ACADEMIC YEAR 2017-2019

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

COURSE STRUCTURE AND SYLLABUS

M.Tech (ENVIRONMENTAL MANAGEMENT)

(5+2 PATTERN)

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

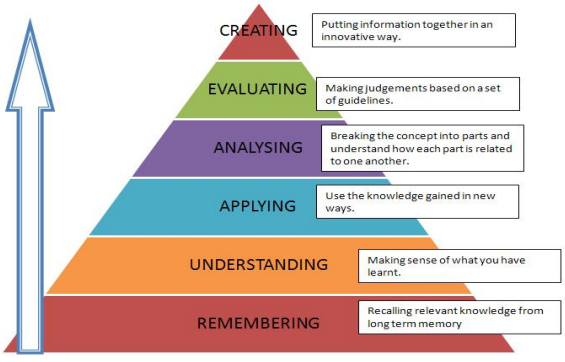
Vision:

- 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:



ACADEMIC YEAR 2018-2019
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
CENTRE FOR ENVIRONMENT
INSTITUTE OF SCIENCE & TECHNOLOGY (Autonomous)
COURSE STRUCTURE AND SYLLABUS
M.Tech (ENVIRONMENTAL MANAGEMENT)
(5+2 PATTERN)

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 abilityto write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area asperthe 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

Course Code	Category	Course Title	Int. marks	Ext. marks	L	P	C
EMT-101	Core Course I	Environmental Chemistry	25	75	4	--	4
EMT-102	Core Course II	Environmental Remote Sensing and GIS	25	75	4	--	4
EMT-103	Core Course III	Environmental Microbiology	25	75	4	--	4
EMT-104	Core Elective I	1. Environment, Health & Safety 2. Environmental Bio technology 3. Climate Change and sustainable development	25	75	4	--	4
EMT-105	Open Elective I	1. Energy Audit 2. Energy and Environment 3. Solid & Hazardous Waste Management	25	75	4	--	4
EMT-106	Laboratory I	Environmental Pollution Monitoring Lab	25	75	-	6	3
EMT-107	Laboratory II	Environmental Microbiology Lab	25	75	--	6	3
	Seminar I	Seminar	50	--	--	4	2
	Total Credits				**20**	**16**	**28**

I YEAR – II SEMESTER

	Category	Course Title	Int. marks	Ext. marks	L	P	C
EMT-201	Core Course IV	Water and Waste water Treatment Technologies	25	75	4	--	4
EMT-202	Core Course V	Environmental Impact Assessment	25	75	4	--	4
EMT-203	Core Course VI	Bio remediation Technologies	25	75	4	--	4
EMT-204	Core Elective II	1. Air pollution & Control Technologies 2. Geomatics for Natural Resource Management	25	75	4	--	4
EMT-205	Open Elective II	1. Air pollution and Modeling 2. Geomatics for Disaster Risk Reduction & Management 3. Prokaryotic diversity and bio-prospecting (a small world initiative course)	25	75	4	--	4
EMT-206	Laboratory III	Environmental Remote Sensing and GIS Lab	25	75	-	6	4
EMT-207	Laboratory IV	Water & Waste water Treatment Lab	25	75	--	6	2
	Seminar II	Seminar	50	--	--	4	2
	Total Credits				**20**	**16**	**28**

II YEAR - III SEMESTER

Course Title	Int. marks	Ext. marks	L	P	C
Comprehensive Viva-Voce	--	100	--	--	4
Project work Review	50	--	--	24	12
Total Credits			--	24	**16**

II YEAR – IV SEMESTER

Course Title	Int. marks	Ext. marks	L	P	C
Project work Review II	50	--	--	8	4
Project Evaluation (Viva-Voce)	--	100	--	16	12
Total Credits			**--**	**24**	**16**

Total Credits = 88

M. TECH. -ENVIRONMENTAL MANAGEMENT
COURSE STRUCTRURE
I YEAR
I SEMESTER

Course Title	**ENVIRONMENTAL CHEMISTRY**		
Course code	**EMT - 101**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Course**		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C111.1:** Explain the relation between the chemistry and environmental and describe the types of instruments used for analyzing the environmental samples **C111.2:**describe the reactions that occurs in polluted and non-polluted atmosphere and their toxic effects **C111.3:** explain the significance of water, water quality, redox reaction that occur in water and effects of water pollutants. **C111.4**: describe the difference between polluted soil and non-polluted soils, causes for soil deterioration and chemical reaction that occur in soil **C111.5:**explain different major environmental initiatives taken up at global level for sustainable development		

UNIT I: 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, titrimetric,Instrumentalmethiods and analysis: Spectroscopy(UV-Visible,AAS,Flame photometer) Chromotography: (GC,GCMS,HPLC & HPTLC),Radioactive: Gama **UNIT II**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- Aerosol and Radiation –- temperature inversion –- Green House gases - Global warming, toxicity of ai 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), Aquatic Stratification.
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 Proces 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 – Oxfor 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, PragatiPrakashav, Meerut.
6. Fundametals of Environmental chemistry, 2nd ed. CRC press, Inc., USA, 2001.

https://www.footprintnetwork.org
https://www.carbonfund.org
https://www.cdm.unfccc.int
https://www.epa.gov>greenchemistry

Course Title	**REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS)**		
Course code	**EMT - 102**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Course – II**		
Course outcomes (COs)	**At the end of the course, The student will be able to** **C112.1:**Identify the interaction of electromagnetic spectrum with atmospheric interactions on earth surface materials. **C112.2:**Interpret remote sensing systems, sensors and their capabilities with varied resolutions. **C112.3:**Extract different features from the satellite imageries and analyze various data products **C112.4:**Demonstrate GIS architecture, categories and key elements and basic elements for the visual interpretation. Preprocessing techniques of Digital image processing. **C112.5:**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, Absorptio Ozone, Atmospheric Effects on Spectral Response Patterns. Energy Interactions with Earth' 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 Imag Interpretation, Interpretation of Aerial Photo, Basic elements of Image Interpretation, Application o Aerial Photo Interpretation, Interpretation of Satellite Imagery, Key Elements of Visual Imag Interpretation, Concept of Converging Evidence. Basic Character of Digital Image, Preprocessing Image Registration, Image Enhancement Techniques, Image Classification. Image classification an GIS.

UNIT IV: FUNDAMENTALS OF GIS

Introduction, Roots of GIS, Overview of Information System, The Four Ms, Contributio Disciplines, GIS Definitions and Terminology, GIS Queries, GIS Architecture, Theoretical Model

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 dataInput 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.

Books Recommended

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

Course Title	ENVIRONMENTAL MICROBIOLOGY		
Course code	EMT - 103	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Core Course - III		
Course outcomes (POs)	**At the end of the course, the student will be able to** **C113.1:**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 **C113.2:**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. **C113.3:**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. **C114.4:** 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. **C115.5:**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 analyte 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.

Books Recommended

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 McGraw-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., JoahnneM.Willey, Linda M. Sherwood, Christopher J. Woolverton-2010, 8th Edition, McGraw-Hill publishing company.

References:

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

Course Title	ENVIRONMENT HEALTH & SAFETY		
Course code	EMT - 104	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Core Elective - IA		
Course outcomes (COs)	At the end of the course, the Student will be able to C114.1: Give reasons for accident occurrence, how to investigate and report the accident and explain the responsibilities of safety officer. C114.2: Explain about the industrial best work practices regarding machine guarding, occupational health, material handling and hazards storage practices etc. C114.3:Give the causes for fire, describing the emergency preparedness and explain about prevention techniques of fire. C114.4:Analyze the environmental stress in industries C114.5: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 o Accidents, Injury Data, Accident Investigations & Reporting, Accident Costing, Employer & Employe Responsibilities, Record-keeping & Reporting Requirements, Safety Organization, Responsibilities of Safet 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, Radiatio Safety, Petroleum Storage Requirements, Pesticide Safety, In Electrical, Mechanical, Fire, Machin Guarding, Personal Protective Equipment, Occupational Health, Ergonomics Ambulance, Noise Abatemen 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, Socia

Accountability Standards, System Implementation, Benefits.

Books Recommended

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

Course Title	**ENVIRONMENTAL BIOTECHNOLOGY**		
Course code	**EMT - 104**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Elective– I B**		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C114.1:**Explain the necessity for renewable sources of energy need for energy production from waste and non-conventional fuels like methane (biogas) hydrogen and ethanol **C114.2: 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. **C114.3: 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. **C114.4: 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 biofertilizers and biopesticides. They will be able to explain the mechanism of biological control. They will be able to suggest appropriate biofertilizers and biocontrol agents for different crops/soils. **C114.5: E**xplain the importance of 1PR in encouraging innovation and disclosure in biotechnology. They will be able to list out different types of 1PR, 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 IV: 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 *Metarhiziumanisopliae*). 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.

Books Recommended

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 PrentisS.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.

Course Title	**CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT**		
Course code	**EMT - 104**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Elective – I C**		
Course outcomes (COs)	**At the end of the course, the student will be able to** **C114.1:**Categorise the role of aerosols and radiative effects of aerosols on global climate change. **C114.2:** Elaborate changes in global climate and evaluate climate change policies **C114.3:**Debate the impact of ecosystem, water resources developmental planning and their adaption on climate change. **C114.4:**Infer GHG management, inorganic carbon sequestration on mitigation of climate change. **C114.5:**Recommend climate modelling and early warning systems using GST towards Sustainable development in view of SDG's		

UNIT I: INTRODUCTION TO CLIMATE CHANGE

i. Introduction to atmospheres: vertical structure and residence time.
ii. overview of aerosols, radiative effects of aerosols: direct and indirect; scattering and absorbing behaviour of aerosols
iii. Energy budget - and greenhouse effect

Global climate change- Evidences and Observations of climate change; Ice and climate change; Isotope evidence

UNIT II: CLIMATE CHANGE GOVERNANCE , INTERNATIONAL POLICY AND LEGAL FRAMEWORK

i. Global Climate Change Governance
ii. Climate change finance sources : Challenges and opportunities to accessing and managing climate finance
iii. Evaluate climate change policies :
   - UNFCCC and other entities
   - Kyoto protocol
   - Climate negotiations
iv. National scenario: NAPCC, India's commitments (INDCs) and National Communication (NATCOM) initiative

Policies and regulation : Important agencies and organizations

UNIT III: CLIMATE CHANGE IMPACTS AND ADAPTATION

i. Climate Change Adaptation: Importance of adaptation- Adaptation options .
ii. Linkages between climate change adaptation and development planning
iii. approaches to climate change impacts and adaptation practices for :
   - ecosystems,

- land use,
- water resources and
- human health

Green Engineering

UNIT IV: CLIMATE CHANGE MITIGATION

i. Mitigation options :
   - technological and economic mitigation strategies:

ii. Biological and Inorganic Carbon Sequestration
iii. GHG Management
iv. energy system transformation and renewable energy technologies
v. carbon trading and carbon offsetting.

Key sectors for low carbon development

UNIT V: CLIMATE CHANGE EARLY WARNING SYSTEM & SUSTAINABLE DEVELOPMENT

i. Climate Modellingglobal and regional climate models, its applications and importance. climate change projections.
ii. Climate Prediction and Early Warning System: Tools and Technologies
iii. Preparedness to Climate Change: Geospatial Approach
iv. Human Behaviour and Climate Change

Overview on SDG 2030:

References • Business and Climate – UNFCCC • GHG protocol – A Corporate Accounting and Reporting Standard • Kyoto Protocol – UNFCCC • Low carbon inclusive growth – GoI • Making Paris Work (Accepted Manuscript) • Fundamentals of Climate change • IPCC – Climate change Action, Trends and Implications for Business • India-Biennial report to UNFCC – 2015 • Global Warming – Six Indias • IPCC technical guidelines for assessing Climate change impacts and adaptation

TED talks • Can clouds buy us more time to solve climate change https://www.ted.com/talks/kate_marvel_can_clouds_buy_us_more_time_to_solve_climate_change• A critical look at Geoengineering against climate change - https://www.ted.com/talks/david_keith_s_surprising_ideas_on_climate_change • Let's prepare for our new climate(Adaptation) - https://www.ted.com/playlists/78/climate_change_oh_it_s_real

Documentaries • Before the flood (2016) • An inconvenient truth (2006) • National Geographic: Six Degrees Could Change the World (2007) • An Inconvenient Sequel: Truth to Power (2017)

Course Title	ENERGY AUDIT		
Course code	EMT - 105	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Open Elective – I A		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C115.1:**Demonstrate the types of energy and their production, consumption and Future strategies of energy role in climate change. **C115.2:**Examine the Basics of electricity and its demand along with thermal energy production and effects. **C115.3:**Estimate the energy audit practices along with Energy consumption reducing appliances and their efficiency like CFL & LED **C115.4:**Assess the energy systems and process flow. Explain the energy monitoring and targeting. **C115.5:** 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

v. Global Climate Change Governance

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, Light Emitting Diode (LED) and Compact Fluorescent Lights (CFL), 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

Course Title	ENERGY AND ENVIRONMENT		
Course code	EMT - 105	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Open Elective – I B		
Course outcomes (COs)	At the end of the course, the Student will be able to C115.1: Give the information on energy demand and the contribution by each energy source worldwide. Can also explain about the different energy generation processes. C115.2: Describe the present status of bio-fuels and also how to produce various bio-fuels like bio ethanol, bio-hydrogen, biogas and biodiesel etc C115.3: Correlate the role of energy in economic development and also can explain about major treaties and energy polices worldwide. C115.4: Give the data on Indian energy scenario and major acts related to energy conservation Act, electricity Act, Central and state electricity regulatory commission, National solar mission. C115.5: Explain the environmental problems associated with different forms of energy production.		

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 III: 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
Books Recommended 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.

Course Title	SOLID & HAZARDOUS WASTE MANAGEMENT		
Course code	EMT - 105	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Open Elective – I C		
Course outcomes (COs)	**At the end of course, the student will able to** **C115.1:** Differentiate different solid wastes and their sources including their effects on environment. **C115.2:** Explain about the present MSW management practices and the required level of treatment based on regulatory aspects. **C115.3:** Define the hazardous waste and explain the characteristics, treatment and disposal methods according to regulatory aspects. **C115.4:** give introduction to the radioactive waste management and can describe the biomedical waste segregation, treatment and disposal according to BMW rules. **C115.5:** Define E-waste, explain the characteristics and sources, illustrate the treatment and recovery processes of E-waste.		

UNIT I: SOLID WASTE

Definition of solid wastes – types of solid wastes – Sources - Industrial, mining, agricultural, municipal solid waste, E-waste and Biomedical waste. 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, Plastic 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, fly ash bricks, Regulatory aspects of HWM/HWM rules.

UNIT IV: BIOMEDICAL AND RADIOACTIVE 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.

Books Recommended

1. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hill 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, McGraw Hill 1997.
7. Management of Solid waste in developing countries by FrankFlintoff , WHO regional publications 1976

Course Title	ENVIRONMENTAL POLLUTION MONITORING LAB		
Course code	EMT - 106	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Laboratory - I		
Course outcomes (COs)	**At the end of course, the student will able to** **C106.1:** Analyze and assess the soil quality **C106.2:** Analyze and assess the sludge quality **C106.3:**Collect water samples, analyze water and assess the quality of water. **C106.4:**Assess the wastewater characteristics and suggest suitable treatment techniques. **C106.5:**Collect the ambient air samples and analyze the air samples.		

ANALYSIS OF PHYSICAL AND CHEMICAL PARAMETERS

Physical parameters of soil and sludge:

1. Moisture content
2. Bulk density
3. Specific gravity
4. Water holding capacity

Chemical parameters:

1. pH
2. Electrical conductivity
3. Turbidity
4. Hardness – Calcium, Magnesium and total hardness
5. Alkalinity
6. Nitrates, Nitrites and Ammonical nitrogen
7. Phosphates
8. Sulfates by Spectrophotometric Method
9. Residual Chlorine
10. Dissolved Oxygen
11. Fluorides
12. Sodium
13. Potassium
14. Biological oxygen demand / organic matter
15. Chemical oxygen demand
16. Instrumentation analysis-HPLC,GC,AAS

Air Pollution Monitoring:

1. NO_x
2. SO_x
3. Particulate matter

Course Title	ENVIRONMENTAL MICROBIOLOGY LAB		
Course code	EMT - 107	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Laboratory - II		
Course outcomes (COs)	**After completion of course the students will be able to** **C117.1**:The student will be able to cultivate microorganisms without any contamination using aseptic techniques of microbiology **C117.2:**The student will be able to isolate and enumerate different microorganisms using an appropriate method **C117.3**: The student will be able to select an appropriate method, do the experiment and report the microbiological quality of diverse water samples **C117.4:**The student will be able to determine antimicrobial activity of diverse chemicals using standard techniques and determine MIC**.** **C117.5:** The student will be able to isolate antibiotic producing microorganisms using crowded plate techniques		

1) Ubiquitous nature of microorganisms.
2) Enumeration of algae by MPN method.
3) Isolation of fungi from environmental samples.
4) Isolation and enumeration of air-borne bacteria.
5) Standard plate count.
6) Standard coliform test.
7) Presence absence test.
8) Fecal coliform test.
9) 7hr FC test.
10) Membrane filtration test.
11) Enumeration of coliform bacteria by MPN method.
12) H_2S strip test.
13) Kirby-Bauer test.
14) Determination of MIC.
15) Crowded plate technique for isolation of antibiotic producing microorganisms
16) Microbial fuel cells for bioelectricity generation.
17) Photo biological hydrogen production from industrial effluents.

M. TECH. -ENVIRONMENTAL MANAGEMENT
COURSE STRUCTRURE
I YEAR
II SEMESTER

Course Title	**WATER AND WASTE WATER TREATMENT TECHNOLOGIES**		
Course code	**EMT - 201**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Course - IV**		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C121.1:**Describe the different unit operations that are used in water treatment based on the water sources **C121.2:**Access the quality of effluent and design the biological treatment system **C121.3:**Describe the tertiary treatment techniques and decide which treatment technique is feasible based on the quality of effluent C1**21.4**: Differentiate between water and sewage treatment unit operations along with the characteristics **C121.5:**Illustrate the different industrial processes, its effluent characteristics and appropriate treatment scheme		
UNIT I: WATER POLLUTANTS AND TREATMENT			
Types and Sources, quality of water (water, sewage and industrial wastewater), 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, Coagulation, Flocculation, 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,			

Ozonation, Fenton process, Hydrodynamic cavitation.

UNIT IV: SEWAGE TREATMENT AND DISPOSAL

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

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, Zero liquid discharge (ZLD).

1. Waste water treatment by M.N.Rao and A.K. Dutta- Oxford & IBH publications
2. Biological waste water treatment series- IWA publishimg
3. Waste water engineering, treatment and reuse by Metcalf and eddy, fifth edition, Tata McGraw Hill.
4. Water Supply and Sanitary Engineering G.S.Bridie&J.S.Brides, DhanpatRai& Sons 1993.
5. Introduction to waste water treatment by Fr.MichaelR.Templeton, Prof.David butler-bookboon.com

Web links/sites
cpcb.nic.in
https://www.epa.gov

https://nptel.ac.in/courses/105105048/

https://nptel.ac.in/courses/105106119

https://nptel.ac.in/courses/105106119/36

6.

Course Title	ENVIRONMENTAL IMPACT ASSESSMENT (EIA)		
Course code	**EMT - 202**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Course - V**		
Course outcomes (COs)	**At the end of the course, The student will be able to** **C122.1:**Direct, Indirect, cumulative and induced environmental impacts at Regional, sectoral and project level. **C122.2:**Data products, thematic maps, collateral data in planning and management of baseline data acquisition. **C122.3:**Screening of environmental clearance, for category B&B2 industries and feasibility studies. **C122.4:**Predicting impact of Air, Water, Noise, Socio economic status on environment. **C122.5:**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, Classificatio 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 determin impact significance, Environmental Monitoring network Design, Monitoring Stations, Air quality data acquisition, Water Quality data acquisition, soil data, socioeconomic data and biological dat acquisition. Impact on Environmental Components: Significance of Impacts, Criteria to determin 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 Control

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 o Appropriate Valued Environmental Components (VEC), Identification of Impacts, Information i 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, Impac Prediction, Impact significance.
b) Water Environment: Basic Information on surface-Water Quantity and Quality, Conceptua Approach for Addressing Surface-Water-Environment Impacts, Identification of Surface-Wate 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 o Impact Significance.
d) Biological Environment: Basic Information on Biological Systems, Conceptual Approach fo Addressing Biological Impacts, Identification of Biological Impacts, Description of Existing Biological Environment Conditions.
e) Socio-Economic Environment: Procurement of Relevant Legislation and Regulations, Impac Prediction, Assessment of Impact Significance.

UNIT V: ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Case Study, identification of Impacts, EMP for Air Environment: Dust Control Plan, Procedura Changes, Diesel Generator Set Emission Control Measures, Vehicle Emission Controls an 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.

Books Recommended

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&KeiferPrintice Hall Intl., 1994.
8. Renewable Energy: environment and development, MaheswarDayal, Konark Publishers, 1989..

Course Title	BIO REMEDIATION TECHNOLOGIES		
Course code	EMT - 203	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Core Course - VI		
Courseoutcomes (COs)	**On successful completion of the course student will be able to:** **C123.1:**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. **C123.2:** 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. **C123.3:** 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. **C123.4:** define phytoremediation and explain physical, chemical and biological mechanism of phytoremediation the students will be able to suggest the type of plants/mechanism to be applied for different pollutants/environments. **C123.5:** 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 IV: PHYTOREMEDIATION

What is phytoremediation? Basic physiological processes involved, Mechanism of Phytoremediation, Phytosequestration, Phytovolatilisation (evapotranspiration): Phytodegradation: Rhizofiltration: Phytoextraction, PhytostabilizationPhytotransformation, 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)

Books:
Ref:

Course Title	**AIR POLLUTION & CONTROL TECHNOLOGIES**		
Course code	**EMT - 204**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core course – II A**		
Course Outcomes (COs)	**At the end of the course, the Student will be able to** **C124.1:**List the air pollutants, their resources, effects and can explain about the turbulence and reasons for Indoor air pollution **C124.2:**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 **C124.3:**List and describe and explain the design criteria for different air pollution control techniques **C124.4:**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 **C124.5**: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

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 and particulate matter (Suspended particulate matter(SPM), $PM_{10,}$ $PM_{2.5,}$ PM_1), Air pollution modelling.

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.

Books Recommended

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-KosakushaLtd.,Tokyo.
3. Fundamentals of Environmental Pollution, Krishnan KhannanS.Chand& Company Ltd.,1994
4. Environmental Air Analysis, Trivedi&Kudesia, Akashdeep Pub.1992
5. Air Pollution Control and Engineering, De Nevers, McGraw- Hills, 1993
6. Noise Pollution -VandanaPandey, Meerut Publishers,1995

Web links:

https://nptel.ac.in/courses/105102089/8

https://nptel.ac.in/courses/105104099/35

Course Title	**GEOMATICS FOR NATURAL RESOURCE MANAGEMENT**		
Course code	**EMT - 204**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Core Course – II B**		
Course outcomes (POs)	**At the end of the course, the Student will be able to** **C124.1:** Categorize the land use land cover practices and its evaluation. Identify the usage of Geospatial technology in Urban studies and waste disposal methods. **C124.2:** Prioritize the Geospatial techniques in mineral exploration studies and applications. **C124.3:** Estimate thedrainage basin, Ground water exploration, watershed and its influence. Analize the soil classes , crop suitability and yield prediction. **C124.4:** Estimate the spectral response, wetland area and modelling **C124.5:** 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 Recommended

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.

Course Title	**AIR POLLUTION AND MODELING**		
Course code	**EMT - 205**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Open Elective – II A**		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C125.1: E**xplain about the Air Quality Monitoring network design and how to do the Quality Assurance process for air Quality monitoring. **C125.2: D**escribe about different types of air Quality models and their applications. **C125.3: S**uggest the requirement tools for dispersion modeling and its applications **C125.4: S**uggest the tools and applications of receptor modeling. **C125.5: A**nalyze the air Quality data and to use the analytical data for chemical transport modeling.		

UNIT I: INTRODUCTION TO AIR QUALITY ASSURANCE AND DATA ANALYSIS

Overview of Air Quality Management Process with a focus on QA, Air quality management process, Components of AQM, Accountability and review, Air Quality Monitoring Network Design and QA, Sources of Data Error and Uncertainties, Quality Assurance Process, Internal and External Evaluations, Method detection limits, Uncertainty calculations, Levels of QA/QC, Data Checks to Ensure Data Quality, Tools and Approaches, Applications of Air Quality Modeling.

UNIT II: TOOLS OF AIR QUALITY MODELING

Eulerian and Lagrangian Models, Categories of Air Quality Modeling, Dispersion Modeling, Receptor Modeling, Air Pollution Chemical Transport Modeling, Data Visualization, Data analysis of air quality measurements and modeling data, Case Studies and troubleshooting of data modeling issues.

UNIT III: DISPERSION MODELING

Mathematical Formulations: Lagrangian models, Common Dispersion Models, Applications of Dispersion Modeling, Hands-on data analysis with actual examples, Interpresting air quality events, Investigating issues with data, Investigating soirces of poor air quality, Discusion about utilizing multiple data sources to enable understanding.

UNIT IV: RECEPTOR MODELING

- Chemical Mass Balance (CMB)
- Factor Analysis: Positive Matrix Factorization (PMF) and UNMIX
- Applications of Receptor Modeling

UNIT V: AIR POLLUTION CHEMICAL TRANSPORT MODELING

Advection-Diffusion-Reaction (ADR) Equations, Chemistry of Air Pollution, Numerical Solutions of the ADR Equations, Applications of Photochemical Modeling, Evaluations and Analysis of Air Quality Modeling Results, Comparison with Observation, Time Series Analysis, Uncertainty and Data Assimilation.

Books Recommended

1. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd Edition, John H Seinfeld and Spyros N. Pandis, 2006, ISBN 978-0-471-72018-8(required).
2. Fundamentals of Atmospheric Modeling, 2nd Edition, Mark Z. Jacobson, 2005, ISBN 978-0-521-54865-6 (optional).

Course Title	**GEOMATICS FOR DISASTER RISK REDUCTION &MANAGEMENT**		
Course code	**EMT - 205**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Open Elective – II B**		
Course outcomes (COs)	**At the end of the course, The student will be able to** **C125.1:** Relate definitions, levels of disaster risks and phenomena. **C125.2:** List Disaster trends at Global and regional levels, differentiate natural and manmade disasters. **C125.3:** Compare disaster risk vulnerabilities, hazard mapping prevention and mitigation of disasters. **C125.4:** Assess impact of climate change, Biodiversity loss on desertification and disasters. **C125.5:** Evaluate Disaster Management Policy, organizational frame work in preparation of disaster management plans.		

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.

Books Recommended

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.

Course Title	**PROKARYOTIC DIVERSITY AND BIO-PROSPECTING (A small world initiative course)**		
Course code	**EMT - 205**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Open Elective – II C**		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C125.1:**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. **C125.2:**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. **C125.3:** Students will be able to describe polyphasic characterization and rules of nomenclature and bacteriological code. **C125.4:**Students will be able to explain, indicate relative advantages, disadvantages and application of various methods available for understanding prokaryote diversity. **C125.5:**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 theirapplication 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
Books Recommended **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 valumesspringers, New York. **4.** The prokaryotes . An evolving electronic resource for the Microbiological community – springer – verlag, New York.

Course Title	ENVIRONMENTAL REMOTE SENSING AND GIS LAB		
Course code	EMT - 206	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	Laboratory - III		
Course outcomes (COs)	**At the end of the course, the Student will be able to** **C126.1:**Master and apply methods of interpreting and analyzing remote sensing data. **C126.2:**Use GIS to identify, explore, understand, and solve spatial problems Demonstrate GIS modeling skills. **C126.3:**Demonstrate critical thinking skills in solving geospatial problems. Design and implement a GIS project. **C126.4:**Use queries in GIS Analysis Formulate applications of GIS technology. **C126.5:**		

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.

Course Title	**WATER & WASTE WATER TREATMENT LAB**		
Course code	**EMT - 207**	No. of credits	04
Centre/ Department	Centre for Environment , IST, JNTUH		
Program	M. Tech : Environmental Management		
Course type	**Laboratory - IV**		
Courseoutcomes (COs)	**At the end of the course, the Student will be able to** **C127.1:** Demonstrate different physico, chemical and biological treatment techniques **C127.2:** Choose appropriate tailor mode treatment techniques for different effluent streams **C127.3:** Experiment to find suitable low cost treatment scheme **C127.4**: Think on cost economics for wastewater treatment. **C127.5**: Choose the treatment method for ZLD system and also for recovery of materials		

Water and waste water treatment methods

1. Coagulation
2. Softening
3. Mixing and Flocculation
4. Chlorinating and Disinfection
5. Defluoridation
6. Hardness removal by lime soda process
7. Reverse Osmosis

Unit operations for wastewater treatment

1. Trickling filter
2. Activated Sludge
3. Rotating biological contractor
4. Anaerobic digester
5. UASB
6. Adsorption
7. Ion exchange