KriederandA.Rabl(2000),HeatingandCoolingofBuildings:DesignforEfficiency,McGraw-Hill.

References

1. S.M.GuinnessandReynolds(1989),MechanicalandElectricalEquipmentforBuildings,Wiley.
2. A.Shaw(1991),EnergyDesignforArchitects,AEEEnergyBooks.
3. ASHRAE(2001),HandbookofFundamentals,ASHRAE,Atlanta,GA.
4. Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University ofIllinois,USA.

COURSE CONTENT

Unit I	
	Indooractivitiesandenvironmental control-Internalandexternal factorsonenergy use-Characteristicsof energyuseanditsmanagement -Macroaspect ofenergyuseindwellingsanditsimplications-Thermal comfort - Ventilationandairquality-Air-conditioningrequirement -Visual perception-

Illumination requirement-Auditoryrequirement		
Unit II		
The sun-earth relationship-Climate, wind, solar radiation andtemperature- Sun shading and solar radiation on surfaces-Energyimpact ontheshapeandorientationofbuildings-Lightinganddaylighting:Characteristics andestimation, methodsofday-lighting-Architecturalconsiderationsforday-lighting		
Unit III		
Steady andunsteadyheattransferthroughwallandglazedwindow- Standardsforthermalperformanceof building envelope- Evaluation of the overallthermaltransfer - Thermalgainandnetheatgain- End-use energyrequirements- Statusofenergyuseinbuildings-Estimationofenergyuseinabuilding		
Unit IV		
Energyaudit andenergytargeting-Technological optionsforenergymanagement - Naturalandforced ventilation-Indoorenvironmentandairquality-Airflow andairpressureonbuildings-Flowduetostack effect		
Unit V		
Passive buildingarchitecture-Radiativecooling -Solarcooling techniques - Solar desiccant dehumidificationfor ventilation- Naturalandactivecoolingwithadaptivecomfort-Evaporativecooling – Zero energy buildingconcept		

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	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
ENE591	Energy in Built Environment	2	2	1				2		2	1		1

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

ENE681	Mathematical Modeling in Environmental Engg.	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.
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- 4.To study use of CDM in sustainable development
- 5.Case studies of various CDM of major projects

Course Outcomes

- CO1 understandthevariousenergyuseandenergyprocessesinbuilding
CO2 knowinteractionofvariousexternalparametersinfluencingbuildingenergyrequirements
CO3 knowtheenergyrequirementsforlighting,air-conditioning,etc.
CO4 takeenergyauditandenergyconservation measuresinbuildings
CO5 understandthe managementofindoorenvironmentalrequirements

Catalog Description

The main aimofintroducingthissubjectistoimpartknowledgeaboutthecompletefundamentalconceptabout treatment of the industrialwastewaterand its recycle

Text Books:

1. Gilbert M., Master, 'IntroductiontoEnvironmental Engineeringand Science' Prentice-Hall ofIndia,New Delhi,1998

References:

1. Howard S.Peavy, Donald R. Rowe,and GeorgeTchobanoglous.'Environmental Engineering'. McGraw-Hill BookCompany, New York.1985
2. Roland b. Stull : Introduction toBoundary LayerMeteorology. John Wiley 1988.
3. Plus,JournalArticlesfromJ.Geophys.Res.,GeophysicalResearchLetters,QuarterlyJournalof the Royal Meteorological Society.

COURSE CONTENT

Unit I	
	The origins: Formation of the Physical Environment. The evolutionof the Earth's atmosphere. Quantification ofthe Lapse Rate. The states of stability of the atmosphere Quantification of Wind circulation : Geo-strophic winds. Necessity ofmathematical models. Concentration calculationsand conversionsinliquidsandgases. Converting ppminto microgrammes/m3and vice-versa. Material Balance –Steady-stateconservative systems-non-conservativepollutants.Mass-Energyflowsandbalances–specific examples in real-lifenvironmentalproblems:Thermal pollution of aRiver

Unit II	
	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 Roadway Noise
Unit III	
	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	
	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	
	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	

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	1, 2, 12
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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
ENE681	Mathematical Modeling in Environmental Engg.	2	2	1				2		2	1		1

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