DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

PROGRAMME : M-Tech Environmental Science & Engineering

Programme Educational Objective

a) To impart students with strong knowledge base through theory courses and sessional that makes them suitable for industries, academics, research
and consultancies.
b) To develop students analytical, computational and research skills through assignments, weekly presentations and modeling software.
c) To train the students on developing practical, efficient and cost effective solutions on problems and challenges on environmental sciences and
engineering.
d) To inculcate among students sensitivity towards social and corporate responsibilities.

Programme Outcomes:

i. To develop environmental scientists and engineers and sensitize them towards environmental issues.
ii. To acquire analytical skills in assessing environmental impacts through a multidisciplinary approach.
iii. To identify environmental problems and solutions through organized research.
iv. To improve the communication and writing skill so as to face the competitive world

	POs			
PEOs	To develop environmental scientists and engineers and sensitize them towards environmental issues.	To acquire analytical skills in assessing environmental impacts through a multidisciplinary approach.	To identify environmental problems and solutions through organized research	To improve the communication and writing skill so as to face the competitive world.
To impart students with strong knowledge base through theory courses and sessionals that makes them suitable for industries, academics, research and consultancies.	Ö	Ö	Ö	Ö
To develop students analytical, computational and research skills through assignments, weekly presentations and modeling softwares.		Ö	Ö	Ö
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To inculcate among students sensitivity towards social and corporate responsibilities.	Ö	Ö		

1ST SEMESTER COURSE STRUCTURE
(Units-6)

I. Core Papers: (Units-3)
   i. Air Pollution and Control Technology
   ii. Environmental Chemistry & Microbiology
   iii. Water Supply and Wastewater Management

II. Electives: (Unit-1)
   i. Ecological Dynamics & Energy
   ii. ISO 14000-Environmental Management System
   iii. Environmental & Natural Resource Management
   iv. Ecological Science & Management

III. Sessionals: (Units-1)
   i. Geospatial Laboratory
   ii. Environmental Lab I

IV. Breadth Paper: (Unit-1)
   i. Breadth paper for the department (Remote Sensing & GIS for Spatial Data Analysis)

V. Breadth Paper Offered By The Department
   i. Ecological Science & Management
   ii. Environmental & Natural Resource Management

TES 1001: AIR POLLUTION MONITORING & CONTROL TECHNOLOGY

Course objectives

1. Understanding of basic concepts of air pollution.
2. Study of air pollution episodes. Reasoning of the entire episode, identification of the parameters, conditions, mechanisms.
3. Study of sampling types and methods for ambient air and stack.
4. Study of macro and micro meteorology for understanding the dispersion of pollutants.
5. Simple and complex modeling for point source, line source and area source.
6. Study of pollution control methods, mechanism and devices.

Course learning outcomes

a. Ability to identify air pollution problems and interpret criteria air quality data
b. Ability to recognize various environmental transformation processes of pollutants under extreme weather condition.
c. Ability to interpret meteorological data and develop capability to assessment of project proposal, air quality pollution index for any region
d. Ability to justify the use of pollution control equipment and their design

Mapping of CO and CLO

Course Objectives	CLO (a)	CLO (b)	CLO (c)	CLO (d)
CO 1	✓	✓	✓	✓
CO 2	✓		✓	
CO 3		✓	✓	
CO 4		✓	✓	
CO 5		✓	✓	
CO 6			✓	✓

Module 1 [4 lectures]

Air Pollution: Sources of air pollution- stationary and mobile, fugitive emissions, secondary pollutants; Effects of air pollution in regional and global scale, air pollution episodes; Emission factors inventory and predictive equations.

Module 2 [4 lectures]

Air Quality Monitoring - objectives, time and space variability in air quality; air sampling design, analysis and interpretation of air pollution data, guidelines of network design in urban and rural areas. Stack monitoring. Air pollution standards and indices.

Module 3 [6 lectures]

Atmospheric meteorology, wind profiles, turbulent diffusion, topographic effects, separated flows, temperature profiles in atmosphere, stability, inversions, plume behaviour.

Module 4 [6 lectures]

Dispersion of air pollutants and modelling -- Basic concepts, inversion layer and mixing height, atmospheric stability classes, The Gaussian dispersion model -- point, area and line sources, Box model. Effective stack height - physics of plume rise, Holland's equation, Briggs equation, etc.

Module 5 [8 lectures]

Air Pollution Control Technologies: Gravity settling chambers, Cyclone Separator, Wet Scrubbers, Fabric filters, Electrostatic precipitators: design and operation.

Module 6 [4 lectures]
Control devices for gaseous pollutants with special emphasis on adsorption, absorption, mass transfer, condensation, and combustion.

Module 7 [2 lectures]
Vehicular emissions and its control. Indoor air pollution and its control.

Books and References

i. Introduction to Environmental Engineering and Science, Gilbert M Masters
ii. Environmental Engineering- Peavy& Rowe. Prentice Hall Pub.
iii. Air Pollution Control – Rao and Rao
iv. Environmental Pollution and Control – C.S. Rao

TES 1003: ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Course objectives

1. Identify and apply chemistry and microbiology nomenclature relative to basic concepts of environmental sciences.
2. Demonstrate and utilize by application and understanding of the concepts of chemistry as they apply to the environment with particular focus on air, water and soil pollution.
3. To understand the transformation and degradation of organic pollutants in the environment.
4. Demonstrate and utilize by application and understanding of the concepts of aquatic chemistry as they apply to the water pollution with particular emphasis on deoxygenation and eutrophication.
5. To impart knowledge on soil sciences and develop understanding about pollutants fate and partitioning processes in soil.
6. To introduce the basic concepts of environmental microbiology and assessment of bacteriological status of water.
7. To understand the role of various microbes in waste water treatment.

Course learning outcomes

a. Ability to identify air pollution problems and interpret air quality data on chemical characteristic.
b. Ability to recognize various biotic and abiotic environmental transformation processes of pollutants.
c. Skill to monitor and assess the functioning and status of various aquatic systems and devise management strategy to control the identified problems.
d. Skill to monitor the health of soils for desired value such as agricultural activity, forestry etc.
e. Capability to understand the partitioning of pollutants in various fractions of soil.
f. Capacity to assess the bacteriological status of water and aquatic systems.
g. Ability to understand the importance of various microbial processes in wastewater treatment.
h. Capacity to apply conventional and novel bacterial wastewater treatment processes for nutrient removal.

Module-1 [05 lectures]
Atmospheric chemistry and Air Pollution

Various segments of atmosphere & their significance, Classification, sources and toxic effects of air pollutants with emphasis on reactive intermediates in atmosphere like hydroxyl radical, ozone and nitrate radical, types of hydrocarbon in the troposphere, reaction of organic compounds in the atmosphere.

Module 2: 02 lectures]
Environmental transformation and degradation processes.

Module 3: [05 lectures]
Aquatic Chemistry

Chemistry of natural waters, physico-chemical properties of water, organic components in natural waters, physical interaction of fresh and sea water in estuaries, salinity of sea water.

Module 4: [10 lectures]

Water Pollution

Water pollution: Deoxygenating substances, influence of chemical process on dissolved oxygen, measurement of oxygen reducing capacity of waste water-The BOD test, Kinetics of BOD reduction, The DO sag, seasonal variations and vertical profiles of dissolved oxygen, anaerobic processes, and production of poisonous gases from animal and vegetable waste, nutrient enrichment and eutrophication.

Module 5 *[04 lectures]*

Soil Chemistry

Composition of soil, micro and macro nutrients, Sources and chemical nature of soil contaminants, important environmental properties of soil, distribution of soil contaminants: Soil – water partition process, soil- organism processes Ecological and health effects of soil contaminants.

Module6 [04 lectures]

Bacteria

Classification and characteristics of bacteria, , growth rate curve, , MPN.

Module 7 *[04lectures]*

Algae

Factors affecting algal growth, control of algae, Fungi, moulds, protozoa , role of microbes in biological waste treatment, , aerobic and anaerobic metabolism

Books and References

1)Chemistry for Environmental Engineers - Swayer and McCarty
2) Outlines of Biochemistry - Conn and Stump
3) Microbiology - Pelzar and Reid
4) Microbiology for Sanitary Engineers - Ray MaKinney

Mapping of CO and CLO

Course Objectives	CLO (a)	CLO (b)	CLO (c)	CLO (d)	CLO (e)	CLO (f)	CLO (g)	CLO (h)
CO 1	✓	✓	✓	✓	✓	✓	✓	
CO 2		✓	✓	✓	✓			
CO 3		✓			✓			
CO 4		✓	✓					
CO 5		✓		✓	✓			
CO 6							✓	✓
CO 7							✓	✓

TES 1005: WATER SUPPLY ENGG. AND WASTEWATER MANAGEMENT

Course Objective:

1. To inculcate the basics of water supply, purification and treatment.
2. To inculcate the basics concepts of waste water treatment, its design and management.

Course Outcomes:

1. Define and explain the significance of terms and parameters frequentlyused in water supply engineering and wastewater management.
2. Evaluate the influence of the different parameter in design and treatment of water treatment plant (water quality parameters) and wastewater treatment plant (wastewater characteristics).
3. Understand the uses of pumps and their applications in rural, urban and industrial sectors. Uses of pumps for raw water supply and wastewater supply. Its capacity calculations, costing, head loss, total head etc.
4. Basic methodology for water treatment (viz., sedimentation,coagulation, flocculation, filtration, disinfection and water softening) and wastewater treatment (screening, grit chambers, sedimentation, biological treatment and chemical treatment)
5. Assess methods employed for water reuse,wastewater reclamation and reuse, characterization of wastewater and storm water control.
6. Give design for unit operations specific to wastewater treatment. Operation, control and monitoring of wastewater treatment facilities. Particular emphasis is given to the following areas:

- Pretreatment practices and methodology
- Biological treatment kinetics
- Activated sludge, extended aeration and sequencing batch reactors
- Aerobic and aerated lagoons
- Oxygen utilization and aeration
- Trickling filters

Mapping of CO and CLO

	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5	CLO 6
CO 1	X	X	X	X		
CO 2	X				X	X

Course Structure

Module-1 **(04 Lectures)**
Introduction , Design Period, Population Forecast, Factors affecting population growth, Water Demand, Factors affecting rate of demand, variations in rate of demand.

Module - 2 **(05 Lectures)**
Hydrological cycle, Rainfall and runoff, groundwater and its development, Surface sources.

Module-3 **(06 Lectures)**
Pumps and pumping, water distribution network and its optimization , leakage analysis and leakage control.

Module –4 **(03 Lectures)**
Impurities in water and their impurities, water quality parameters and analysis. Physical, chemical , Bacteriological analysis.

Module –5 **(06 Lectures)**
Purification of water supplies : Sedimentation, Flocculation, Coagulation, Filtration, Disinfection Adsorption, softening and demineralization ,ion-exchange, reverse-osmosis. Epidemiological and toxic aspects.

Module-6 **(08 Lectures)**

Wastewater Management : Primary, Secondary, Tertiary treatment.
Activated sludge, Trickling filter, Oxidation pond, RBC, Oxidation lagoons, Land application systems.
Flow of sewage, quantity of sanitary sewage, Hydraulic formulae, Design of sewers, Microbiology of sewage, Sewage disposal and treatment methods.

Module-7 **(02 Lectures)**

Wastewater reclamation, wastewater treatment of Paper and Pulp industries.

Books and References:

1. Water supply Engineering - By S.k.Garg (Env.Engg. Vol-1)
2. Sewage and air pollution engg – by S.k.Garg (Env.Engg. Vol-2)
3. Wastewater engineering – Metcalf AND Eddy.

TES 1007: ECOLOGICAL DYNAMICS AND ENERGY

Course Objective

The objective of this paper is to

1. Introduce the fundamental processes, principles, and attributes of different ecosystems.
2. The applicability of conceptual models in understanding of complex biological systems, its importance, threats and management options.
3. Overview of current energy scenario and energy resources of the world.

Course Learning Outcomes:

1. Develop an understanding of structure and function of an ecosystem with reference to nutrient dynamics and energy flow.
2. Become familiar with the biotic and abiotic components of various ecosystems of the earth and know the variety of ways that organisms interact with both the physical and the biological environment.
3. Develop an understanding of the biogeochemical cycles and their significance in the sustainability of ecosystems.
4. Be familiar with the major energy issues and challenges of the 21st century
5. Have knowledge of the technicalities of Renewable energy resources and their major role in dealing with the recent energy crisis of the world.
6. Be familiar with the energy audit procedure for commercial and industrial units.
7. Be aware of the hazards related to energy related industrial operations.

	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6	CLO7
CO1	**X**	**X**	**X**				
CO2			**X**				**X**
CO3				**X**	**X**	**X**	

Course Structure

Module 1: [6 lectures]

Concept of Ecosystem: Structure, functions and Nutrient energy flow. Concepts pertaining to energy in ecological system: Food chain, Food web, Detritus food chain Tropical levels, ecological pyramids, Eco-modeling. Landscape Ecology: Definition, Ecological units, and classification. Millennium Ecosystem Assessment and Millennium Developmental goals.

Module 2: [5 lectures]

Major Ecosystem of the world: Terrestrial ecosystem, Northern Coniferous forest, temperate deciduous forest, Grassland, Desert, Tropical Rain forest. Aquatic ecosystem, marine, fresh water & estuarine Biogeochemical Cycles: Sulphur, Carbon & Hydrogen, oxygen, Nitrogen & Hydrological Cycle. Principles pertaining to limiting Factor: Limits to population growth, limiting factor, carrying capacity etc.

Module 3: [7 lectures]

Energy policy and environmental issues: Energy needs, energy Options; Thermal (Coal, lignite, oil &natural gas) Hydro electric, Nuclear, comparative merits.

Module 4: **[5 lectures]**

Renewable energy sources-solar, wind, wave, tide, geothermal ,OTEC. Siting criteria and problems associated with it. Energy from animal waste, municipal garbage etc.

Module 5: **[3 lectures]**

Energy/ Costs including Environmental Management costs; Capital and recurring. Suitable site selection from dams and fuel supply position in Indian Context.

Module 6: **[5 lectures]**

Energy audit – Energy Conservation. A few case studies- example from TPS (Coal fired, lignite, liquid fuel, gas fired- combined cycle, hydroelectric power plants, nuclear reactor and wind energy). Study of G obar Gas Plant and Solar Collector Units

Module 7: **[3 lectures]**

Hazards associated with nuclear reactors and disposal of spent fuel rods-safe guards from exposure to radiations, international regulation.

Books and References:

1. Non-Conventional Energy Sources – G. D. Rai, Khanna Pub.
2. The Renewable Energy Handbook: A Guide to Rural Energy Independence, Off-Grid and Sustainable Living - William H. Kemp, Aztext Press
3. Ecology of Desert Ecosystem – Walter Whitford, Academic Press.
4. Introduction to Ecology, E.P.Odum. Prentice Hall.
5. Environmental Ecology-P.D.Sharma.

TES 1011: ISO-14000: ENVIRONMENTAL MANAGEMENT SYSTEM

Course Objectives:

1. To develop an understanding of international environmental standards
2. To develop basic knowledge on components of ISO 14000
3. To develop and apply ISO 14000 for Environmental Management.

Course Learning Outcomes

1. Ability to understand the need and origin of Environmental Management Standards
2. Ability to identify environmental aspects and impacts
3. Conduct Mock Auditing
4. Assess and understand product life cycle.
5. Identify global and national eco labels

Mapping of CO and CLOs

	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
CO 1	X				X
CO 2		X	X	X	X
CO 3		X	X	X	X

Course Structure

Module 1 **(4 Lectures)**

The evolution of environmental management standard, British Standard 7750, Technical Committee 207, ISO 9000

Module 2 **(4 Lectures)**

ISO 14000 series, origin, objective, scope and applicability of ISO 14000, components parts of ISO 14000 and their relationship, legal considerations and requirements of ISO 14000.

Module 3 **(6 Lectures)**

ISO 14000 based Environmental Management System : definition, principle, elements, structure and benefits of Environmental Management System, preparation of documents for ISO 14000, sites, implementation steps, internal audit for ISO 14000 compliance.

Module 4 **(6 Lectures)**

ISO 14010: EMS Audit-definition, objective, general principles, scope, types and guidelines of environmental auditing process. Registration process for implementing ISO 14000: organization decision to implement ISO 14000, potential registration problems, minimizing registration costs, steps to registration,

Module 5 **(4 Lectures)**

ISO 14024: Eco-labelling communication to the public. How a company will participate in ISO 14024 based eco-labelling programme.

Module 6 **(5 Lectures)**

ISO 14031: Evaluating the organization environmental performance. ISO 14020 : Guidelines & standards on environmental claims & declarations.

Module 7 **(5 Lectures)**

ISO 14040: Guidelines standards for a company's management system ; general principle of conducting life cycle assessment (LCA), definition, stages and scope of LCA and LCA inventory. ISO guide 64 : its purpose. ISO 14000 checklist.

Reference Books:

1. Global Green standards: ISO 14000 and Sustainable Development. IISD pub. Minitoba.
2. Environmental Audit: A.K.Shrivastava. APH pub Corp. New Delhi.
3. ISO 14000: NILEM pub.

TES 1013: ENVIRONMENTAL ECONOMICS & SUSTAINABLE DEVELOPMENT

Module 1: [6 lectures]
Economic principles: Introduction to microeconomic theory covering theories and applications of individual and market demand, as well as production economics. Welfare economics and its application to imperfect competition and factor markets.

Module 2: [6 lectures]
Introduction to environmental economics and policy: Essential economic concepts and theory relevant to environmental issues. Economic theories of pollution and management of natural resources. The impact of macroeconomic policies on the environment and the role of international environmental agreements on transboundary issues are examined.

Module 3: [4 lectures]
Environmental Values beyond use value: Environmental Resources and Market Failure, Signals of Natural Resource Depletion/ Scarcity (Direct and Indirect Approaches and their Limitations)

Module 4: [6 lectures]
Approaches to Environmental Valuation: Cost-Benefit/ Social Cost-Benefit Analysis, Health Cost Approach, Travel Cost Approach, Amenities and Hedonic Pricing, Contingent Valuation Methods: Revealed and Stated preferences, Willingness to pay and Willingness to Accept.

Module 5: [4 lectures]
Natural resource economics: Economic models of natural resource allocation and demonstrates their application to policy making and natural resource management to provide useful insights to both policy makers and managers.

Module 6: [4 lectures]
Application of Environmental Economics in Public Policy and Natural Resource management: Forest, Water, Fisheries and Pollution Management: key issues and options

Module 7: [4 lectures]
Sustainable Development: Concept of sustainable development, its main principles, the evolution of ideas about sustainability, strategies for promoting sustainable development, resistances to the concept, and some alternative approaches.

Books and References:

1. Values for the Environment: A Guide to Economic Approach – Winpeny JT, Overseas Development Institute, London, HMOS, 1991.
2. Economic Analysis of Environmental Impacts – Dixon, John, A, Scura LF, Carpenter RA and Sherman PB, Earthscan Publications Ltd., London 1995.

TES-1015: ENVIRONEMNTAL & NATURAL RESOURCE MANAGEMENT

COURSE LEARNING OBJECTIVES
1. To introduce the necessity of natural and ecological resources and their management.
2. Conservation of ecological resources.
3. Students will also learn the concept of sustainable development
4. To learn about different recent initiatives and guidelines for environmental management.

COURSE OUTCOMES:
After completion of this course students will be able to:
i. Explain the functions and structure of different ecosystems.
ii. Sketch the energy flow within different trophic levels of ecosystem.
iii. List the various categories of natural resource.

iv. Justify the necessity of natural resource conservation.
v. Design ecological restoration plan for different types of degraded ecosystems.
vi. Identify the reasons for biodiversity loss and evaluate the status of biodiversity in a particular region.
vii. Explain different biodiversity conservation measures.
viii. Interpret earth's behavior as natural system.
ix. Justify the need of sustainable development.
x. Judge the applicability of life cycle assessment, product stewardship, cleaner production and corporate social responsibility as tools of environmental management.

Course Objectives	Course Outcomes									
	i	ii	iii	iv	v	vi	vii	viii	ix	x
1	✓	✓	✓	✓	✓	✓	✓	✓		
2			✓	✓	✓	✓	✓			
3				✓	✓				✓	
4				✓	✓					✓

Course Structure:

Module-1 **(3 lectures)**
Ecology: Basic Principles and Concepts
Introduction, concept of species, populations, communities and ecosystem, Ecotype, ecocline, acclimation, ecological amplitude, ecological equivalents, the law of tolerance, law of limiting factors.

Module-2 **(3 lectures)**
Ecologically Important Plant Groups
Exotic species, genetically modified plants, Indicator plants

Module-3 **(4 lectures)**
Ecological Restoration
Philosophy of ecorestoration, Methods of restoration, Social, political and biological factors affecting ecorestoration task, Case studies from wetland, terrestrial and mountain regions

Module-4 **(6 lectures)**
Conservation of Biodiversity
Biodiversity and its conservation; Hotspots, Mega-biodiversity zones, Threats to biodiversity, Climate change and vulnerable ecosystems: Coral reefs, Mangroves, Mountains

Module-5 **(4 lectures)**
The Context of Environmental Management
Overview of the state of the global environment, the earth's natural systems, sustainability and sustainable development

Module-6 **(**8 **lectures)**
Life Cycle Assessment:
Components of LCA, Measuring environmental impact, strategic framework for LCA, LCA cost assessment (case studies), triple bottom line concept; sustainable development.

Module-7 **(6 lectures)**
Newer concepts of corporate environmental management
Product design for the environment, product stewardship, the social responsibility function of corporations, principles of clean production, packaging, eco-labelling, sustainable procurement

Books and References

i. Environmental planning and management, Christian N Madu, Imperial College Press.
ii. Introduction to Ecology – E.P. Odum, Prentice Hall.
iii. Introduction to environmental engineering and science, Gilbert M Masters
iv. Tools to Aid Environmental Decision Making, Virginia H. Dale and Mary R. English
v. Forest Ecology **,**Barnes, Zak, Denton and Spurr. , 4th edition. John Wiley and Sons, NY.
vi. Ecology of a changing planet, Mark B. Bush. , Prentice hall.

TES 1017: ECOLOGICAL SCIENCE AND MANAGEMENT (3 credits)

Module-1 **(2 lectures)**

Definitions, Principles and scope of Ecology, Branches of Ecology, Ecology and other Sciences, Man and Environment. Principles pertaining to limiting factors- Liebigs law of minimum, Shelfolds law of Tolerance. Ecomodelling.

Module-2 **(4 lectures)**

Ecosystem; Concept of ecosystem, Structure and function, Abiotic and biotic components, Energy flow in ecosystem, Food chain and food web, interrelationship of food chain and food web, Keystone species, Trophic levels. Ecological pyramids - types and diversity. Biomagnification.

Module-3 **(4 lectures)**

Material cycling; Carbon, Oxygen, Nitrogen, Phosphorus, Sulphur and Mineral cycling. Biogeochemical cycling. Productivity and Ecological efficiencies.

Module-4 **(12 lectures)**

Community Ecology; Community structure, Concepts: dominance, diversity, spatial structure, ecological niche, ecotones.

Ecological succession. Population Ecology; Population growth and regulation - Birth rate, death rate, life tables, survivorship curves, population growth, functions.

Types of Ecosystem; Forest ecosystem, grassland ecosystem, desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem, Cropland ecosystem.

Module-5 **(5 lectures)**

Biodiversity and its conservation; Hotspots, Megabiodiversity zones, Threats to biodiversity, Conservation of biodiversity.

Module-6 **(5 lectures)**

Resources; Renewable resources and Non- renewable resources.

Module-7 **(2 lectures)**

Environmental Economics: Concept, Economics of pollution control, Environmental accounting of natural resources. Management of resources.

Reference books

1. Environmental Ecology – P.D. Sharma
2. Introduction to Ecology – E.P. Odum, Prentice Hall.
3. Environmental Studies – AninditaBasak
4. Environmental Science – S.C.Santra
5. Non -Conventional Energy Sources – G. D. Rai, Khanna Pub.

BREADTH PAPER FOR THE DEPARTMENT

TRS 1015: Remote Sensing & GIS for Spatial data Analysis

Course Objectives:

1. To develop basic understanding of remote sensing, GIS and GPS tools.
2. To interpret and develop understandings on applications of satellite imageries and maps.

Course Learning Outcomes

The students will be able to:

1. Understand working principles of remote sensing and history of satellite development in India and globally.
2. Understand how and why FCC are used for interpretation of satellite images.
3. Interpret satellite images and derive conclusions
4. Classify land use and land cover based on various tools.
5. Differentiate between vector and raster data and how the errors in GIS can be minimized.
6. Conceptualize working of GPS and DGPS

Mapping of CO and CLOs

	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5	CLO 6
CO 1	X	X			X	X
CO 2		X	X	X		X

Course Structure:

Module 1: [6 lectures]

Fundamentals of Remote Sensing: Electromagnetic Radiations, EMR spectrum, Atmospheric Windows, Physics of Remote Sensing, Spectral Signatures, Spectral Response pattern of soil, Vegetation & water.

Module 2: [4 lectures]

Satellite, Sensors and Applications: Imaging & non-imaging sensors, Active & passive sensors, Potential & Applications of different sensors. Data analysis & ground Truth collection, Satellite: Landsat (MSS & thematic Mappers), IRS (LISS –I, II, III). Fundamentals of Image Interpretation Techniques.

Module 3: [05 lectures]

Digital Image: Concepts about Digital Image and Its Characteristics, Spectral, Spatial, Radiometric and Temporal Resolution, Visual vs Digital Methods, Image Data Storage and Retrieval, Types of Image Displays and FCCs.

Module 4: [06 lectures]

Digital Image Processing: Preprocessing: Sources of Image Degradation, Radiometric and Geometric Correction Techniques. Single Based and Multi Enhancement Techniques: Contrast Enhancement, Filtering Band Ratio and Vegetation Indices. Elements of Pattern Recognition: Supervised Classification and Unsupervised Clustering.

Module 5: [6 lectures]

Basic Concepts of GIS (Geographical Information System) and Spatial Information, Manual vs Automated GIS. Data Structure: Raster and Vector Formats, Various Structures and Data Formats.

Module 6: [4 lectures]

GIS Analysis: Data Input: Digitization and Scanning Methods. Data Outputs. Spatial Data Analysis: Data Manipulation techniques, Overlay Operations, Buffers, GIS and Remote Sensing Integration. Common errors in GIS.

Module 7: [03 lectures]

Global Positioning Systems (GPS):Main Segments, GPS Signals, Differential GPS

Books and References:

1. Essentials of GPS – N.K.Agarwal,Spatial Network Pvt.

2. Geographical Information Systems-Stan Aronoff,WDL Publ.
3. Remote Sensing & Image Interpretation.Lillesand&Keifer.John Wiley & Sons.
4. Introduction to Remote Sensing –James B.Campbell – Taylor & Francis.

BREADTH PAPER OFFERED BY THE DEPARTMENT

TES 1013: ENVIRONMENTAL ECONOMICS & SUSTAINABLE DEVELOPMENT
TES-1017: ECOLOGICAL SCIENCE AND MANAGEMENT

SESSIONALS:

TES 1002: GEOSPATIAL LABORATORY

OBJECTIVE:
To develop working skills on satellite data interpretation, integration, processing, and analysis**.**

Outcomes
1. Ability to interpretation of satellite imagery.
2. Ability to download data and its processing.
3. Preparation of LULC maps.
4. Analysis of maps.

LAB WORK:
Lab 1: To Prepare a Base Map from the hard copy of the image provided and developing the image interpretation keys.
Lab 2: To prepare an FCC of an unknown image and Analyze it using Erdas Imagine.
Lab 3 : To Subset and Mosiac the given images using Erdas Imagine
Lab 4: To create an Area of Interest from the given image in Erdas Imagine.
Lab 5: To perform mosaicing on subset images using Erdas imagine.
Lab 6: To perform georeference in ERDAS
Lab 7: To perform Unsupervised Classification on a given image using Erdas imagine.
Lab 8: To Create a new shape file in Arc Map.
Lab 9: To Digitize different point, line and polygon features using Arc Map.
Lab 10: To add attributes to different digitized features and map generation using Arc Map software.

2nd SEMESTER COURSE STRUCTURE

(Units-6)

I. Core Paper (Unit- 2)
   i. Solid Waste Management
   ii. EIA, Laws and Protocols

II. Advanced Engineering Science (unit-1)
   i. Environmental System Engineering

III. Electives: (Unit-1)
   i. Environmental Biotechnology& Ecotoxicology
   ii. Industrial Health and Safety
   iii. Industrial Pollution Control
   iv. Remote Sensing for Environmental Studies

IV. Sessionals (Unit-1)
   i. Environmental System Engg. Lab
   ii. Environmental Lab-II

V. Breadth Paper: (Unit-1)
   i. Breadth paper for the department (Environmental Biotechnology)
   ii. Science of Climate

VI. Breadth Paper Offered By The Department
   i. Industrial pollution Control
   ii. Waste management

TES 2001: SOLID WASTE MANAGEMENT (1.0 UNIT)

Course objectives

1. To provide an overview of waste generation, waste characterization and waste management processes.
2. To impart knowledge on solid waste management with particular emphasis on municipal solid waste management which includes different waste processing options such as pyrolysis, composting, and incineration; designing and operating sanitary landfill.
3. To enrich knowledge about characteristics of hazardous wastes and their management.
4. To make learners focus on energy recovery from biomass, agricultural and industrial wastes for production of biogas, ethanol, methanol and hydrogen
5. To impart knowledge on industry specific solid waste management practices.
6. To provide an overview about the concept of land degradation and land reclamation

Course learning outcomes

a) An ability to identify and interpret the criteria for the classification of a substance as a solid/hazardous wastes.
b) An ability to recognize waste minimization and source reduction, assess and describe the procedure for solid and hazardous waste identification and characterization and various waste processing options.
c) Define and elucidate the management, treatment and disposal of hazardous wastes.
d) Skill to assess and develop physical/chemical/biological treatment techniques for the control of hazardous wastes.
e) Skill to address and describe solid waste management including landfill operation.
f) Skill to manage industry specific solid waste issues.
g) Ability to design and execute land reclamation projects.
h) Ability to apply ecological concepts in reclamation of degraded lands.

Course Structure

Module 1 **[05 lectures]**
Solid waste problems: Industrial, agricultural and domestic (urban) wastes. Municipal Solid Waste Management and Handling Rules 2000.

Module 2: **[04 lectures]**
Solid waste disposal: sanitary landfill- planning, site selection, design and operation, equipment, costs, pollution problems, dump closure. Hydrologic aspects of solid waste.

Module 3: **[08 lectures]**
Aerobic landfill stabilization. Biological oxidation composting, optimum conditions for composting & pyrolysis. Incineration: Waste characterization, combustion, calculation unit operations supply of air, products of combustion, furnace temperature, furnace calculation, storage of refuse, waste reduction, environmental control**.**

Module 4: **[6 lectures]**
Industry specific solid waste management: Agriculture, process industry, mineral and metallurgical industry Agriculture, Steel Plants, Coal Mining Industries, Cement Industries.

Module 5: **[4 lectures]**
Hazardous waste management, Resource and energy recovery, recycling solid waste, waste utilization and new concepts, Disposal of industrial and mill tailings.

Module 6: **[03 lectures]**
Reclamation planning: Pre-project land use planning, post project and use monitoring: Physical reclamation – recontouring, terracing, slope preparation, segregation and burial of toxic substance, reclamation alternatives, reclamation equipment, scheduling and costs.

Module 7: **[4 lectures]**

Factors affecting plant establishment; soil characteristic – physical, chemical and biological; solid amendments; selection of species, ecological succession theory, topsoil, mine spoil evaluation, nitrogen fixation, mycorrhiza, financial aspects of reclamation.

Books and References:

1. Text Book of Solid Waste Management.- Iqbal H.Khan, Nawed Ahsan, CBS Pub.
2. Handbook of Industrial Pollution & Control-S.C. Bhatia, Vol – I, CBS Pub.
3. Soils in our Environment-Miller & Donahue, Prentice Hall.
4. Introduction to Environmental Engineering- Gilbert and Masters.
5. Environmental Engineering- Peavy& Rowe. Prentice Hall Pub.

Mapping of CO and CLO

Course Objectives	CLO (a)	CLO (b)	CLO (c)	CLO (d)	CLO (e)	CLO (f)	CLO (g)	CLO (h)
CO 1	✓	✓	✓	✓	✓	✓	✓	
CO 2		✓	✓					
CO 3			✓	✓	✓	✓	✓	
CO 4							✓	✓
CO 5		✓					✓	✓
CO 6							✓	✓

TES 2003: EIA, LAWS AND PROTOCOLS (1.0 UNIT)

Course Objectives:

1. To provide an overview on national and international laws, treaties and conventions for sustainable environment.
2. To develop an understanding on environmental clearance process, project impact assessment, and audits.
3. To understand the benefits, challenges and gaps under the current scenarios of laws.
4. To develop TORs, EMPs, and apply tools for environmental management.

Course Learning Outcomes

1. Understand the various international and national treaties, and convention that laid the foundation for environmental awareness and revolution globally.
2. Understand the protocols responsible for GHG control, ozone hole depletion, control on transboundary movement of hazardous waste and their dumping into forum island.
3. Elucidate and assess the Indian regulations on control and prevention of air pollution, water pollution; protection of forest and wildlife, and public liability insurance.
4. Understand project clearance process, the authorities and EIA process.
5. Identify term of references for various projects and respective mitigation measures.
6. Assess the impacts of various projects based on EIA methodologies.
7. Identify the components of conflicts and the need of public participation in EIA.
8. Develop plan for Disaster management.
9. Analyse the concept of ISO 14000 and EA with reference to Life cycle of a product.

Mapping of CO and CLOs

	CLO 1	CLO2	CLO 3	CLO 4	CLO 5	CLO 6	CLO 7	CLO 8	CLO 9
CO 1	*	*	*					*	
CO 2				*	*	*	*	*	*
CO 3	*	*	*	*					
CO 4				*	*	*	*	*	*

Course Structure:

Module 1: **[03 lectures]**

Environmental policies: Rio Declaration and its principles, Agenda 21 and sustainable development initiatives, Earth Charter.

Module 2: **[04 lectures]**

International Treaties: Waigani Convention, Basel Convention, Montreal Protocol and Kyoto Protocol.

Module 3: **[7 lectures]**

Legal provisions of environmental protection: The Environmental Protection Act 1986,The Air Act 1981,The water Act 1974, The Indian Forest Act 1927,The Forest Conservation Act 1980, Factories Act, Companies Insurance Act.

Module 4: **[7 lectures]**

The Wild Life Protection Act 1980. Environmental Standards: Stages of Development of International Standards, Criteria for standard setting, Public Liability Insurance Act and Acts relating to hazardous and toxic substances.

Module 5: **[05 lectures]**

Framework for environmental impact assessment. Scoping and baseline studies, Techniques for assessment of impacts on ecological, Air, Water, Noise and socio-economic environment.

Module 6 **[04 lectures]**

Impact assessment methodologies: Various methods, Their applicability EMP preparation. Uncertainty in EIA and Risk Analysis.

Module 7: **[04 lectures]**

Disaster management plan. An Introduction to Environmental auditing and ISO 14000: History, Evolution, BIS, Life Cycle Assessment, and Eco-Labeling. Conflict Management.

Books and References:

1. Environmental Impact Assessment: Larry Canter. McGraw Hill Publication.
2. Disaster Management- Edited by R. B. Singh. Rawat Publications.
3. Environmental Impact Assessment- A. K. Shrivastava. APH Pub.

TES 2005: ENVIRONMENTAL SYSTEM ENGINEERING (1.0 UNIT)

Course Objectives:

1. To Identify the impact of industrial activities on the environment and apply the knowledge of environmental system engineering in the choice of cost-effective remediation strategies
2. To identify Safe and healthful design of industrial activity/systems
3. To address the critical environmental issues with optimization techniques for the useful utilization of energy and mineral resources, public-sector concerns of water supply, municipal waste water (sewage) treatment, and solid waste (trash) management and disposal.
4. To understand the need of maintaining professional competency
5. To identify the contemporary issues ,design , formulate and solve the problem.

Course Learning Outcomes:

a. An ability to apply the knowledge of science, mathematics and engineering and work with multidisciplinary team
b. An ability to analyze , interpret data and use appropriate optimization techniques
c. An ability to design & formulate a system and its components as per the desired need and solve engineering problems
d. An understanding of professional , ethical responsibility and knowledge of contemporary issues
e. An ability to minimize the environmental impact and opt for cost-effective remediation techniques

Mapping of COs, CLOs

Course Objectives	CLO (a)	CLO (b)	CLO (c)	CLO (d)	CLO (e)
CO 1	✓	✓	✓	✓	✓
CO 2		✓	✓		✓
CO 3		✓			✓
CO 4		✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Course Structure

Module 1: **[04 lectures]**
System approach: concept and analysis. problem formulation, model construction and deriving solution from models.

Module 2: **[06 lectures]**
Linear Programming Problem (LPP): Primal and Dual Simplex Method. Limitations of LPP. Sensitivity analysis.

Module 3: **[06 lectures]**
Application of linear programming to wastewater management systems, pesticide management problems, planning of municipal wastewater treatment, air quality management, and agricultural non-point source pollution.

Module 4: **[4 lectures]**
Lagrange's multipliers: Unconstrained and constrained optimization, Limitations of Lagrange's multipliers. Sequential search algorithms: Box algorithm.

Module 5: **[8 lectures]**
Separable and integer programming: Application to multi-objective planning. Application of integer programming to municipal solid waste management. Transportation models.

Module 6: **[4 lectures]**
Dynamic programming models: Application to land use planning and air pollutant emission control.

Module 7: **[2 lectures]**
Present value concepts: Optimization over time.

Books:

1. Operations Research: An Introduction - Hamdy A. Taha, Prentice Hall Pub.
2. Operation Research: theory & applications – J. K. Sharma,
3. Environmental System Engineering & Economics – Robert Wills & Brad A. Finney, Kluwer Academic Pub.
4. Environmental Systems Optimization – D.A.Haith , 1982, Wiley Sons, NY.
5. Techniques for Environmental System Analysis - R.H.Pantell Wiley, NY, 2001.

ELECTIVES

TES 2007: ENVIRONMENTAL BIOTECHNOLOGY & ECO-TOXICOLOGY

Module-1 **(5Lectures)**
Concept of Environmental Biotechnology and Environmental Engineering, scope and importance. Genetic engineering structure of DNA, RNA, Replication of DNA, genetic code, Transcription, Protein synthesis.

Module-2 **(5 Lectures)**
Introduction to Genetic Engineering and Recombinant DNA Technology(RDT), Restriction endonucleases, Steps in gene cloning, cDNA and genomic library, Chemical synthesis of gene, Polymerase Chain Reaction (PCR), Vectors and their types, Selection of recombinant clones.

Module-3 **(5 Lectures)**
Introduction to Environmental Toxicology : Definition, classification, origin and general nature of toxicants in environment, factors affecting toxicity, nutritional and non nutritional food supplements and their effects, mutagenesis, teratogenesis, carcinogens,hellucinogens, phytotoxins and animal toxins.

Module-4 **(5 Lectures)**
Systematic and Eco-toxicology: Toxic response of different body systems like respiratory, gastro-intestinal tract, Liver, kidney, immune system, reproductive system. Problems and approach, Environmental distribution of chemicals in air, water, sediments,soil and biota; Effects of toxicants on ecosystem, Detoxification of toxicants in resistant biota.Unit

Module-5 **(5 Lectures)**
Air pollution and its control through Biotechnology, Biotechnology in reduction of CO2 emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications.

Module-6 **(5 Lectures)**
Bioremediation, Types of bioremediations, Bioaugmentation for bioremediation, Bioreactors, Bioremediation of herbicides, pesticides, hydrocarbons, oil spills.

Module-7 **(4 Lectures)**
Novel methods of pollution control – Vermitechnology, Methane production,Root zone treatment, Membrane technology, Biodegradable plastics.

Books and References:

1.Microbial Biotechnology : A. N. Glazer and H. Nikaids .
2.Molecular Biotechnology : Gleek and Pasternack.
3.Biotechnology : A Text Book of Industrial Microbilogy, T. D.Brock,

4.IndustrialMicrobiology : Presscott and Dunn.
5.Biotechnology:B.D.Singh. ,KalyaniPublishers

TES 2009: INDUSTRIAL HEALTH & SAFETY

Course Objectives

The course objective of the paper TES-2009, Industral Health & Safety is to help the students to develop a comprehensive knowledge at the introductory level, in the area of Health and Safety. The overall objective is to enhance the students' awareness and sensitivity to Health and Safety practice in industry.

Course Learning Outcomes

After completing a course in this paper, the students would be able to

1. Understand the role of occupational health and safety in the workplace in the prevention of incidents, injury and illness.
2. Develop an understanding about the role of plant layout, housekeeping and machine guards to assure health and safety in workplaces.
3. Have a basic understanding of fire hazards in industry, its causes, types, detection and extuinguishing procedures.
4. Be familiar with Safety training and education to be imparted to employees and employers of an organisation to ensure health and safety.
5. Understand the safety organisational structure and function to implement OHSAS 18001 in industries.
6. Have knowledge about the different types of effective personal protective gears used in industry for specific operations, their maintenance and disposal methods.
7. Have knowledge about Hazard assessment studies and ways to handle hazard situations in industry acting as Environment and Safety officers.
8. Understand the modus operandi of onsite and offsite emergency control plans in industry.
9. Know the structure and function of Disaster management group to handle emergency situations.
10. Understand the economics of safety regarding individual and family, organisation and society.

Course Structure

Module – I (Lecture:5)

Plant layout for safety location and design distance between hazardous units, lighting, ventilation, color coding, flow charts, pilot plant applications, and machine guarding and its types, house keeping

Module 2 (Lecture: 5)

Nature and type of work places, Workers exposure to toxic chemicals and its effects. TLVs, Safety measures in the use of gas cylinder. Factors contributing towards fire: chemistry of fire, common causes of industrial fires, types of fires, fire extinguishers-types and handling. Fire detection and alarm systems, water spray systems- BLEVE, Confined and UVCE

Module-3 (Lecture: 5)

Safety organization in loss prevention, safety education and training, Hazard identification, Fault tree analysis, event tree analysis, HAZOP studies. Introduction to OHSAS 18001.

Module-4 (Lecture: 5)

Accident investigations, classifications, steps, reports, remedial measures, first aid training. Human factors contributing to accidents-causes for unsafe acts.

Module –5 (Lecture: 5)

Personal protective equipments- need, selection, applicable standards, supply, use, care and maintenance. Respiratory PPE and Non- respiratory PPE.

Module –6 (Lecture: 5)

Major accidents, hazards consequences of major hazard accidents, role of management and public. On-site and Off-site emergency planning, structure of disaster management system, constitution of disaster management group, control of emergencies.

Module –7 (Lecture: 4)

Economics of safety, financial costs to individual and family, organization and society. Compilation procedure, utility and limitation of cost data, budgeting for safety.

Books & References:

TES 2011: INDUSTRIAL POLLUTION & CONTROL

Course Objective:

1. To develop a general understanding on types of various industrial pollutions and associated problems.
2. To develop management techniques for degraded landforms due to industrial activities.
3. To develop and understanding on occupational health and safety measures.

Course Learning Outcomes:

The students would be able to:

1. Identify sources, types, and control equipment's for industrial air pollution.
2. Identify sources of water pollution, general water treatment, wastewater treatment and issues pertaining water quality degradation
3. Understand reasons for land degradation, soil quality loss, and identify essential nutrients for productivity.
4. Define reclamation process with specification for on mining area reclamation, grassland reclamation and wetland reclamation.
5. Specify the components of OHSAS and its requirement in hazard identification and management.
6. Classify various health problems emerging out off industrial activities.

Mapping of Cos and CLOs

	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5	CLO 6
CO 1	*	*	*	*		*
CO 2	*	*	*	*	*	
CO 3					*	*

Course Structure

Module -1

Introduction: (3 lectures)

Industrial pollution: definition, Types of Pollutants**,** industrial toxicants and hazardous materials.

Module-2

Industrial Air Pollution: (5 lectures)

Point and non-point sources of air pollution in thermal power plants, nuclear power plants, agro based industry, pulp and paper industry, plastic industry, mining and metallurgy industry, cement industry, Preventive measures of industrial air pollution.

Module-3

Industrial water pollution: (5 lectures)

Industrial water,.Types, sources and classification of water pollutants, constituents of aquatic Environment, oxygen contents of water and aquatic life, Effects of water pollutants on life and Environment Water and waste water treatment for specific industry.

Module-4

Industrial soil pollution: (5 lectures)

Components of soil, micro and macro nutrients, source and chemical nature of soil contaminants, Distribution of soil contaminats, Ecological and health effects of soil contaminants. Fertilizers effect of modern agro-technology on quality of soil.

Module – 5

Safety and Health Hazards : (5 **lectures**)

Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation, international and national perspective, safety standards and management systems, ISO 18000. Industrial health safeguards and implementation mechanisms.

Module-6:

Occupational health: (7 lectures)

Occupational diseases: pneumoconiosis, silicosis, asbestosis, byssinosis, baggasis, metal Poisoning (lead, mercury, manganese, copper etc) Notifiable Diseases; possible symptoms and target organs. Synergistic effects: enhancement in toxic effects to extraneous factors. Reversible and irreversible effects synergism.

Module- 7

Social Issues and the Environment (4 lectures)

Basic concepts of sustainable development, social environmental issues, Resettlement, rehabilitation of people, its problems and concerns. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, wasteland reclamation, consumerism and waste products, public awareness.

Books & References:

i. Handbook of Industrial pollution & Control- Vol 1 & 2, S.C.Bhatia, CBS Publishers.
ii. Industrial waste treatment Handbook- Woodward and Cirran, Elsevier Pub,
iii. Industrial Pollution Control Handbook- Edited by Herbert, F.Lund, McGrawhill Pub.
iv. Introduction to Environmental Engineering – Gilbert and Masters
v. Wastewater engineering: Metcalf & Eddy, et.al.,Mcgraw Hill Pub.
vi. Textbook of environmental studies – by E. Bharucha.

TES 2013: REMOTE SENSING IN ENVIRONMENTAL STUDIES

Course Objectives:

1. To develop basic knowledge on remote sensing technique and environmental and ecological issues.
2. To develop an understanding on applicability of remote sensing and GIS tools in environmental management.

Course Learning Outcomes:

1. Ability to understand remote sensing technology and download and interpret satellite imageries.
2. Ability to assess environmental and ecological status and changes.
3. Apply GIS tools in environmental assessment & management.
4. Ability to use GIS techniques in disaster studies.

Mapping of Cos and CLOs

	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	*	*		
CO 2		*	*	*

Course Structure:

Module -1 **(5 Lectures)**

Principles: Sustainable Development and Sustainability**.** Ecological and Biological Aspects of Environment: Hydrosphere, Lithosphere and Biosphere.

Module -2 **(5 Lectures)**

Landscape Ecology: Elements, Units and Indices**.** Applications of Landscape Ecology.

Module -3 **(5 Lectures)**

Spectral Properties: Spectral Properties of Air, Land (Soil), Vegetation and Water**.** Remote Sensing for Assessment of Air, Land (Soil) and Water Quality Parameters.

Module -4 **(5 Lectures)**

Pollution: Types of Pollution, Chemistry of Pollutants: Air, Land (Soil), Vegetation and Water**.** Acid Rain, Smog, Green House Effect and Global Warming**.** Eutrophication, Water logging and Stalinization.

Module -5 **(5 Lectures)**

Environmental Management: Selection of Disposal Sites for Industrial and Municipal Wastes**.** Air, Land, and Water Quality Management**.** Solid Waste Management.

Module -6 **(5 Lectures)**

Environmental Impact Assessment: Basic Concepts, Environmental Impact Assessment (EIA): Methods and Benefits of EIA**.** Role of Remote Sensing and GIS in EIA and EMP (Environmental Management Plan).

Module - 7 **(4 Lectures)****Degradation of Biosphere:** Natural and Human-induced Disasters. Role of Remote Sensing and GIS in Monitoring and Assessment of Natural and Human-induced Disasters such as Landslides, Flooding, Urbanization and Deforestation (Heat Island Effect).

REFERENCES:

1. Remote Sensing – Principles and Interpretation", Sabins, F.F. Jr., 2007, (2^{nd}) Edition W.H. Freeman & Co.
2. Manual of Remote Sensing, Vol. I, Reeves, Robert G., 1991. American Society of Photogrammetry and Remote Sensing, Falls Church, USA.
3. Introductory Digital Image Processing: A Remote Sensing Perspective, Jensen, J.R., 2004, Prentice Hall.
4. Remote Sensing and Image Interpretation, Lillesand, T. M. and Kiefer, R.W., 2007, Wiley and Sons.

BREADTH PAPER

BREADTH PAPER FOR THE DEPARTMENT

- **IPA 1001: SCIENCE OF CLIMATE** (TO BE OFFERED BY MATHEMATICS DEPARTMENT)

BREADTH PAPER OFFERED BY THE DEPARTMENT

- **TES 2011: INDUSTRIAL POLLUTION & CONTROL (Details provided earlier)**
- **TES 2017: WASTE MANAGEMENT**

Course objectives

1. To provide an overview of waste generation, waste characterization and waste management processes.
2. To impart knowledge on solid waste management with particular emphasis on municipal solid waste management which includes different waste processing options such as pyrolysis, composting, and incineration; designing and operating sanitary landfill.
3. To enrich knowledge about characteristics of hazardous, radioactive and biomedical wastes and their management.
4. To make learners recognize the importance of renewable energy, particularly focusing on energy recovery from biomass, agricultural and industrial wastes for production of biogas, ethanol, methanol and hydrogen.
5. To introduce the concept of biological based technologies for treatment of wastewater and solid wastes.

Course learning outcomes

a. An ability to identify and interpret the criteria for the classification of a substance as a solid/hazardous wastes.
b. An ability to recognize waste minimization and source reduction, assess and describe the procedure for solid and hazardous waste identification and characterization and various waste processing options.
c. An ability to explain and interpret the regulations concerning the handling, transportation and disposal of municipal, hazardous, radioactive and biomedical wastes.
d. Define and elucidate the management, treatment and disposal of hazardous, radioactive, biomedical wastes.
e. Skill to assess and develop physical/chemical/biological treatment techniques for the control of hazardous wastes.
f. Skill to address and describe solid waste management including landfill operation.
g. An ability to explore various options such as biogas and biofuel production for energy recovery from biomass and wastes
h. Capability to describe and assess various biotreatment technologies for solid and liquid waste management.

Course Structure

Module-1 **(3)**

Classification of wastes – (domestic, industrial, municipal, hospital, nuclear, agriculture),
Storage of waste at source, Primary collection of waste, characterization of waste.

Module-2

Solid waste management: **(9)**

Management of municipal solid wastes (MSW): Sources of generation, physical composition and characteristics. Methods of sampling,, Proximate and ultimate analysis. Collection, storage, transport and disposal methods; Open-dumping and sanitary landfills. Reduction, reuse and recycling of materials. Optional technologies for processing of MSW: Incineration, pelletization, gasification, pyrolysis.

Module-3

Hazardous waste management (5)

Sources and characteristics. Classification. Health and environmental effects. Safe storage, transport and treatment of hazardous wastes. Stabilization and disposal of hazardous wastes. Criteria for selection for secured and unsecured landfill disposal sites.

Module-4:

Radioactive waste management (4)

sources, classification, health and safety aspects. Management of radioactive wastes.

Module-5:

Biomedical waste: **(5)**

Definition, types, sources and categories, generation in different clinical areas in hospitals. Classification, segregation and colour coding- coding for storage containers. Code of practice for proper handling and management of biomedical wastes: Disinfection/ sterilization, autoclaving, microwave treatment and incineration. Disposal methods. Preventive and control measures for biomedical wastes.

Module-6:

Energy from waste (5)

Renewable energy – sources and status; Energy from biomass, agricultural and industrial wastes. Biogas production, Biofuels: ethanol, methanol, hydrogen, and their production.

Module-7: **(3)**

Biotreatment technologies for waste from food, paper, tanneries, pesticides, petrochemical and pharmaceutical industries .

Reference books:

Introduction to Environmental Engineering – Gilbert and Masters
Environmental engineering by peavey and Rowe
Solid and hazardous waste management by Liu and Liptak.

Mapping of CO and CLO

Course Objectives	CLO (a)	CLO (b)	CLO (c)	CLO (d)	CLO (e)	CLO (f)	CLO (g)	CLO (h)
CO 1	✓	✓	✓	✓	✓	✓	✓	
CO 2		✓	✓					
CO 3			✓	✓	✓	✓	✓	
CO 4							✓	✓
CO 5		✓					✓	✓

SESSIONALS:

TES – 2002 : Environmental System Engineering Lab

Course Objectives:

1. Design, develop, implement and improve integrated industrial and service systems to achieve organizational goals.
2. To Continue to develop skills and implement in engineering, business, management, or other Industrial and Systems Engineering related fields
3. To Identify the impact of industrial activities on the environment and apply the knowledge of environmental system engineering in the choice of cost-effective remediation strategies
4. To address the critical environmental issues with optimization techniques for the useful utilization of energy and mineral resources, public-sector concerns of water supply, municipal waste water (sewage) treatment, and solid waste (trash) management and disposal.
5. To understand the need of maintaining professional competency
6. To identify the contemporary issues, design , formulate and solve the problem.

Course Learning Outcomes:

a. An ability to apply the knowledge of science, mathematics and engineering and work with multidisciplinary team
b. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
c. An ability to design & formulate a system and its components as per the desired need and solve engineering problems
d. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
e. An understanding of professional , ethical responsibility and knowledge of contemporary issues
f. An ability to minimize the environmental impact and opt for cost-effective remediation techniques
g. Have established careers in Industrial and Systems Engineering in industry, service, consulting, or government organizations.

Mapping of COs, CLOs

Course Objectives	CLO (a)	CLO (b)	CLO (c)	CLO (d)	CLO (e)	CLO (f)	CLO (g)
CO 1	✓	✓	✓	✓	✓	✓	✓
CO 2		✓	✓	✓	✓		
CO 3		✓					
CO 4		✓	✓				
CO 5		✓		✓	✓		✓
CO 6							✓

List of Experiments :

1. To introduce LINGO software
2. To solve an optimization problem using LINGO 9.0 software
3. Write a programme to determine the reciprocal of number, maximum and minimum value of a set of numbers
4. To solve transportation problem for solid waste management using "for loop" and LINGO 9.0.
5. To solve solid waste generation and disposal problem for optimizing the total cost
6. To solve a given transportation problem for solid waste management through LPP using LINGO 9.0.
7. To solve the pollution control problem using LINGO 9.0. : case study I – Air pollution control
8. Case study II – wastewater management
9. Case study III – warehouse problem
10. Staff scheduling problem

11. Revenue optimization problem