ACADEMIC YEAR 2015-2017

CENTRE FOR ENVIRONMENT
INSTITUTE OF SCIENCE & TECHNOLOGY
(Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

COURSE STRUCTURE AND SYLLABUS

M.Tech (ENVIRONMENTAL MANAGEMENT)

(6+1 PATTERN)

CENTRE FOR ENVIRONMENT
INSTITUTE OF SCIENCE & TECHNOLOGY
JAWAHARLALA NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
KUKATPALLY: HYDERABAD – 500 085.

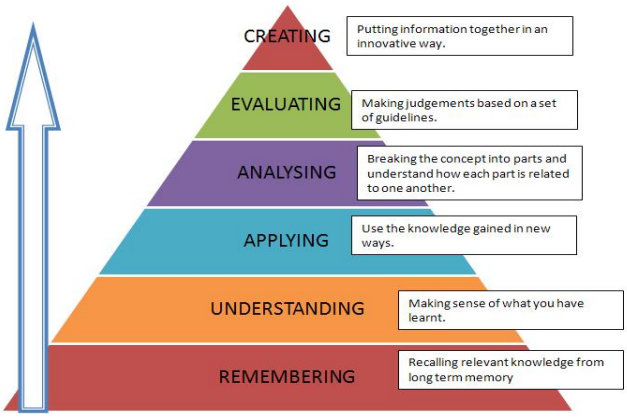
Vision:

- To disseminate advance knowledge by providing effective instruction and innovative research in environmental science and technology by promoting inter-disciplinary studies and research.
- To respond and to find technological solutions for pollution monitoring, abatement and control through innovation in environmental chemistry, environmental biotechnology and Environmental Geomatics.
- To maintain and develop liaison/collaboration with reputed universities, R&D organizations, industries and consultancy firms in India and abroad.

Mission:

- Producing highly motivated, technically competent, morally strong graduates with deep roots in our culture and with ability to respond to global challenges, thereby delighting all stakeholders namely parents, employers and humanity at large.
- To excel as a centre of Higher Education and Research in the field of Environmental Science & Technology.

Blooms Taxonomy:



M. Tech (Environmental Management)

Educational objectives of the Programme:

Programme was started in 2001 (under UGC innovative programme) totrainthemanpowerinEnvironmentalManagementareaduetothenecessityofskilledPostgraduates to address the industrial and societal issues related to:

PEO1: Provide engineering graduates and science post graduates with scientific principles and technical expertise in Environmental Management to enable them to have a career and professional accomplishment through multidisciplinary/interdisciplinary approach.

PEO2: Give in depth knowledge of interdisciplinary areas including ecology, Environmental chemistry, Microbiology, Biotechnology, Remotesensing, GIS, etc. to develop innovative entrepreneurial and ethical future professionals for globally competitive environment.

PEO3: Provide knowledge on the scope, steps involved and various methods related to assessment of environmental impacts in different fields.

PEO4: Provide practical skills through hands on training.

PEO5: Over see the environmental performance including compliance with environmental legislation and coordinating all aspects of pollution control, waste management, environmental health and conservation.

PROGRAM OUTCOMES

PO1: An ability to independently carryout research/investigation and development work to solve practical problems.

PO 2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area asper the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Student preparedness in handling environmental and natural hazards in providing optimal solutions

M. TECH. -ENVIRONMENTAL MANAGEMENT
COURSE STRUCTRURE

I YEAR

I SEMESTER

I Semester		Course Title	Int. marks	Ext. marks	L	P	C
1	**EMT-CC- I**	Environmental Chemistry	25	75	4	--	4
2	EMT **-CC- II**	Environmental Microbiology	25	75	4	--	4
3	EMT **-CC- III**	Remote Sensing and GIS	25	75	4	--	4
4	EMT **-CE- I A** EMT **-CE- I B**	1. Ecology and Environment 2. Remote Sensing for Vegetation	25	75	4	--	4
5	EMT **-CE- II A** EMT **-CE- II B**	1. Air pollution & Control Technologies 2. Environmental Biotechnology	25	75	4	--	4
6	EMT **-OE- I A** EMT **-OE- I B**	1. Energy and Environment 2. Geomatics for Natural Resource Management 3. Ecosystem based disaster risk reduction 4. Biodegradation and remediation	25	75	4	--	4
7	EMT **-LAB- I**	Environmental Pollution Analysis Lab	25	75	--	4	2
8	**Seminar**		50	--		4	2
Total Credits (6 Theory + 1 Lab+ seminar)							**28**

M. TECH. -ENVIRONMENTAL MANAGEMENT
COURSE STRUCTRURE

I YEAR

II SEMESTER

II Semester		Course Title	Int. marks	Ext. marks	L	P	C
1	**EMT -CC- I**	Water and Waste water Treatment Technologies	25	75	4	-	4
2	EMT **-CC- II**	Environmental Impact Assessment (EIA)	25	75	4	-	4
3	EMT **-CC- III**	Bio remediation technologies	25	75	4	-	4
4	EMT **-CE- I A** EMT **-CE- I B**	1. Solid & hazardous waste management 2. Industrial waste management technologies	25	75	4	-	4
5	EMT **-CE- II A** EMT **-CE- II B**	1. Environmental Health and Safety 2. Global Environmental Issues	25	75	4	-	4
6	EMT **-OE- I A** EMT **-OE- I B**	1.1 Energy Audit 1.2. Instrumental methods of Chemical Analysis 1.3. Geomatics for Environmental Management 1.4. Environmental modeling and Smart cities 1.5. Prokaryotic diversity and bio-prospecting	25	75	4	-	4
7	**EMT LAB- II**	Remote Sensing and GIS Lab	25	75		4	2
8	**Seminar II**		50	--		4	2
Total Credits (6 Theory + 1 Lab+ seminar)							**28**

M. TECH. -ENVIRONMENTAL MANAGEMENT
COURSE STRUCTRURE

II Year

	I Semester	Int. marks	Ext. marks	L	P	C
1	Comprehensive Viva-Voce	--	100	--	--	4
2	Project work Review I	50	--	--	24	12
	Total Credits			--	24	16

	II Semester	Int. marks	Ext. marks	L	P	C
1	Project work Review II	50	--	--	8	4
2	Project Evaluation (Viva-Voce)	--	150	--	16	12
	Total Credits			--	24	16

M. TECH. -ENVIRONMENTAL MANAGEMENT
COURSE STRUCTRURE
I YEAR

I SEMESTER

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Core Course. 1	**EMT I_CC1 : ENVIRONMENTAL CHEMISTRY**	**4**	**-**	**4**
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:** Explain the relation between the chemistry and environmental and describe the types of instruments used for analyzing the environmental samples **CO.2:**describe the reactions that occurs in polluted and non-polluted atmosphere and their toxic effects **CO.3:** explain the significance of water, water quality, redox reaction that occur in water and effects of water pollutants. **CO.4**: describe the difference between polluted soil and non-polluted soils, causes for soil deterioration and chemical reaction that occur in soil **CO.5:**explain different major environmental initiatives taken up at global level for sustainable development			

UNIT1 FUNDAMENTALS OF ENVIRONMENTAL AND ANALYTICAL CHEMISTRY:

Stoichiometry, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides. Chemical methods of analysis -gravimetry, titrimetry, Instrumental methods and analysis: Spectroscopy(UV-Visible,AAS,Flame photometer) Chromatography: (GC,GCMS,HPLC & HPTLC),Radioactive: Gama spectrometer, alpha, beta Counters.

UNIT II ATMOSPHERIC CHEMISTRY:

Structure and composition of atmosphere - Chemical reactions in the atmosphere: Ozone chemistry- CFC's – Acid Rain – Photochemical smog - Aerosols types- production and distribution- Aerosols and Radiation –- temperature inversion –- Green House gases - Global warming, toxicity of air pollutants.

UNIT III WATER CHEMISTRY:

Water resources, hydrological cycle, physical and chemical properties of water, complexation in natural and waste water - Water pollutants- Types – Sources- Heavy metals – Metalloids – Organic – Inorganic – Biological and Radioactive – redox reactions in various water bodies including marine environment – Eutrophication – Groundwater – Potable water, Evaluation methods – $LD_{50,}$ $LC_{50,}$ toxicity of Pesticides, heavy metals and carcinogens (PCB & PAH).

UNIT IV SOIL CHEMISTRY:

Physical and Chemical Properties – Cation exchange capacity – soil pH –Leaching and erosion – reactions with acids and bases – Geochemical reactions that neutralize acidity – Biological Process that neutralize acidity – salt affected soils – Trace metals in soils.

UNIT V GREEN ENVIRONMENTAL ISSUES:

Ecological and Carbon foot print –Carbon Sequestration – Clean Development mechanism (CDM) – Polluters Pay principle – Consumerism – Principles of Green chemistry- matrices-green computing. Sustainable mining – Urban forestry –Green building practices – Nanotechnology

Books Recommended

1. Environmental Chemistry, aglobal perspective by Gary W. Vanloon & Stephen J. Duffy – Oxford University press.

2. Chemistry for environmental Engineering and science fifth edition by clair N. Sawyer, Perry L. Mecarly, Gene F. Parkin, Tata megrahil edition.

3. Environmental Chemistry by Ajay Kumar Bhagi, G.R. Chatwal, Himalaya Publishing house.

4.Environmental Chemistry by A.K. de, 4th edition New Age International (p) Ltd., Nee Delhi, India, 2000.

5. Environmental chemistry by V.P. Kudesia, Pragati Prakashav, Meerut.

6. Fundametals of Environmental chemistry, 2nd ed. CRC press, Inc., USA, 2001.

SUBJECT : CODE	SUBJECT TITLE	L	P	C
Theory: Core Course. 2	**EMT I_CC II : ENVIRONMENTAL MICROBIOLOGY**	**4**	**-**	**4**
Course outcomes (POs)	**At the end of the course, the student will be able to** **CO1:** The students will be able to draw the structures of typical prokaryotic and eukaryotic cell structures and label. They would be able to find out the similarities and differences between the two cell types. They would be able to explain the general characters and their beneficial and harmful effects **CO2:** The students will be able to list various nutritional requirements of microorganisms and classify the nutrients. They will be able to categorize different nutritional types based on different criteria and classify microorganisms into different nutritional types. From media composition students will be able to predict nutritional types of organisms. **CO.3:** The students will be able to list, describe, differentiate and suggest suitable methods of isolation, preservation of microorganisms. Students will be able to explain different methods for determining growth and differentiate and analyze relative advantages and disadvantages. Students will be able to draw bacterial growth curve and label them. They will be able to explain the changes that take place during various stages. **CO.4:** Students will be able to categorize microorganisms based on the range of environmental parameters in which they grow. Students will be able to explain different effects of extremes of environment and microbial adaptations to grow under extremes. Students will be able to list out, define and explain different types of microbial control. They will also be able to list various physical and chemical control agents, their mode of action applications, advantages and limitations. They will be able to compare and contrast between different processes and agents of microbial control. Students will be able to suggest a suitable antimicrobial agent for a particular situation and substantiate. **CO.5:** They will be able to draw a flow chart explaining the principle and different components of biosensor. They would classify biosensors based on different criteria. They will explain, differentiate and indicate applicability of different			

	transducing principles for biosensors. They will explain the working of different specific biosensors for glucose, ammonia, BOD, methane and mutagen. They would able to suggest appropriate biochemical recognition element and transducer to be used for biosensors of any analyze of interest.			

UNIT I- DIVERSITY OF MICROORGANISMS

Eukaryotic and prokaryotic cell structure. Prokaryotes and eukaryotes. General characters, beneficial and harmful effects of major groups of microorganisms, protozoa, algae, fungi, bacteria and viruses.

UNIT II- MICROBIAL NUTRITION

Microbial nutrition, Nutritional requirements, major elements, minor elements trace metals and growth factors, Nutrient media (selective, differential, enriched, enrichment and special purpose media) and growth conditions. Nutritional types based on energy source, principal carbon source, electron donor. Proto and auxotrophs, copio and oligotrophs, phago and osmotrophs.

UNIT – III –MICROBIAL GROWTH: Isolation, cultivation (aerobic & anaerobic) and preservation of microorganisms, methods for determining growth (bacterial numbers, mass and cell constituents). Physiology of growth, bacterial growth curve, Exponential growth and generation time. Bacterial growth in batch and continuous culture (chemostat and turbidostat), synchronous growth.

UNIT IV- EFFECT OF ENVIRONMENT & CONTROL MICROORGANISMS

Effect of temperature, pH, O_2, radiant energy, osmotic pressure and dessication on microorganisms and microbial adaptations. Control of microorganisms by physical and chemical agents, sterilization disinfection, sanitization and antisepsis. Physical agents – temperature, filtration, and radiation. Classes of disinfectants – phenol and phenolics – alcohol, halogens, surfactants, and heavy metals. Desirable characteristics of an antimicrobial agent; mode of action of antimicrobial agent. Evaluation of antimicrobial agents.

UNIT V- BIO-INDICATORS AND BIOSENSORS:

Plankton and hydrophyte community as indicators of water pollution. Diversity index in evaluation of water quality; species richness & species evenness. Determination of microbiological quality of potable and recreational waters. Indicators of air pollution. Microbial biosensors – definition, advantages and limitations, different components of biosensor, various transducer principles. (conductometric, potentiometric, amperometric, optical,). Specific biosensors-glucose, ammonia gas, BOD, methane and mutagen sensor.

Text books:

1. Environmental Microbiology – Maier, R.M; Pepper, L; Gerba, C.P.-2009-2nd edition Academic Press.
2. Microbiology – Pelczar, K.J; Chan, E.C.S; Kreig, N.R.-2008-5th edition – Tata Mc Graw-Hill Publishing Biotechnology: the science & the business-Moses, V; Springham, D.G; cape, R.E-1999-2nd edition
3. Microbial Biotechnology – Glazer, A.N; Nikaido, H-2007-2nd edition.

4. Microbiology Prescott, L., Joahnne M.Willey, Linda M. Sherwood, Christopher J. Woolverton-2010, 8th Edition, Mc Graw-Hill publishing company.

References:

Review articles in Advances in Applied Microbiology, critical reviews in microbiology, Annual review of Microbiology, Bacteriology etc.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory : Core Course 3	**EMT I_CC III : Remote Sensing and Geographical Information System (GIS)**	**4**	**-**	**4**
Course outcomes (COs)	**At the end of the course, The student will be able to** **CO1:** Identify the interaction of electromagnetic spectrum with atmospheric interactions on earth surface materials. **CO2.2:** Interpret remote sensing systems, sensors and their capabilities with varied resolutions. **CO.3:** Extract different features from the satellite imageries and analyze various data products **CO.4:** Demonstrate GIS architecture, categories and key elements and basic elements for the visual interpretation. Preprocessing techniques of Digital image processing. **CO.5:** Analysis of GIS data error sources, precision, accuracy and applications.			

UNIT I- REMOTE SENSING – BASIC PRINCIPLES:

Introduction, Electromagnetic Remote Sensing Process, Physics of Radiant Energy: Nature o Electromagnetic Radiation, Electromagnetic Spectrum. Energy Source and its Characteristics Atmospheric Interactions with Electromagnetic Radiation: Atmospheric Properties, Absorption Ozone Atmospheric Effects on Spectral Response Patterns. Energy Interactions with Earth's Surface Materials Spectral Reflectance Curves. Cossine Law.

UNIT II- REMOTE SENSING PLATFORMS AND SENSORS:

Introduction, Satellite System Parameters: Instrumental Parameters, Viewing Parameters. Sensor Parameters, Spatial Resolution, Spectral Resolution, Radio metric resolution. Imaging Sensor Systems: Multispectral imaging sensor systems, thermal sensing systems, microwave image systems.

Latest Trends in Remote Sensing Platforms and sensors: Examples of different satellites and sensors.

UNIT III- VISUAL IMAGE INTERPRETATION AND DIGITAL IMAGE PROCESSING:

Introduction, Types of Pictorial Data Products, Image interpretation strategy, Process of Image Interpretation, Interpretation of Aerial Photo, Basic elements of Image Interpretation, Application of Aerial Photo Interpretation, Interpretation of Satellite Imagery, Key Elements of Visual Image Interpretation, Concept of Converging Evidence. Basic Character of Digital Image, Preprocessing, Image Registration, Image Enhancement Techniques, Image Classification. Image classification and GIS.

UNIT IV- FUNDAMENTALS OF GIS:

Introduction, Roots of GIS, Overview of Information System, The Four Ms, Contribution Disciplines GIS Definitions and Terminology, GIS Queries, GIS Architecture, Theoretical Models of GIS Theoretical Framework for GIS, GIS Categories, Levels/Scales of Measurement.

GIS data Types, Spatial data models, Comparison of Raster and Vector models, and Topology.

GIS data Input and Storage: Introduction, The data stream, Data input methods: Keyboard entry Manual digitizing, Scanning and automatic digitizing; GPS for GIS data capture; Storage of GIS database.

UNIT V- GIS DATA- EDITING, QUALITY, ANALYSIS AND OUTPUT:

Data editing, Detecting and correcting errors, Data reduction and generalization, Edge matching and Rubber sheeting. Components of data quality, Accuracy, Precision and resolution, Consistency, Completeness, Sources of error in GIS; Data Analysis- Format and Data medium conversion, spatial measurement methods, Reclassification, buffering techniques and overlay analysis; GIS output- Maps as output and graphical outputs. GIS applications.

Textbooks:

1. M.Anji Reddy, Text book of Remote sensing and GIS by, BSP Publications, Hyderabad, 2001.
2. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley and Sons Inc, New York, 1987.
3. Principles of **Geographic Information Systems** by John **Jensen** and Ryan
4. Remote Sensing: Principles and Applications - Kindle edition by Floyd F. **Sabins**.

Fundamentals of Geographic Information Systems by Michael N DeMers. Published By john Wiley & Sons Inc., 3rd edition, 2008

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Core Elective. 1	**EMT CE 1A: ECOLOGY AND ENVIRONMENT**	**4**	**-**	**4**
COs	**CO1**.Able to define ecological concepts **CO2**.able to explain the relation between abiotic factor s and ecology **CO3**. Able to ezplain the importance of biodiversity a nd how to conserve the biodiversity **CO4**.able to explain the population dynamics with reference to ecological changes **CO5.** Able to explain the status of natural resources availability and their exploitation			

UNIT-I -Fundamentals of Environment & Ecology: Environment definition, Environmental Segments, Concepts of Ecosystem: Fundamentals of Ecology and Ecosystem, Components of ecosystem, Food chain, Food web, Trophic level, Energy flow. Role of producers and consumers, Methods of calculating energies in the ecosystems- Nutrient cycles in ecosystem- Atmospheric cycles- Edaphic cycles. Introduction, types, characteristic features, structure and function of the following ecosystem: Pond ecosystem- Marine ecosystem- Grassland ecosystem- Forest ecosystem- Desert ecosystem - Cropland ecosystem- Productivity of different ecosystems- Primary production in terrestrial ecosystems- Secondary ecosystem. Effects of human activities on environment: Agriculture, Housing, Industry, Mining and Transportation activities, Basics of Environmental Impact Assessment & Sustainable Development.

UNIT-II- Scope of ecology: Physical, chemical, environmental factors and their relation to organisms. Climatic Factors: Environmental complex- Interaction of ecological factors- Light factor- Temperature factor- Precipitation (rain fall)- Humidity of Air- Atmosphere- Gases and Wind- Atmospheric gases- Wind factor- Fire factor. Topographic (Physiographic) Factors: Height of mountain chains- Direction of mountains and valleys- Steepness of slope- Exposure of slope.

UNIT- III- Biodiversity and its conservation: Current levels of biodiversity – alpha and beta diversity- extinction and endangered species – steps to preserve biodiversity- insitu and ex-situ conservation – gene banks –biodiversity conservation and agenda –21 – hotspots of biodiversity –

national parks and sanctuaries – gene pools. Biodiversity Act 2002 of India.

UNIT-IV- Population and Community ecology: Relation within species, population growth, population dynamics positive and negative growth, bio potential, age structure, equilibrium position, oscillation and fluctuation- Restriction of Urbanization. Different communities and their occupation in different ranges in the environment and their relationship for the maintenance of eco-balance in the environment- Niche ecological succession.

UNIT-V - Natural Resources: Water Resources - Availability and Quality aspects. Mineral Resources, Soil, Material cycles- Carbon, Nitrogen and Sulphur Cycles. Energy - Different types of energy, Conventional and Non-Conventional sources - Hydro Electric, Fossil Fuel based, Nuclear, Solar, Biomass and Geothermal energy and Bio-gas. Gas Hydrates, Hydrogen as an alternative future source of Energy.

Text Books

1. Environmental Chemistry by B.K. Sharma & H. Kaur, Goel Publishing House.
2. Environmental Chemistry by A. K De, New Age International Publishers.
3. Concepts of Ecology. E.J.Kormondey, 1984. Indian reprint 1991 Prentice-Hall of India.
4. Basic Ecology, E.P. Odum, 1983, Holt-Saunders International Edition.
5. Ecology & Environment, P.D.Sharma, Ashish publications,1994.

Reference Books

1. Introduction to Ecology, Paul Colinvaux, 1973. Wiley International Edition.

2. Advanced Ecological Theory- Principles and Applications, Bleak well Science Ltd., Oxford (1999).

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Core Elective. 1	**EMT CE 1B: REMOTE SENSING FOR VEGETATION**	4	-	4
Cos	**CO1**. Able to explain the application of remote sensing for assessment of vegetation **CO2** able to explain the fundamentals of radiation physics which is used for remote sensing **CO3** able to explain the radiative details of vegetation **CO4**. Able to explain the spectral indices of vegetation **CO5**. Able to apply the remote sensing for crop management and to assess the stress on vegetation			

UNIT I

Introduction , History , introduction and and interpretation of Remote sensing , Concepts of Plant Physiology and Remote Sensing. Data availability.

UNIT II : BASICS OF RADIATION PHYSICS FOR REMOTE SENSING OF VEGETATION

Introduction, Radiation characteristics, Electromagnetic Radiation, Electromagnetic Spectrum, Electromagnetic Energy , Sources and terminology. Energy Interactions with matter and surfaces. The radiation Environment. LAI.

UNIT III : Radiative properties of Vegetation, Soils and Water

Optical region: Leaf radiative properties, radiative properties of soil and water, radiative properties canopies.

Thermal region: Emissivity of canopy components, and canopies. Microwave region: Microwave emissivity , back scatter, and advantages. Plant and Canopy Function: water relations ,evaporations and water loss.

UNIT IV: Spectral Information for Sensing Vegetation

Estimation of Vegetation Cove: Spectral Indices -Vegetation indices and vegetation descriptors.

Microwave vegetation indices- estimation of vegetation using Lidar.

UNIT V : INTEGRATED APPLICATIONS

Detection and diagnosis of plant stress. Precision agriculture and crop management , Ecosystems and

Forestry Management.

1. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley and Sons Inc, New York, 1987.
2. Principles of **Geographic Information Systems** by John **Jensen** and Ryan
3. Remote Sensing: Principles and Applications - Kindle edition by Floyd F. **Sabins**.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Core Elective. 1I	**EMT-CE IIA: AIR POLLUTION & CONTROL TECHNOLOGIES**	4	-	4
Course Outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:** List the air pollutants, their resources, effects and can explain about the turbulence and reasons for Indoor air pollution **CO2:** Explain atmospheric dispersion equation and calculate the ground concentration of the pollutants due to stack emissions. Student will be able to explain the ambient air sampling and stack sampling techniques **CO3:** List and describe and explain the design criteria for different air pollution control techniques **CO.4:** Explain the pollution emissions from two stroke and four stroke engines and the type of fuel and air pollution, existing vehicular pollution control technologies and need for improvement **CO.5**: Explain about sources of noise pollution, impact of meteorological aspects on noise preparation and the noise measurement and control techniques			

UNIT I CLASSIFICATION AND PROPERTIES OF AIR POLLUTANTS:

Emission sources -major emissions from Global sources -importance of anthropogenic sources- behaviour and fate of air pollutants- photochemical smog effects of air pollution health, vegetation and materials damage in India air pollution standards -different types of terrain – effects of terrain features on atmosphere – mechanical and thermal turbulence- Indoor air pollution.

UNIT II METEOROLOGICAL ASPECTS OF AIR POLLUTION DISPERSIONS I & II

Temperature lapse Rates and Stability, wind velocity and turbulence, Plume behaviour dispersion of air pollutants- solutions to the atmospheric dispersion equation - the Gaussian Plume Model. Air pollution sampling and measurement- types of pollutant sampling and measurement- Ambient air sampling- collection of gaseous air pollutants- collection of particulate pollutants- stock sampling, analysis of air pollutants- sulphur dioxide- nitrogen dioxide, carbon monoxide, oxidants and ozone- hydrocarbons, particulate matter.

UNIT III CONTROL METHODS:

Sources- correction methods- -particulate emission control- gravitational settling chambers- cyclone separators- fabric filters- electrostatic precipitators- wet scrubbers- -control of gaseous emissions- adsorption by solids- absorption by liquids- combustion, condensation – control of SO_2 emission – desulphurization of flue gases – dry methods – wet scrubbing methods. Control of sulphur dioxide emission- desulphurization of flue gases- dry methods- wet scrubbing methods- control of nitrogen oxides- modification of operating conditions- modification of design conditions- effluent gas treatment methods- carbon monoxide control- control of hydrocarbons.

UNIT IV VEHICULAR AIR POLLUTION:

Genesis of Vehicular emissions- Natural Pollution- Gasification of Vehicles- Point sources of Air Pollution from automobiles- Fuel tank, carburettor, crank case- Exhaust emissions- Mechanism of Origin of air pollution from automobiles. Automobile air pollution – Indian Scenario- Population and pollution loads of vehicles- Automobile Pollution Control- Control at sources- Exhaust gas treatment devices- Alternate fuels comparison- Thermal Reactor- Catalytic Converter- Automobile Emission Control- Legal measures.

UNIT V NOISE POLLUTION:

Sources of noise pollution – measurement of noise and indices – effect of meteorological parameters on noise propagation- noise exposure levels and standards – noise control and abatement measures – impact of noise on human health.

Textbooks:

1. Air Pollution, H.C.V.Rao, 1990, McGraw Hill Co.
2. Environmental Pollution Control, C.S.Rao, Wiley Eastern Ltd.,1993
3. Air Pollution , M.N.Rao McGraw Hill 1993.

Reference Books:

1. Fundamentals of Air Pollution, Samuel, J.W., 1971, Addison Wesley Publishing Co.
2. Air Pollution, Kudesia, V.P. International Student Edition McGram-Hill-Kosakusha Ltd.,Tokyo.
3. Fundamentals of Environmental Pollution, Krishnan Khannan S.Chand & Company Ltd.,1994
4. Environmental Air Analysis, Trivedi & Kudesia, Akashdeep Pub.1992
5. Air Pollution Control and Engineering, De Nevers, Mc Graw- Hills, 1993
6. Energy Technology and the Environment Atilio Bisio, Sharan Boots, Wiley Encyclopaedia Series in Environmental Science
7. Noise Pollution -Vandana Pandey, Meerut Publishers,1995

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Core Elective. II	**EMT-CE IIB: ENVIRONMENTAL BIOTECHNOLOGY**	4	-	4
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:** Explain the necessity for renewable sources of energy need for energy production from waste and non-conventional fuels like methane (biogas) hydrogen and ethanol **CO.2: E**xplain various mechanisms of microbial augmentation of oil recovery, overcoming problems in secondary oil recovery. Students will be able to explain the role of microorganisms can play in biodiesel production and also in transesterification of vegetable oils. Students will be able to explain the mechanism, limitations and application of bioelectricity generation through microbial fuel cells. **CO.3: E**xplain the role of microorganisms and mechanism of transformation accumulation concentration and leaching of metals. Specific application of microbes in copper and uranium extraction will be explained Exploitation of microbes as single cell protein will be explained. They will be able to analyze relative advantages and limitations of different groups of microorganisms for use as SCP. **CO.4: E**xplain various mechanisms in which microorganisms help plants by providing nutrients like Nitrogen, Phosphorous and also by helping in their uptake. They will be able to list out microbes which can be applied as bio fertilizers and bio pesticides. They will be able to explain the mechanism of biological control. They will be able to suggest appropriate bio fertilizers and bio control agents for different crops/soils. **CO.5: E**xplain the importance of 1PR in encouraging innovation and disclosure in biotechnology. They will be able to list out different types of 1 PR, explain their significance and applicability of growth cure. They will be able to calculate doubling time and growth rate. They will predict conditions for varying lag period-both nutritional and environmental. They will be able to explain compare and differentiate between batch and continuous culture. Students will be able to predict how to achieve synchronous culture and explain their application in microbiological studies.			

UNIT – I: MICROBIAL BIOFUELS-1:

Scope and importance Renewable sources, energy from waste materials, production of non-conventional fuels – methane (biogas), hydrogen and ethanol.

UNIT – II: BIO FUELS 2 :

Use of microorganisms in petroleum augmentation and recovery; Bio-diesel from microbial sources. Microbial fuel cells.

UNIT – III: METAL BIOTECHNOLOGY AND MICROORGANISMS AS FOOD:

Microbial transformation, accumulation and concentration of metals, metal leaching, extraction; Exploitation of microbes in copper and uranium extraction. Microbial production of food (SCP), essential prerequisites for organisms to be used as SCP & as food and feed supplements. Major groups of microorganisms used, relative advantages and disadvantages. Substrates used, SCP production, Harvesting SCP;

UNIT – VI: BIO FERTILIZERS AND BIOLOGICAL CONTROL:

PGPR bacteria, general mode of action of plant growth promoting microorganisms, Biofertilizers - Biological nitrogen fixation, phosphate solubilization, VAM fungi and crop productivity, Biological control-Microbial insecticides, (Microorganisms like *Bacillus* species, viral insecticides, certain fungi like *Metarhizium anisopliae*). Biocontrol of plant pathogens. Microorganisms and mechanisms involved-amensalism, competition, predation and parasitism, antibiosis, siderophore production; Integrated Pest Management.

UNIT – V: BIOTECHNOLOGY AND INTELLECTUAL PROPERTY RIGHTS:

Intellectual property rights (IPR) and protection (IPP), patents, trade secrets, copyrights, trade marks, Patents and TRIPS, convention on biodiversity, transfer of biological material.

Text Books:

1. Elements of biotechnology 2001. P.K.Gupta, Rastogi. Rastogi publication.
2. Industrial microbiology- L. E. Cassida, Wiley Eastern publishers.
3. Industrial microbiology-Prescott and Dunn.
4. Microbial Biotechnology 2007 (2nd Ed)- Glazer,A.N. and Nikaido; Freeman and company.

Reference Books:

1. Biotechnology – A new industrial revolution Prentis S.Orbis Publishing Ltd., London.

2. Review articles published in annual reviews, current opinion in microbiology etc. R.C. critical reviews in microbial.

3. Review articles in Adv. Microbial physiol; Adv. Appl microbial; Bacteriol reviews, microbial reviews etc.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory Open Elective.1	**EMT-OE I.1: ENERGY AND ENVIRONMENT**	4	-	4
COs	**CO1**. Able to explain different forms of energy with principle s of generation **CO2**.able to explain the biofuel generation and the impacts of generation **CO3**. Able to assess the global energy scenario **CO4**.able to assess Indian energy scenario **CO5**.able to explain the impacts of energy systems			

Unit I- Energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar, geothermal, tidal and wave energy. Depletion of energy sources and impact, exponential rise in energy consumption on economies of countries and on international relations. Need for use of new and renewable energy sources. Status of Nuclear and Renewable Energy: Present Status and future promise, Hydrogen and fuel cell, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy.

Unit II- Bio fuels: what are biofuels? Need, Advantages and limitations of biofuels. Debates regarding the production and use of biofuel. first, second , third and fourth generation biofuels. Production and impacts of bioethanol, biohydrogen, biogas , bioelectricity and biodiesel.

Unit-I1I-: Global Energy Scenario: Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics. Exponential increase in energy consumption and Projected future demands - International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EUCountries. International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal. Future Energy Options: Sustainable Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies.

Unit-IV: Indian Energy Scenario: Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise

energy consumption, Impact of Energy on Economy, Development and Environment, Need for use of new and renewable energy sources. Status of Nuclear Energy. Energy, Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs) , Jawaharlal Nehru National Solar Mission.

Unit-V: **Impact of Energy Systems on Environment:** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, Green House Gases Emission, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environemtal and health problems due to energy plants. Effect of Hydro electric power stations on ecology and environment. Environmental pollution limits guidelines for thermal power plant- Various pollution control equipments , Limitations and advantages of pollution control systems. Nuclear power plants and environmental pollution, pollution control measures. Pollution due to vehicles and Control emission from Vehicles

Reference Books:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams (Wiley Eastern).
2. Energy policy for : B.V.Desai (Weiley Eastern).
3. TEDDY Year Book Published by Tata Energy Research Institute (TERI).
4. World Energy Resources : Charles E. Brown, Springer2002.
5. Environmental Impact Analysis Handbook -J.G.Rau, D.C.Wood (McGraw Hill).
6. Energy & Environment – J.M. Fowler, (McGrawHill)
7.Web site of Ministry of New and renewable energy.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Open Elective. 1	**EMT-OE I.2: GEOMATICS FOR NATURAL RESOURCE MANAGEMENT**	4	-	4
Course outcomes (POs)	**At the end of the course, the Student will be able to** **CO.1:** Categorize the land use land cover practices and its evaluation. Identify the usage of Geospatial technology in Urban studies and waste disposal methods. **CO.2:** Prioritize the Geospatial techniques in mineral exploration studies and applications. **CO.3:** Estimate the drainage basin, Ground water exploration, watershed and its influence. Analize the soil classes , crop suitability and yield prediction. **CO.4:** Estimate the spectral response, wetland area and modelling **CO.5:** Assess the impact studies of forest, floods, drought, industrial accidents and their mapping.			

UNIT I: LAND RESOURCES AND MUNICIPAL & URBAN GIS:

Appropriate methodology, Rapid land use assessment, Rapid land use information system. Land evaluation and suitability studies by Remote sensing and

. Techniques of land use / land cover map preparation. Land use / land cover mapping and planning. Dynamic urban land use, Semi dynamic land use.

GST for Urban Environmental Monitoring. GST for Municipal Administration. Geomatics in Solid and Hazardous waste disposal site selection, Environmental Information System Development for municipalities: Case studies GST for Traffic and Transportation planning assessment

UNIT II: GEOSCIENCES :

Role of Remote sensing and GIS in geological studies and case studies. Evaluation of Geological Mapping, Introduction to Prospection Techniques, History of Remote Sensing in Geological Exploration. Image Lineaments and structural origin, Prospecting, Applications of thermal and Radar remote sensing in structural geology. Spectral response of Minerals, Rocks, Alterites, case studies

UNIT III: WATER RESOURCES, GRICULTURE AND FORESTRY:

The hydrological cycle, Hillslope hydrology, The drainage basin, Channel networks, Automatic derivation of catchment characteristics, The global cycle.Ground water exploration and targeting. Introduction, Characteristics, Watershed and people, Watershed characteristics, watershed management and Integrated approach for sustainable planning. Water quality modeling. Watershed Management in India, Case studies.

Soil and altitude, Soil and aspect, Soil and slopes, Soil landscapes, Soil erosion modeling.

Crop type classification, area estimates, and spectral response of different crops. Crop diseases and Assessment, Crop and Water management and monitoring. Advances in Crop monitoring.

Survey and mapping of forest cover, Forest change detection, Forest damage assessment and Forests monitoring, Land evaluation for forestry.

UNIT IV: ECOSYSTEM MODELING:

Spectral response of vegetation and mapping, Ecosystem Analysis, Environmental impact analysis and monitoring, Ecosystem modeling, Wetland mapping. Spatial Models of Ecological Systems and Process.

UNIT V: DISASTER MANAGEMENT:

Introduction and Overview- Natural and man made hazards – Vulnerability assessment and Mapping on Disasters- Spatial Information for natural Hazard and risk assessment -Land slides- volcanoes- floods and famines- earth quakes- Drought hazard and risk assessment-Human Induced disasters- industrial disasters- dams- constructional and others.

Books:

1. Good child : Environmental Modeling With GIS
2. Manual of Geospatial Science and Technology Edited By John. D. Bossler, Taylor And Francis, London
3. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley and Sons, Inc, New York, 1987.
4. Geographical Information Systems by David Martin
5. RS in Geology by Siegal
6. RS in Forest Resources by John. A. Howard, Chapman and Hall.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory: Open Elective. 1	**EMT-OE I.4: ECOSYSTEM BASED DISASTER RISK REDUCTION**	4	-	4
COs	**CO1**. Able to explain the fundamentals of ecosystem and causes for disasters **CO2**. Able to classify the disasters **CO3**. Able to explain the disaster risk mitigation measures **CO4**. Able to relate the disaster and environment **CO5**. Able to give plan for disaster management for an area.			

Unit I: Understanding Ecosystem and disaster phenomena
Concept and definitions and functions of different terms of disaster and Ecosystem, Approaches to understand disaster phenomena (natural science, applied science, progressive and holistic approaches),Parameters of Disaster Risk, Levels of disaster as per national guideline.

Unit II: Overview, classification, characteristics, problem areas of disasters
Disaster trends (Global, national and regional),Selected models for understanding the causes of disaster and disaster risk mitigation, Classification of hazards (natural and manmade),Response time, frequency, forewarning, exposure time of different hazards, General characteristics and problem areas of different natural and man-made hazards (e.g. flood, erosion, earthquake, landslide, lightning, tropical cyclone, drought, civil unrest etc.),Common approaches to study natural and manmade hazards; vulnerability and disasters.

Unit III: Disaster risk mitigation
Disaster risk assessment (Hazard-Vulnerability-Capacity analysis), Hazard mapping and forecasting; Principles and aspects of Disaster prevention, Disaster mitigation, Preparedness for damage mitigation and coping with disasters; Capacity building for disaster/damage mitigation (structural and non-structural measures); Contingency planning for damage mitigation of different hazards; Relevance of indigenous knowledge, appropriate technology and local resources in disaster risk mitigation; Community based disaster risk reduction mechanism; Counter disaster resources and their roles.

Unit IV: Environment and disasters
Environment, ecosystem and disasters. Climate change – issues and concerns. Biodiversity loss and DRR; Global water crisis and DRR; Desertification, soil erosion and DRR; ecosystems for urban risk reduction; Industrial hazards and safety measures; Post disaster impact on environment; Impact of developmental projects on disaster risk; Aspects of environmental management for disaster risk reduction; Environmental Impact Assessment (EIA).

Unit V: Planning for disaster management
Concept of spatial planning for DRR; Community-hazard profile in India; Different phases of

Disaster Management (DM cycle; Relief mechanism (needs assessment, relief administration and distribution, management of relief centres, external support etc.);Disaster Management Act (2005); Disaster Management Policy (2009); organizational framework for disaster management in India.

Case studies: Hazard mapping of vulnerable areas, Vulnerability assessment (physical, social, organizational, economical, technological), Risk mitigation planning for vulnerable areas.

Text books

1. Alexander, D. Natural Disasters, ULC press Ltd, London, 1993.
2. Carter, W. N. Disaster Management: A Disaster Management Handbook, Asian Development Bank, Bangkok, 1991.
3. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.
4. National Policy on Disaster Management, NDMA, New Delhi, 2009.
5. Disaster Management Act. (2005), Ministry of Home Affairs, Government of India, New Delhi, 2005.
6. Parasuraman, S & Unnikrishnan, P. V. (ed.), India Disasters Repot Towards a policy initiative. Oxford, 2000.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Open Elective. 1	**EMT-OE I.5: BIODEGRADATION AND BIOREMEDIATION**	**4**	**-**	**4**
Course outcomes (COs)	**On successful completion of the course student will be able to:** **CO1:** define and explain what, when, where, why and how of bioremediation. List out advantages and its application. They will be able to explain the phenomena of biodegradation, acclimation, detoxification, activation, co-metabolism and biotransformation and recalcitrance and their significance in bioremediation. They would be able to explain the concept of bio-availability, the effect of chemical structure on biodegradation and predict biodegradability and the products of biodegradation of any given compound. **CO.2:** classify bioremediation into different types, based on different criteria. They will also be able to list and explain different factors which aid or are detrimental to bioremediation and thus identify criteria to be met for bioremediation. They will be able to list explain different methods available for assessing biotreatability and also analyze, differentiate and explain relative advantages, disadvantages and application. **CO.3:** list and describe different bioremediation technologies, bringing about the differences between them and practical application. They will be able to suggest suitable bioremediation technologies for specific pollutants/environments. **CO.4:** define phyto remediation and explain physical, chemical and biological mechanism of phyto remediation the students will be able to suggest the type of plants/mechanism to be applied for different pollutants/environments. **CO.5:** explain how oil pollution can be bioremediated. The students will be able to explain the mechanism of metal bioremediation. The students will be able to outline bioremediation technologies for various inorganic pollutants like arsenic, chromium, selenium, uranium,			

	nitrate, cyanide and mercury.			

UNIT – I: FUNDAMENTALS OF BIODEGRADATION- 1:

What is biodegradation? Growth linked biodegradation, acclimation, detoxification, activation, threshold and sorption. Cometabolism and biotrasformation

UNIT – II FUNDAMENTALS OF BIODEGRADATION- 2 :

Bio-availability, Nonaqueous phase liquids, Effect of chemical structure on biodegradation, recalcitrance, predicting products of biodegradation, Factors affecting biodegradation.

Unit-III :BIODEGRADATION OF SPECIFIC COMPOUNDS:

Degradation of biopolymers-Cellulose, xylan, starch and other glucans, pectin, lignin, chitin, protein, nucleic acids, lipids and fats and polyhydroxy alkanoates (Bioplastics),
Degradation of hydrocarbons-Microbial degradation of hydrocarbons: Methane, ethane, propane, butane and other long chain alkanes, alkenes, alkynes, aerobic and anaerobic biodegradation of aromatic compounds, degradation of halogenated and sulfonated compounds, biodegradation of pesticides

UNIT – IV: INTRODUCTION TO BIOREMEDIATION:

what is Bioremediation, Constraints, advantages and applications, Types of bioremediation (definition)- Natural (attenuation) and engineered, ex-situ and in-situ, Bioaugmentation and biostimulation, solid phase and slurry phase bioremediation. Criteria to be met for considering bioremediation- factors affecting bioremediation, treatability studies for bioremediation.

UNIT – V: BIOREMEDIATION TECHNOLOGIES:

Application, Advantages and disadvantages of specific bioremediation technologies- land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, Deodorization process bioscrubbers, biobed, biotrickling filters. use of bioreactors for bioremediation. Phytoremediation, restoration of coal mines a case study. Constructed wet lands,

Text books:

1. Bioremediation 1994. Baker, K.H and Herson, D.S.Mc Graw Hill, Inc. New York
2. Biotreatment of Industrial & Hazardous Waste 1993, M.V.Levin & Gealt, M.A McGraw Hill. Inc.
3. Biodegradation and Bioremediation 1999 (2nd editon). Martin Alexander, Elsevier Science & Technology.
4. Environmental Microbiology 2001. Raina M. Maier, Ian L. Pepper, Academic Press.
5. Bioremediation engineering.. J.T.Cookson, Mc.Grwhill Inc.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Laboratory I	**EMTL I: ENVIRONMENTAL POLLUTION ANALYSIS LAB**	-	4	2
Course outcomes (COs)	**At the end of course, the student will able to** **CO.1:** Analyze and assess the soil quality **CO.2:** able to analyze the sludge sample CO3Collect water samples, analyze water and assess the quality of water. **CO.4:** Assess the wastewater characteristics and suggest suitable treatment techniques. **CO.5:** Collect the ambient air samples and analyze the air samples.			

Analysis of Physical and Chemical parameters

1. Estimation of pH
2. Estimation of Electrical conductivity
3. Estimation of Chlorides by argentometric method
4. Estimation of Hardness by EDTA titration method
5. Estimation of Nitrates by Spectrophotometric Method
6. Estimation of Sulfates by Spectrophotometric Method
7. Estimation of Sodium by flame photo meter
8. Estimation of Potassium flame photo meter
9. Estimation of Biological Oxygen Demand (BOD)
10. Estimation of Chemical Oxygen Demand (COD)
11. Estimation of NO_x, SO_x and Particulate matter in ambient air

General techniques of microbiology

1. Media preparation
2. Sterilization
3. Cultivation of microorganisms
4. Isolation and purification of microorganisms
5. Preservation of microorganisms
6. Ubiquitous nature of microorganisms.
7. Enumeration of algae by MPN method.
8. Isolation of fungi from environmental samples.
9. Isolation and enumeration of air-borne bacteria.
10. Enrichment of purple nonsulfur bacteria
11. Effect of environment on microbial growth
12. Kirby –Bauer method for determining anto microbial activity
13. Determination of MIC
14. Standard plate count.

15. Standard coliform test.
16. Presence absence test.
17. Fecal coliform test.
18. 7hr FC test.
19. Membrane filtration test.
20. Enumeration of coliform bacteria by MPN method.
21. H_2S strip test.

II SEMESTER

II SEMESTER

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory CORE COURSE -1	**EMT-CC1 : WATER AND WASTE WATER TREATMENT TECHNOLOGIES**	**4**	**-**	**4**
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:**Describe the different unit operations that are used in water treatment based on the water sources **CO.2:**Access the quality of effluent and design the biological treatment system **CO.3:**Describe the tertiary treatment techniques and decide which treatment technique is feasible based on the quality of effluent CO**.4**: Differentiate between water and sewage treatment unit operations along with the characteristics **CO.5:**Illustrate the different industrial processes, its effluent characteristics and appropriate treatment scheme			

UNIT I WATER POLLUTANTS AND TREATMENT

Types and Sources, quality of water, various stages of water treatment flocculation and coagulation , Sedimentation, Filtration: slow and rapid sand filters, disinfection.

UNIT II WASTEWATER TREATMENT

Characterization and degree of treatment-Self purification in a stream, characteristics of waste water and treatment plant effluents, Dissolved oxygen, Esturine pollution **Primary treatment**: Screening, Grit removal, Neutralization, equalization, Sedimentation, Flotation (oil & grease removal), Air stripping **Secondary treatment**- principles of waste treatment, basic kinetic equations, continuous flow treatment models, oxygen requirement in aerobic process, production of sludge. Conventional biological process: Activated Sludge Process (ASP), UASB, Trickling Filters and RBC, ***Nitrogen removal***: Nitrification and denitrification process, phosphorous removal. Low cost wastewater treatment: Aerated lagoons, stabilization ponds, oxidation ditches.

UNIT III TERTIARY TREATMENT OF WASTEWATER

Tertiary treatment-ion exchange, ***Membrane separation Techniques***: Brief description of MF, UF, NF membranes. Reverse osmosis principle , Membrane materials , Types of membranes – Plate & frame , tubular, hollow fibre , spiral wound membranes, application of membranes in various industrial applications., ***electro chemical techniques***: electro dialysis, electro coagulation, ***Evaporators***: forced evaporation , Multiple effect evaporators – falling film , raising film , forced circulation , agitated thin

film driers. Advanced oxidation process, photo catalysis.

UNIT IV SEWAGE TREATMENT AND DISPOSAL:

Introduction, importance of sewage, Characteristics of sewage, Sampling and analysis of sewage, Sewage treatment and disposal: Grit chamber, Sedimentation tanks, Septic tank, Secondary treatment Activated sludge process, sludge digestion. Sludge disposal.

UNIT V INDUSTRIAL WASTEWATER TREATMENT:

Sources, Characteristics, methodology and process for the treatment of industrial wastes of sugar industry- beverage industry- tannery industry- textile mill waste industry- fertilizer plant- steel plant- oil refinery-paper and pulp mill. Legislation, Cleaner technologies: Water conservation, By-product recovery

Text Books:

1. Water Supply and Sanitary Engineering G.S.Bridie & J.S.Brides, Dhanpat Rai & Sons 1993.
2. A treatise on Rural, Municipal, and industrial water management KVSG Murali Krishna
3. Environmental sanitation (Social and Preventive medicine) Dr.P.V. Rama Raju & KVSG Murali Krishna.
4. Waste water engineering, treatment and reuse by Metcalf and eddy, fifth edition, Tata Mc Graw Hill.

Reference Books:

1. Municipal and Rural Sanitation-Ehlers,V.M.&Steel,E.W.McGRAW-HILLBook Company,IncV.edition. 1987.
2. Environmental Sanitation, Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc.
3. Environmental pollution and Toxicology, Meera Asthana and Asthana D.K, Alka Printers (1994)

SUBJECT : CODE	**SUBJECT TITLE**	L	P	C
Theory **CORE COURSE -II**	**EMT-CC II: ENVIRONMENTAL IMPACT ASSESSMENT (EIA)**	**4**	-	**4**
Course outcomes (COs)	**At the end of the course, The student will be able to** **CO1:** Direct, Indirect, cumulative and induced environmental impacts at Regional, sectoral and project level. **CO.2:** Data products, thematic maps, collateral data in planning and management of baseline data acquisition. **CO.3:** Screening of environmental clearance, for category B&B2 industries and feasibility studies. **CO.4:** Predicting impact of Air, Water, Noise, Socio economic status on environment. **CO.5:** Environmental management plans on emission controls and green belt development and hazardous wastes.			

UNIT I: CONCEPTUAL FACTS OF EIA:

Introduction, Definition and Scope of EIA, Objectives in EIA, Basic EIA Principles, Classification of EIA: Strategic EIA (SEIA),
Regional EIA, Sectoral EIA, Project Level EIA and Life Cycle Assessment, Project Cycle, Grouping of Environmental Impacts: Direct Impacts, Indirect Impacts, Cumulative Impacts and Induced Impacts. Significance of Impacts: Criteria/Methodology to Determine the Significance of the Identified Impacts.

UNIT II: BASELINE DATA ACQUISITION, PLANNING AND MANAGEMENT OF IMPACT STUDIES:

Environmental Inventory, Data Products and Sources: thematic data, topographical data, collatera data and field data. Environmental Baseline Monitoring (EBM), Preliminary Study to determine impact significance, Environmental Monitoring network Design, Monitoring Stations, Air quality data acquisition, Water Quality data acquisition, soil data, socioeconomic data and biological data acquisition. Impact on Environmental Components: Significance of Impacts, Criteria to determine the significance of the identified Impacts.
Conceptual Approach for Environmental Impact Studies, Proposal Development, Interdisciplinary Team Formations, Team Leader Selection and Duties, General Study Management, Fiscal Contro

UNIT III: OPERATIONAL ASPECTS OF EIA AND METHODS FOR IMPACT IDENTIFICATION:

Screening: Application for Prior Screening for Environmental Clearance, Screening Criteria; Category A Projects, Category B Projects, Criteria for Classification of Category B1 and B2 Projects, Consistency with other Requirements and Siting Guidelines. Scoping: Identification of Appropriate Valued Environmental Components (VEC), Identification of Impacts, Information in Form 1, Structure of a Pre-feasibility Report. Public consultation: Appraisal, Decision Making, Post-clearance Monitoring Protocol.
Background Information, Interaction-Matrix Methodologies: simple matrices, stepped matrices,

development of a simple matrix, other types of matrices, summary observations on matrices, Network Methodologies: Checklist methodologies, simple checklists, descriptive Checklists, summary observations on simple and descriptive Checklists.

UNIT IV: PREDICTION OF IMPACTS (AIR-WATER- NOISE- BIOLOGICAL AND SOCIO-ECONOMIC):

a) Air Environment: Basic information on air quality, Sources of Pollutants, effects of pollutions, Conceptual approach for addressing air environment impacts, Air quality standards, Impact Prediction, Impact significance.

b) Water Environment: Basic Information on surface-Water Quantity and Quality, Conceptual Approach for Addressing Surface-Water-Environment Impacts, Identification of Surface-Water Quantity or Quality Impacts, Procurement of Relevant Surface-Water Quantity-Quality Standards Impact Predictions, Assessment of Impact Significance.

c) Noise Environment: Basic Information on Noise Key Federal Legislation and Guidelines, Conceptual Approach for Addressing Noise-Environment Impacts, Identification of Noise Impacts, Procurement of Relevant Noise Standards and/or Guidelines, Impact Prediction, Assessment of Impact Significance.

d) Biological Environment: Basic Information on Biological Systems, Conceptual Approach for Addressing Biological Impacts, Identification of Biological Impacts, Description of Existing Biological Environment Conditions.

e) Socio-Economic Environment: Procurement of Relevant Legislation and Regulations, Impact Prediction, Assessment of Impact Significance.

UNIT V: ENVIRONMENTAL MANAGEMENT PLAN (EMP):

Case Study, identification of Impacts, EMP for Air Environment: Dust Control Plan, Procedural Changes, Diesel Generator Set Emission Control Measures, Vehicle Emission Controls and Alternatives, Greenbelt Development. EMP for Noise Environment, EMP for Water Environment Water Source Development, Minimizing Water Consumption, Domestic and Commercial Usage, Horticulture, Storm Water Management. EMP for land Environment: Construction Debris, hazardous Waste, Waste from temporary Labour settlements.

Text Books:

1. Textbook of Environmental Science & Technology by M.Anji Reddy, BS Publications, 2010
2. Technological guidance manuals of EIA. MoEF.
3. Environmental Impact Assessment by Harry W. Canter, McGraw Hill, 1996, 2nd edition.
4. Man and Environment D.H.Carson 1976 Interactions Part I and III.
5. Environmental Impact Assessment, 2003, Y.Anjaneyulu, B.S Publications
6. Erickson, P.A.1979 Environmental Impact Assessment Principles and applications
7. Basic Concepts in Remote Sensing & Arial Photogrammetry Lillesand & Keifer Printice Hall Intl., 1994.
8. Renewable Energy: environment and development, Maheswar Dayal, Konark Publishers, 1989.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory CORE COURSE - III	**EMT -CC III :BIO REMEDIATION TECHNOLOGIES**	**4**	**-**	**4**
Course outcomes (COs)	**On successful completion of the course student will be able to:** **CO1:** define and explain what, when, where, why and how of bioremediation. List out advantages and its application. They will be able to explain the phenomena of biodegradation, acclimation, detoxification, activation, co-metabolism and biotransformation and recalcitrance and their significance in bioremediation. They would be able to explain the concept of bio-availability, the effect of chemical structure on biodegradation and predict biodegradability and the products of biodegradation of any given compound. **CO.2:** classify bioremediation into different types, based on different criteria. They will also be able to list and explain different factors which aid or are detrimental to bioremediation and thus identify criteria to be met for bioremediation. They will be able to list explain different methods available for assessing biotreatability and also analyze, differentiate and explain relative advantages, disadvantages and application. **CO.3:** list and describe different bioremediation technologies, bringing about the differences between them and practical application. They will be able to suggest suitable bioremediation technologies for specific pollutants/environments. **CO.4:** define phyto remediation and explain physical, chemical and biological mechanism of phyto remediation the students will be able to suggest the type of plants/mechanism to be applied for different pollutants/environments. **CO.5:** explain how oil pollution can be bioremediated. The students will be able to explain the mechanism of metal bioremediation. The students will be able to outline bioremediation technologies			

	for various inorganic pollutants like arsenic, chromium, selenium, uranium, nitrate, cyanide and mercury.			

UNIT-I INTRODUCTION TO BIOREMEDIATION:

What is Bioremediation, Constraints, advantages and applications. Biodegradation, Acclimation, detoxification, activation, cometabolism and biotransformation, bio-availability, effect of chemical structure on biodegradation, recalcitrance, predicting products of biodegradation.

UNIT-II TYPES OF BIOREMEDIATION AND FACTORS AFFECTING:

Types of bioremediation (definition) - Natural (attenuation) and engineered, ex-situ and in-situ, Bioaugmentation and biostimulation, solid phase and slurry phase bioremediation. Criteria to be met for considering bioremediation- factors affecting bioremediation, treatability studies for bioremediation.

UNIT-III SPESIFIC BIOREMEDIATION TECNOLOGIES:

Application, Advantages and disadvantages of specific bioremediation technologies- land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, biofilters, biotricking filters, bioscrubbrers, bioreactors for bioremediation.

UNIT-VI PHYTOREMEDIATION

What is phytoremediation? Basic physiological processes involved, Mechanism of Phytoremediation, Phytosequestration, Phytovolatilisation (evapotranspiration): Phytodegradation: Rhizofiltration: Phytoextraction, Phytostabilization Phytotransformation, Phytomining. maintenance of hydraulic control using deep rooted tree systems. Constructed wetlands.

UNIT-V BIOREMEDIATION OF OIL SPILLS AND METALS & OTHER INORGANIC POLUTENTS

Bioremediation of oil pollution, advantages and limitations. Biostimulation, Bioaugmentation. Microbial inoculants. Bioremediation of metals and other inorganic pollutants: Biosorption and bioaccumulation, Reduction, Solubilization/Oxidation, Precipitation, Methylation, Individual pollutants (arsenic, chromium, selenium, uranium, nitrate, cyanide, and mercury)

SUBJECT CODE	SUBJECT TITLE	L	P	C
Core Elective -I	**E CE I : SOLID & HAZARDOUS WASTE MANAGEMENT**	4	-	4
Course outcomes (COs)	**At the end of course, the student will able to** **CO.1:** Differentiate different solid wastes and their sources including their effects on environment. **CO.2:** Explain about the present MSW management practices and the required level of treatment based on regulatory aspects. **CO.3:** Define the hazardous waste and explain the characteristics, treatment and disposal methods according to regulatory aspects. **CO.4:** give introduction to the radioactive waste management and can describe the biomedical waste segregation, treatment and disposal according to BMW rules. **CO.5:** Define E-waste, explain the characteristics and sources, illustrate the treatment and recovery processes of E-waste.			

UNIT I SOLID WASTE AND THEIR HANDLING:

Definition of solid wastes – types of solid wastes – Sources - Industrial, mining, agricultural and domestic – Characteristics. Solid waste Problems - impact on environmental health

UNIT II COLLECTION, SEGREGATION AND TRANSPORT AND MANAGEMENT OF MUNICIPAL SOLID WASTES:

Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; analysis of Collection systems. Transfer stations. Solid waste processing technologies: Mechanical and thermal volume reduction, Biological and chemical techniques for energy and other resource recovery, composting, vermicomposting, termigradation, fermentational. Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation. Regulatory aspects of municipal solid waste management.

UNIT III HAZARDOUS WASTE AND MANAGEMENT:

Hazardous waste definition. Physical and biological routes of transport of hazardous substances – sources and characterization. Sampling and analysis of hazardous wastes –proximate analysis – survey analysis – directed analysis - handling, collection, storage and transport. Hazardous waste treatment

technologies: TSDF concept - Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation, encapsulation, pyrolysis and incineration. Hazardous waste land fills - Site selections, design and operation. HW reduction, recycling and reuse, Regulatory aspects of HWM/HWM rules.

UNIT IV BIOMEDICAL WASTE MANAGEMENT:

Classification, collection, segregation Treatment and disposal. Radioactive waste: Definition, Low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB

UNIT V E-WASTE MANAGEMENT:

Waste characteristics, generation, collection, transport and disposal, regulatory aspects of e waste,

global strategy, recycling.

Book Recommended

1. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hil International.
2. Integrated solid waste management George Tchobanoglous, Hilary Theisen & Sammuel A Vigil.
3. Criteria for hazardous waste landfills – CPCB guidelines 2000.
4. Hazardous waste management by Prof. Anjaneyulu.
5. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition 2009.
6. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGrav Hill 1997.
7. Management of Solid waste in developing countries by FrankFlintoff , WHO regiona publications 1976

SUBJECT CODE	SUBJECT TITLE	L	P	C
THEORY : **Core Elective. II**	**EMT-CE IIA: ENVIRONMENTAL HEALTH & SAFETY**	**4**	**-**	**3**
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO.1: G**ive reasons for accident occurrence, how to investigate and report the accident and explain the responsibilities of safety officer. **CO.2:** Explain about the industrial best work practices regarding machine guarding, occupational health, material handling and hazards storage practices etc. **CO.3:** Give the causes for fire, describing the emergency preparedness and explain about prevention techniques of fire. **CO.4:** Analyze the environmental stress in industries **CO.5:** Explain the salient features of occupational safety management standards and Acts.			

UNIT I INTRODUCTION TO SAFETY & HEALTH MANAGEMENT:

Sequence of Accident Occurrence, Occupational Injuries-Effects of Industrial Accidents, Analysis of Accidents, Injury Data, Accident Investigations & Reporting, Accident Costing, Employer & Employee Responsibilities, Record-keeping & Reporting Requirements, Safety Organization, Responsibilities of Safety Officer, Supervisors, Safety committees.

UNIT II WORK PRACTICES & BEST PRACTICES IN INDUSTRIES:

Hazards in Chemical Operations, Material Handling Hazards, Lifting Machinery & Pressure Vessels, Material Safety Data Sheets, Classification of Chemicals, Hazardous Chemicals, Storage Practices, Radiation Safety, Petroleum Storage Requirements, Pesticide Safety, In Electrical, Mechanical, Fire, Machine Guarding, Personal Protective Equipment, Occupational Health, Ergonomics Ambulance, Noise Abatement Methods, Management Of Contractors.

UNIT III FIRE SAFETY:

Basic Elements, Causes, Industrial Fires, Explosions, Effect On Environment, Property & Human Loss, Prevention Techniques, Building Design, Fire Protection Systems, Contingency Plan, Emergency Preparedness, Evacuation.

UNIT IV RISK MANAGEMENT&INDUSTRIAL HYGINE:

Definitions of Hazards, Risks, Evolution of Methodical Analysis, System safety Analysis techniques, Performance measurement, Operational Reviews - Internal & External. **Environmental stresses**: physical, chemical, biological and ergonomic stresses, Principles of industrial hygiene, Overview of control measures. Permissible limits. Stress, Exposures to heat, Heat balance, Effects of heat stress, WBGT index measurement, Control Measures. Chemical agents, IS/UN classification, Flammables, Explosives, Water sensitive chemicals, Oxidants, Gases under pressure, Chemicals causing health hazards: irritants, asphyxiates, anaesthetics, systemic poisons and carcinogens, Chronic and acute exposure, Routes of entry, Types of airborne contaminants, Introduction to air sampling and evaluation methods, Occupational exposure limits, Engineering control measures, Principles of ventilation.

UNIT V OCCUPATIONAL SAFETY MANAGEMENT STANDARDS & ACTS:

Central Acts, Factory's Act, AP Factory Rules, Construction Safety Regulations, Petroleum Rules 2002, Electrical Act & Rules, Indian Standards, OHSAS 18001 Standard and its Elements, CE Certificate, Social Accountability Standards, System Implementation, Benefits.

Text Books:

1. Industrial safety and health, David L. Goetsch, Macmillan Publishing Company, 1993.
2. Handbook of environmental health and safety, Vol I & II, Herman Kooren, Michael Bisesi, Jaico Publishing House, 1999.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory **Core Elective. II**	**EMT-OE IIB: GLOBAL ENVIRONMENTAL ISSUES**	4	-	3
	C111.1: classify various environmental issues, protocols etc. **C111.2:** discuss significant global environmental movements. **C111.3:** visualize consequences of climate change **C111.4:** speculate the global energy demands and ascertain contemporary issues. **C111.5:** ascertain nuclear power issues and myths.			

UNIT I INTRODUCTION: Human environmental Interactions- Global Environmental Agreements & Movements - Stockholm and Beyond – Evolution of International Environmental Laws- making international , national environmental agreements.

UNIT II ENVIRONMENTAL MOVEMENTS:

Global and national movements of Significance impact: RAMSAR Convention- Green Belt movement- Green Peace – Chipko movement- Narmada Bachao Andolan – Silent valley- Doon valley and related issues / case studies

UNIT III CLIMATE CHANGE: Sea level Change – primary and secondary impacts- Adapting to Sea level changes. Global Warming- Fossil fuels- Green house gases- Global and national scenario. National Action Plan on Climate Change. (NAPCC). Climate Change and Biodiversity loss.

UNIT IV ENERGY CRISIS: Energy requirements- Developed- Developing- Under Developed nations. Cases studies of International and National importance.

UNIT V LAND DEGRADATION :

Land pollution • Desertification - Soil — Soil conservation • Soil erosion • Soil contamination • Soil salination. Mining- reclamation of mined area. Desertification-case studies

UNIT VI NUCLEAR ISSUES:

Nuclear issues —Nuclear power • Nuclear weapons • Nuclear and radiation accidents • Nuclear safety • High-level radioactive waste management.

UNIT VII NATURAL DISASTERS AND ANTHROPOGENIC:

Natural Disaster : Volcanoes- Landslides- Tsunami- Forest Fires – Case studies .Anthropogenic : Oil spills

UNIT VIII CONTEMPORARY ISSUES:

Green Buildings- Genetic pollution- Genetically modified food controversies. Intensive farming

Monoculture. Health and Diseases- Epidemics and Famines.

Textbooks:

1. Global environmental issues: a climatological approach by David D. Kemp, Taylor and Francis.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory **Open Elective IA**	**EMT-OE IA ENERGY AUDIT**	4	-	3
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:** Demonstrate the types of energy and their production, consumption and Future strategies of energy role in climate change. **CO.2:** Examine the Basics of electricity and its demand along with thermal energy production and effects. **CO.3:** Estimate the energy audit practices along with Energy consumption reducing appliances and their efficiency like CFL & LED **CO.4:** Assess the energy systems and process flow. Explain the energy monitoring and targeting. **CO.5:** Evaluate the energy management systems, designing, marketing strategies.			

Unit I Energy Scenario: Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservationand its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features.

UNIT II Basics of Energy and its various forms: Electricity basics - DC & AC currents, Electricity tariff, Load management and Maximum demand control, Power factor.Thermal basics -Fuels, Thermal energy contents of fuel, Temperature & Pressure, Heatcapacity, Sensible and Latent heat, Evaporation, Condensation, Steam, Moist air and Humidity & Heat transfer, Units and conversion

UNIT III Energy Management & Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

UNIT IV Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams

Energy Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM)

UNIT V ENERGY ACTION PLANNING: key elements, force field analysis, energy policy purpose, perspective,contents, formulation, ratification, organizing-location of energy manangement, top management support, managerial functions, roles and responsibilities of energy manager, accountability, motivating-motivation of employees, information systems- designing barriers, strategies, marketing and communicating-training, and planning - Financial Management

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory Open Elective IB	**EMT-OE IB INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS**	4	-	3
COs	CO1. Able to explain about the accuracy , precision and uncertainties in instrumental methods of analysis CO2. Able to explain the principle, application and how to operate the AAS, flame photometer instruments CO3. Able to explain the principle, application and operation of the UV-Vis spectrophotometer CO4. Able to give the principle and the parts of the chromatographic instruments like GC, HPLC and GCMS. Able to give the application of chromatography CO5.able to explain the principle ,operation and applications of microscope, SEM and TEM			

UNIT I

INTRODUCTION:
Introduction and classification of Instrumental methods of chemical analysis, concepts in spectroscopy, accuracy, precision, types of errors, uncertainties in instrumental measurements-sensitivity, detection limit and calibration of instruments.

UNIT II

ATOMIC ABSORPTION AND EMISSION SPECTROSCOPY:
Principle, Instrumentation, Advantages, Disadvantages and Applications

UNIT III

UV-VISIBLE SPECTROSCOPY, INFRAREDp SPECTROSCOPY, MASS SPECTROSCOPY, NMR:
Introduction, electromagnetic spectrum-frequency-wave number-Absorptivity-deviations from Beer's law, instrumentation-design and working principle, chromophore, auxochromes concept, Qualitative and quantitative analysis and applications.

Infrared spectroscopy- Theory, Instrumentation and Applications.
Mass Spectroscopy: Theory, ionization techniques, GC-MS, interpretation of spectra and applications.

NMR: Theory, instrumentation, chemical shift, shielding and deshielding effects, splitting of signals, spin-spin coupling, coupling constant (J), ^{13}C NMR spectra, COSY and applications.

UNIT IV

CHROMATOGRAPHY:
Column, ion exchange, paper, TLC, GLC, HPLC: Principles and applications, Instrumentation: detectors, columns, injectors- temperature programming – isocratic and gradient programming

UNIT V

MICROSCOPY:
Principles & working of light, phase-contrast, dark-field, fluorescence, polarization microscopy, electron microscopy – SEM, TEM & STEM.

REFERENCES:

1. Instrumental Methods of Chemical Analysis by Chatwal Anand, Himalaya Publishing House.
2. Instrumental Methods of Chemical Analysis by B. K Sharma.
3. Vogel, Textbook of quantitative inorganic analysis, 1990.
4. Separation chemistry (2006), R.P Budhiya, PP424. New age international (p) Ltd.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Theory **Open Elective IC**	**EMT-OE 1C: GEOMATICS FOR ENVIRONMENTAL MANAGEMENT**	**4**	**-**	**3**
Course outcomes (POs)	**At the end of the course, the Student will be able to** **CO.1:** Categorize the land use land cover practices and its evaluation. Identify the usage of Geospatial technology in Urban studies and waste disposal methods. **CO.2:** Prioritize the Geospatial techniques in mineral exploration studies and applications. **CO.3:** Estimate the drainage basin, Ground water exploration, watershed and its influence. Analize the soil classes , crop suitability and yield prediction. **CO.4:** Estimate the spectral response, wetland area and modelling **CO.5:** Assess the impact studies of forest, floods, drought, industrial accidents and their mapping.			

UNIT I: URBAN PLANNING AND MANAGEMENT:
Introduction, Role of Remote sensing and GIS, GIS in Urban Planning, Issues in Urban Planning, Urban growth management: A case study; Disadvantages of using Conventional Methods, Urban land use and infra structure identification and delineation, urban transport network identification and mapping, urban city guide map change detection and updation.

UNIT II: NATURAL DIASTER MANAGEMENT:
Introduction, Major types of Landslides, Common features of Landslides, Causes of Landslides and related phenomena, Landslide analysis, Human causes of Landslides, Remote sensing for landslide mapping, landslide analysis in GIS and Hazard mapping of landslides.
Drought assessment and classification, drought analysis techniques, drought monitoring and mitigation planning. Flood risk analysis, beneficial use of floods, flood control and reservoir operation, case studies on flood damage, flood warning and mitigation planning.

UNIT III: MUNICIPAL SOLID WASTE MANAGEMENT:
Introduction, classification of Solid waste, environmental problems related with the municipal solid waste, characteristics of solid waste, solid waste collection system, factor affecting the solid waste generation rates, solid waste sampling techniques, selection criteria, unacceptable characteristics, converting criteria into data layers, analytic hierarchy process and ranking, DSS and integration of AHP and GIS.

UNIT IV: WATER QUALITY MAPPING AND MODELING:

Introduction, Role of remote sensing and GIS, case study of Hyderabad city, GIS data analysis, correlation between water quality and ground water level, correlation between water quality index and land use, ground water quality studies using SPANS, evaluation of impact of land use/land cover changes on ground water quality and spatial database creation. Salt water intrusion- introduction, applications of geo-informatics, GIS & spatial database, attribute database creation, generation of spatial distribution maps of water quality and SWI model development.

UNIT V: WATERSHED MANAGEMENT:

Introduction, philosophy and concept of watershed, technology vectors and social dynamics, role of remote sensing and GIS, GIS database for watershed management, general objectives of watershed management program, research approach, model watershed, land use and land cover, slope analysis, soil mapping, hydrogeomorphological mapping, groundwater prospects map, drainage mapping, action plan generation.

TEXT BOOKS:

1. Geo-informatics for Environmental Management by M. Anji Reddy, BS Publications, 2nd edition, 2004.
2. Handbook of Solid Waste Management, Second Edition, George Tchobanoglous, Frank KreithPublisher: McGRAW-HILL Companies, Inc 2002.
3. Watershed Management, J. V. S. Murty, second edition, New Age International, 1998,

SUBJECT CODE	SUBJECT TITLE	L	P	C
THEORY : **Open Elective ID**	**EMT-CE IIB: ENVIRONMENTAL MODELING AND SMART CITIES**	**4**	**-**	**3**
	C124.1: Identify various environmental models and justifications for model building. **C124.2:** Classify relevance of Geomatics in evaluating watersheds, water quality and others. **C124.3:** Discuss principles of air pollution dispersion models. **C124.4:** devise sustainable planning towards smart cities. **C124.5:** recommend sustainability of land management, waste management.			

UNIT I Modeling Concepts: Basic concepts & classification of models; Principles of Environmental modeling and GIS models; Casual and statistical models-Characteristics- Steps in model development - Importance of model building;

UNIT II Water Quality Modeling: Philosophy of mathematical models of watershed hydrology, Conceptual and mathematical modeling processes; Classification of watershed models; watershed modeling ---terminology, components and methodology; Lake Water Quality Models; Ground Water Quality Modeling;

UNIT III Air Quality Modeling: Introduction of air quality meteorology and modeling; Air dispersion modeling- Gaussian and non-Gaussian dispersion model, Puff dispersion model; Applications of Air Quality Modeling; Tools of Air Quality Modeling-- Dispersion Modeling- Receptor Modeling- Air Pollution Chemical Transport Modeling;

UNIT IV Smart Cities I:
Benchmarks; Smart city scheme; Infrastructure pillars—Social, Physical, Institutional and Economic; Instruments; Demand; Citizen participation; Role of Government; conditions precedent for smart city development; Financial architecture; Industrial promotion; Smart city reference frame wok and Implementation framework; smart mobility; smart environment; smart living; role of GIS and smart services.

UNIT V: Smart Cities II:
smart city model; principles and spatial planning; Instrumentation; Transportation ; water distribution; sewage treatment; Waste management; Smart communication; Quality assurance; Resilience-- the use of IT; Energy efficiency; Optimisation techniques; Zero emissions; sustainability;
Case studies: Singapore; India; Songdo; Lavasa; and Vienna.

Reference books:

1. Environmental modeling with GIS by Michael F. Good Child, Bradley O.Parks, Louis T. Steyaert.
2. Geo-informatics for Environmental management by Dr. M. Anji Reddy, B Publications

3. Open courseware -Civil and Environmental Engineering (Internet), MIT,USA.

4. Ground water hydrology MIT - Open courseware prof. Harvey.

5. AERMOD Air modeling software (Internet).

SUBJECT CODE	SUBJECT TITLE	L	P	C
Open Elective1E	**EMT-OE IE: PROKARYOTIC DIVERSITY AND BIO-PROSPECTING**	4	-	4
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:** The student will be able to list and describe compare and discrimate between different prokaryotic domains. They will be able to browse taxonomic databases and explain selective isolation programmes. **CO.2:** The students will be able to list out, describe compare and contrast between different types of classification and taxonomy. They will be able to describe prokaryotic species concept and Bergey's manual of systematic Bacteriology. **CO.3:** Students will be able to describe polyphasic characterization and rules of nomenclature and bacteriological code. **CO.4:** Students will be able to explain, indicate relative advantages, disadvantages and application of various methods available for understanding prokaryote diversity. **CO.5:** Students will be able to explain different methods used for culturing the uncultured bacteria. They will also be able to suggest modifications to overcome limitations of currently used methods to improve them. They will be able to explain different methods available for bioprospecting including several "omics". They would be able to identify their limitations and strengths and thus determine practical applicability. Carryout guided research involving isolation, purification, identification of prokaryotes and screening them for antimicrobial activity against pathogen surrogates will develop interest in science and scientific research.			

UNIT- I. Prokaryotic diversity, its scope and importance: Biodiversity and its importance. Prokaryotic domains; definition of terms; taxonomy, classification nomenclature identification: cultured and genetic diversity; Microbial ecology and molecular systematics- third golden era in microbiology.Prokaryotic diversity as an innovation in biotechnology**:** The extent of microbial diversity-facts & estimates; Taxonomic data bases and selective isolation programs.

UNIT- II. Classification of Prokaryotes: 1. General concepts: Phenetic classification, phylogenetic classification and molecular systematics, chemosystematics; Numerical taxonomy, polyphasic taxonomy, taxonomic ranks, micro and macro diversity, classification of prokaryotic organisms and the concept of bacterial speciation.2. Bergey's manual of systematic bacteriology – Domain. Archaea, phyla, AI and AII . Domain Bacteria and phyla BI to BXIII.

UNIT- III. Characterization, identification and description of new taxa of prokaryotes: Ecological, cultural, morphological, physiological, biochemical and genetic characterization.

Diagnostic features.Bacterial nomenclature, etimology in nomenclature of prokaryotes. Bacteriological code, valid and effective publication of description of new taxa RDP database. Databases strain information

UNIT- IV. In situ approaches to prokaryote diversity and genetic diversity studies : approaches to prokaryotic diversity, Nucleic acid probes and their application in environmental microbiology various methods used. FISH, RFLP, ARDRA, DGGE their application. Ribotyping, PFGE . RAPD, cloning, DNA Micro arrays. Metagenomics

UNIT- V. Uncultured prokaryotic diversity and bioprospecting: great plate count anamoly & enrichment bias. Specific methods devised for isolating "uncultured microorganisms in pure culture, high through put methods (diffusion chambers, I chip etc). Screening, selective isolation techniques gene mining metagenomics, transcriptomics, proteomics and metabolomics as a means of bio prospecting

Textbooks:

1. Bergey's manual of systematic bacteriology.
2. Review articles. From:
   a) Annual Review of microbiology
   b) Adv. Microbial physiol.
   c) FEMS microbial reviews.
   d) Bacteriol reviews.
   e) Int. J. Systematic and Evolutionary microbiology.
3. The Prokaryotes. 7 valumes springers, New York.
4. The prokaryotes . An evolving electronic resource for the Microbiological community. – springer – verlag, New York.

SUBJECT CODE	SUBJECT TITLE	L	P	C
Laboratory II	**EMTL II : REMOTE SENSING AND GIS LAB**	-	4	2
Course outcomes (COs)	**At the end of the course, the Student will be able to** **CO1:** Master and apply methods of interpreting and analyzing remote sensing data. **CO.2:** Use GIS to identify, explore, understand, and solve spatial problems Demonstrate GIS modeling skills. **CO.3:** Demonstrate critical thinking skills in solving geospatial problems. Design and implement a GIS project. **CO.4:** Use queries in GIS Analysis Formulate applications of GIS technology. **CO5:** Evaluate the different features in the satellite image and its classification categories.			

1. Study of toposheet and base map preparation;
2. Description of satellite and sensor details of the imagery used for thematic mapping;
3. Land use / land cover map preparation;
4. Field visits for finalization of land use / land cover map and soil map;
5. Scanning / digitization of maps;
6. Digital image display; image enhancement;
7. Image registration
    a. Ground Control points from toposheets (GCP)
    b. Geo referencing
8. Image classifications for land use / land cover using ERDAS, PCI Geomatica and ENVI.

Digital Mapping: GIS Software, ARC GIS and Geo-Server.