**Note: M. Sc. Course is not running from 2013 batch due to minimum students are not admitted:**

# M. Sc - ENVIRONMENTAL SCIENCE & TECHNOLOGY

# COURSE STRUCTRURE

**I YEAR**

## I SEMESTER

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT CODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EST-1.1 | Ecology and Natural Resources  | 4 | 0 | 3 |
| EST-1.2 | Environmental Chemistry | 4 | 0 | 3 |
| EST-1.3 | Environmental Microbiology& Biochemistry | 4 | 0 | 3 |
| EST-1.4 | Remote Sensing and Image Interpretation  | 4 | 0 | 3 |
| EST-1.5 | Experimental Statistics  | 4 | 0 | 3 |
| ESTL-1.6 | Soil, Water, Wastewater & Air Pollution Analysis Lab | - | 8 | 4 |
| ESTL-1.7 | Solid and Hazardous Waste Characterization Lab  | - | 8 | 4 |
| Total Credits (5 Theory + 2 Lab) |  |  | **23** |

II SEMESTER

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECTCODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EST-2.1 | Air Pollution and Control Technologies | 4 | 0 | 3 |
| EST-2.2 | Water Pollution and Treatment Techniques | 4 | 0 | 3 |
| EST-2.3 | Environmental Biotechnology | 4 | 0 | 3 |
| EST-2.4 | Environmental Impact Assessment and Environmental Modeling  | 4 | 0 | 3 |
| EST-2.5 | Instrumental methods of Analysis | 4 | 0 | 3 |
| ESTL-2.6 | Environmental Microbiology and Biotechnology Lab | - | 8 | 4 |
| ESTL-2.7 | Water and Wastewater Treatment methods and Modeling lab | - | 8 | 4 |
| Total Credits (5 Theory + 2 Lab) |  |  | **23** |

**II YEAR**

### III SEMESTER

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT CODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EST-3.1 | Global Environmental Issues | 4 | 0 | 3 |
| EST-3.2 | Biodegradation and Bioremediation  | 4 | 0 | 3 |
| EST-3.3 | Solid and Hazardous Waste Management | 4 | 0 | 3 |
| EST-3.4 | GIS, GPS and its Applications  | 4 | 0 | 3 |
| EST–3.5 | Environmental Health and Safety | 4 | 0 | 3 |
| ESTL-3.6 | Biodegradation and Bioremediation lab | - | 8 | 4 |
| ESTL-3.7 |  RS & GIS Lab | - | 8 | 4 |
| Total Credits (5 Theory + 2 Lab) |  |  | **23** |

### IV SEMESTER

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT CODE | **SUBJECT TITLE**  | **L** | **P** | **CREDITS** |
| ESTP-4.1 | Project Work | - | - | 23 |
|  | Total Credits  |  |  | **23** |

L- No. of Lectures per week; P- No. of Practical’s per week. **EST-1.1 ECOLOGY AND NATURAL RESOURCES**

**UNIT I ECOSYSTEMS:**

Definition, Concept of ecosystem; Biotic, abiotic and ecological systems. structure, functions and classification of ecosystems. Ecological pyramids.

Ecological energetics: Flow of energy through food chains and food webs; Laws of thermodynamics; entropy, ecological efficiency; bioconcentration and biomagnifications Biogeochemical cycles or Nutrient Cycles: sedimentary cycles; Causes and consequences of disruption of nutrient cycles with reference to Greenhouse gases and SOx. Hydrological cycle.

**UNIT II POPULATION ECOLOGY, BIODIVERSITY AND ITS CONSERVATION:**

Concept of a species and definition of a population. Biological and group attributes of populations. Density, natality, mortality, migrations and growth of populations. Natural regulation of populations. Human population explosion and its consequences. Food, fodder, fibre, fuel, timber and medicines. Forests and the ecological implication of depletion of forests,conservation of biodiversity.

**UNIT III SOIL AND WATER RESOURCES:**

Soil formation and soil erosion; conservation of soil and nutrients. Water resources: Distribution, exploitation, depletion of water resources; conservation of water; water use efficiency; water poverty index.

**UNIT IV NATURAL RESOURCES:**

Classification of natural resources, biotic resources; Renewable and non-renewable resources: mutable and immutable resources; Different types of resources and their natural sources. Demographic quotient; rate of consumption and depletion. Value system, equitable resource use.

Distribution and exploitation; environmental implications of mining; strategies for conservation of mineral resources, land evaluation and suitability, land use/land cover mapping, LU/LC for Environmental Planning.

Renewable and non-renewable resources energy; Alternate and additional sources of energy; depletion of energy resources; Conservation of energy resource; Energy use efficiency. Solar radiation and its technological ways of harvesting; Solar collectors, photovoltaic, solar ponds; Hydroelectric power, Tidal, Ocean Thermal Energy Conversion, Wind, Geothermal Energy, Nuclear energy-fission and fusion, Hydrogen & Fuel cells.

**UNIT V SUSTAINABLE DEVELOPMENT:**

Current concepts of conservation; sustainable development; Homeostasis; Ecological foot print; Carbon foot print; consumerism.

**References:**

1. Fundamentals of Ecology by EP odum, WB Saurders & Co., 5th edition.
2. Environment and Natural Resources conservation by Trivedi R.K, 2002.
3. Remote sensing in Geology to Seigal, John wiely 1999.

**Text Books:**

1. **Concepts of Ecology**. E.J.Kormondey, 1984. Indian reprint 1991 Prentice‑Hall of India.
2. **Basic Ecology**, E.P. Odum, 1983, Holt‑Saunders International Edition.
3. **Ecology & Environment**, P.D.Sharma, Ashish publications,1994.

**EST-1.2 ENVIRONMENTAL CHEMISTRY**

**UNIT1 FUNDAMENTALS OF CHEMISTRY:**

Stoichiometry, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

**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 – LD50, LC50, 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.

**EST‑1.3 ENVIRONMENTAL MICROBIOLOGY AND BIO-CHEMISTRY**

**UNIT I MICROBIAL DIVERSITY AND THEIR CULTIVATION**:

Origin, scope and importance. Diversity of microorganisms: Three domains of life- Prokaryotes versus eukaryotes‑ Eukaryotic and prokaryotic cell General characters, important uses and harmful effects of (a) protozoa (b) algae, (c) fungi (d) bacteria and (e) Virus, Isolation cultivation (aerobic & anaerobic) and preservation of microbes; Nutritional types of microbes, nutrient media (selective, differential, enriched and enrichment) and growth conditions. Physiology of growth, bacterial growth curve, methods for determining bacterial numbers, mass and cell constituents. Exponential growth and generation time. Bacterial growth in batch and continuous culture (chemostat and turbidostat), Effect of environmental conditions on survival and growth of microorganisms and adaptations. Temperature, oxygen, desiccation, extreme cold, ionic effect, osmotic pressures, radiant energy, hydrostatic pressures, and surface forces.

**UNIT II CONTROL OF MICROORGANISMS:**

Inhibition of growth and killing, sterilization and disinfection, physical (moist and dry heat, radiation and filtration), chemical agents (disinfectants, antiseptics, antibiotics and other chemotheraptic agents). Characteristics of an antimicrobial agent; mode of action of antimicrobial agent. Classes of disinfectants ‑ phenol and phenolics alcohol, halogens (Cl2, Chloramines, Br2, I2, tinctures of iodine, iodophores), surfactants (soaps and detergents) alkylating agents (formaldehyde, glutaradehyde, β‑propiolactone) Heavy metals (Hg, Silver and copper containing compounds). Factors affecting sterilization and disinfection, (moisture, organic matter, temperature pH) Evaluation of disinfectants

**UNIT III MICROBIAL METABOLISM AND ENERGY CONVERSION:**

I Glycolysis, TCA cycle, EDP and HMP pathways, oxidative and photophosphorylations, anaerobic respiration and fermentation, bacterial photosynthesis ‑oxygenic and anoxygenic, bacterial pigments, photophosphorylation, CO2 fixation.

**UNIT IV MICROBIAL DEGRADATIONS AND BIOTRANSFORMATIONS:**

Degradation of biopolymers: cellulose, xylan, starch , pectin, lignin and chitin, protein, nucleic acids, lipids and fats - Microbial degradation of hydrocarbons : Methane, ethane, propane, butane and other long chain alkanes, and aromatic compounds - Biodegradation of pesticides.

**UNIT V BIO- INDICATORS:**

Plankton community as indicators of water pollution, use of diversity index in evaluation of water quality, lichens as indicators of air pollution, determination of microbiology quality of potable and recreational waters.

**Text Books:**

1. **The microbial world** 1990. Stanier, P.R., Ingraham., Wheelis, M.L and Painter, P.R. Prentice‑Hall of India Private Limited, New Delhi.
2. **Microbiology**‑Pelzar, Reid and Chan. Tata‑Mc Graw‑Hill Publishing Company Limited.,1996

3. **Brock Biology of Microorganisms** 2010, (Twelth Edition) Michael T. Madigan, John M. Martinko and Jack Parker Prentice Hall publication.

4.  **Microbiology** 2008 (Seventh edition) Lansing M Prescott, John P.Harley and Donald A. Klein Mc Graw Hill publication.

 5. **General Microbiology** (Seventh Edition) Schlegel. Cambridge University Press publisher.

**Reference Books:**

1. Microbiology Davis, B.D., Dulbecco, R., Eisen, H.N and Ginsberg,H.S.Harper and Row

Publishers, Singapore,1

**EST-1.4 REMOTE SENSING AND IMAGE INTERPRETATION**

**UNIT I REMOTE SENSING – BASIC PRINCIPLES:**

Definition of a map, types of maps, map reading, map scale, Basics of map projections. Definition- History of Remote Sensing. Components of Remote sensing, Electromagnetic Remote sensing process- Electromagnetic Spectrum Physics of Radiant Energy, Laws governing energy interaction.

**UNIT II EMR ENERGY INTERACTION WITH ATMOSPHERE AND EARTH SURFACE**

Atmospheric Interactions with Electromagnetic Radiation: Atmospheric Properties, Absorption Ozone, Atmospheric Scattering- Rayleigh’s & Mie’s theories and Atmospheric Windows.

Energy Interactions with Earth’s Surface Materials, Spectral Reflectance Curves.

**UNIT III** **REMOTE SENSING SYSTEM AND SENSOR PARAMETERS:**

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 IV OVERVIEW OF IMAGE PROCESSING:**

Basic character of digital image- Preprocessing- Geometric Corrections, Atmospheric Correction Methods and radiometric correction methods , Image registration, Image Enhancements- Contrast Enhancement, Linear Contrast Stretch, Histogram Equalization, Guassian Stretch, Pseudo Color Enhancement, Image classification- Unsupervised classification, Supervised Classification.

**UNIT V IMAGE INTERPRETATION:**

Basics of Visual and Digital image Interpretation- Interpretation of Aerial Photo, Basic Elements of Image Interpretation, Interpretation of Satellite Imagery- Key elements in Visual Image Interpretation- Converging Evidence.

**Text books:**

1. Textbook of Remote Sensing and Geographical Information Systems M.Anji Reddy, BS Publication.
2. Remote Sensing by JAMES B. CAMPBELL Published by Taylor & Francis Ltd.
3. Remote sensing and Image interpretation by Thomas Lilliesand and Ralphw. Keifer Published by John Wiley &Sons.
4. Remote sensing-Principles and interpretation by Floyd F Sabins.Jr. Published by Freeman & Co., New York

**EST-1.5. EXPERIMENTAL STATISTICS**

**UNIT I INTRODUCTION TO STATISTICS:**

Introduction, Development of statistics, Data & its collection, Classification of data, Graphical & diagrammatic representation of data, Measures of Central tendency- Mean, Median, Mode, Geometric mean, Harmonic mean. **Measures Of Variability-** Variability of range, Mean deviation, Variance, coefficient of variation, Standard deviation, standard error.

**UNIT II PROBABILITY**

Classical and relative frequency, definition of probability, additional and multiplication laws of probability and examples, Binomial, poisons and normal distribution (Definitions and statement of properties with examples).

**UNIT III TESTING OF HYPOTHESIS**

Student t- test, level of significance of large sample tests for single mean and differences of mean. Single proposition and difference proposition- Chi square test for goodness of fit and chi square test of means. Applications of chi square test.

**UNIT IV ANALYSIS OF VARIANCE (ANOVA)**

Simple experimental design and the analysis of variance, completely randomized designs. Analysis of variance (ANOVA) - One way ANOVA and Two way ANOVA with examples.

**UNIT V CORRELATION AND REGRESSION**

Correlation, Scatter plot, concept of coefficient correlation (r), properties (without proof), Interpretation of (r), Regression- linear regression, fitting of lines of regression, regression coefficient. Experimental designing and planning of an experiment.

**Textbooks:**

1) Statistical methods 2001 (30th edition) S.P. Gupta. S. Chand Publications

2) Business Statistics 2008 (15th edition). S.P Gupta & M.P Gupta Sage publications, New Delhi.

 3) Programming in ANSI C 2008 (4th edition). E. Balaguruswami Tata Mgraw Hill publisher

 4) Fundamentals of Biostatistics 2004 (1st edition). Khan and Khanun. Ukaaz

 Publications/bsp Books Pvt. Ltd.

 5) Introduction to biostatistics 1987. Robert R. Sokal, F. James Rohlf W.H. freeman and company.

**EST-1.6. SOIL, WATER, WASTEWATER & AIR POLLUTION ANALYSIS LAB**

1. Dissolved oxygen
2. Biological oxygen demand
3. Chemical oxygen demand
4. Fluorides
5. Heavy metals by AAS
6. Estimation of NOX
7. Estimation of SOX
8. Estimation of Particulate matter
9. Total solids & Total dissolved solids
10. pH and Electrical Conductivity
11. Turbidity
12. Color and odour
13. Hardness
14. Alkalinity
15. Nitrate-Nitrogen
16. Ammonical-Nitrogen
17. Nitrite-Nitrogen
18. Phosphates
19. Sulfate

**SOIL ANALYSIS: Estimation of following parameters:**

**Physical & Chemical parameters:**

1)Moisture content 2)Electrical conductivity 3)Bulk density 4)Specific gravity 5)Water holding capacity 6)pH 7)potassium 8)Nitrogen (Kjeldahl) 9)Organic matter 10)Nitrate 11)Chlorides 12)Total phosphorous 13) Sulphate 14) Phosphate 15)Alkalinity 16) Calcium 17) Heavy metal 18) Magnesium 19) Sodium

**ESTL-1.7 SOLID AND HAZARDOUS WASTE CHARACTERIZATION LAB**

**SOLID AND HAZARDOUS WASTE CHARACTERISATION (INDUSTRIAL AND MUNCIPAL)**

**Physical & Chemical parameters:**

1)Moisture content 2) Electrical conductivity 3)Bulk density 4) Specific gravity 5) Water holding capacity 6)pH 7) potassium 8)Nitrogen (Kjeldahl) 9) Organic matter 10)Nitrate 11)Chlorides 12) Total phosphorous 13) Sulphate 14) Phosphate 15) Alkalinity 16) Calcium 17)Volatile Organic Matter

18) Magnesium 19) COD 20) Sodium 21) Calorific value 22) Estimation of aromatic compounds

23) Heavy metals

**C. INSTRUMENTAL ANALYSIS**

1. Ion analyzer
2. AAS
3. HPLC
4. GC
5. GCMS
6. UV-VIS

**EST-2.1 AIR POLLUTION AND CONTROL TECHNOLOGIES**

**UNIT I CLASSIFICATION AND PROPERTIES OF AIR POLLUTANTS:**

Emission sources ‑major emissions from Global sources ‑importance of anthropogenic sources‑ behavior and fate of air pollutants‑ photochemical smog‑effects of air pollution‑health, vegetation and materials damage in India‑air pollution standards - Isolation and heat balance of the atmosphere – 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 behavior 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‑ sulfur 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 SO2 emission – desulphurization of flue gases – dry methods – wet scrubbing methods. Control of nitrogen oxides‑modification of operating conditions and design conditions‑effluent gas treatment methods‑carbon monoxide control‑control of hydrocarbons‑mobile sources.

**UNIT VI 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
8. Air Pollution by T.Shivaji Rao,Lavanya lata Pub. 1988.

**EST‑2.2 WATER POLLUTION AND TREATMENT TECHNIQUES**

## UNIT I WATER POLLUTANTS AND TREATMENT

## Introduction, Sources of water pollution- types of water pollutants, physical & chemical characteristics of water. Treatment Processes: Coagulation, Flocculation, Sedimentation, and Filtration: Theory of slow and rapid gravity filters, multimedia filters, and Disinfection: Theory of chlorination, chlorine demand, other disinfection practices.

**UNIT II PRIMARY AND SECONDARY TREATMENT OF WASTEWATER**

**Primary treatment**: Screening, Grit removal, Neutralization, equalization, Sedimentation, Flotation (oil & grease removal), Air stripping; **Secondary treatment**- Activated Sludge Process (ASP), Trickling Filters, RBC, up flow anaerobic sludge blanket reactor, hybrid reactors, ETP Sludge management, aerobic ponds, facultative ponds, anaerobic ponds.

**UNIT III TERTIARY TREATMENT OF WASTEWATER**

**Tertiary treatment**-, adsorption, solvent extraction, ion exchange, ***Membrane separation Techniques***: Brief description of MF, UF, NF membranes. Reverse osmosis principle , Membrane materials , Types of membranes – Plate & frame , tubular, hollow fiber , 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 , Agitated Nutch filter driers. ***Nutrient removal***: Nitrification and denitrification process, phosphorous removal

##### UNIT VI SEWAGE TREATMENT AND DISPOSAL:

Self purification of streams- BOD and its important- treatment methods- primary, secondary and tertiary levels- disinfections of treated sewage effluent- septic tank design- effluent disposal methods- disposal on land, sewage sickness- disposal by dilution- design of biological treatment units- sludge characteristics, unit operations in sludge disposal, conventional and high rate digesters- disposal of sludge- gas utilization.

## UNIT V INDUSTRIAL WASTEWATER TREATMENT:

Sources, Characteristics, methodology and process for the treatment of industrial wastes of paper and pulp mill-sugar industry- beverage industry- tannery industry- textile mill waste industry- fertilizer plant- steel plant- oil refinery- pharmaceutical plant-.

## 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)

 **EST‑2.3 ENVIRONMENTAL BIOTECHNOLOGY**

**UNIT I BIOFUELS:**

Scope and Importance **-** Microorganisms and energy requirements of mankind **-** Production of nonconventional fuels‑ methane (biogas), hydrogen, alcohols and algal hydrocarbons and microbial fuel cells.

**UNIT II BIOREMEDIATION:**

Bioremediation, constraints, advantages and application, types of bio remediation (natural and engineered), bio-attenuation, ex-situ & In-situ, bio-augmentation and bio-stimulation; application, specific advantages and disadvantages of specific bioremediation technologies. Land farming prepared beds, biopiles, composting, bioventing, pump and treatment method, phytoremediation, constructed wetlands.

**UNIT III MICROBIAL TECHNOLOGY IN AGRICULTURE:**

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 III INDUSTRIAL MICROBIOLOGY:**

Maintenance of Stock Cultures,Culture collection centres/microbial gene banks, inoculum build- up, industrial substrates, batch and continuous fermentation and solid substrate fermentation, immobilization technologies. Major groups of microorganisms used, relative advantages and disadvantages. Microbial production of flavours and food colorants. Probiotics and prebiotics, Penicillin production, vinegar fermentation.VitB12 production;Amylase production.

 **UNIT V BIOTECHNOLOGY AND INTELLECTUAL PROPERTY RIGHTS:**

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

**Text Books:**

1. **Elements of biotechnology**, 1995. P.K.Gupta Rastogi Co.
2. **Industrial Microbiology** ‑ Casida, Wiley Eastern publishers,1994.
3. **Industrial Microbiology**‑ Prescott and Dunn.
4. **Biodegradation & Bioremediation**- Martin Alexander.

**Reference Books:**

1. **Biotechnology‑A new industrial revolution** Prentis S. Orbis Publishing Ltd., London.
2. Microbiology Davis, B>D., Dulbecco, R., Eisen, H.N and Ginsberg, H.S. Harper and Row Publishers, Singapore., 1992.
3. Environmental Microbiology, 2000, Maier, R.M. Pepper, I.L and Gerba, C.P. Academic press.
4. Review articles published in current opinion in microbiology, microbiological reviews, Advances in Microbial physiology, Bacteriological reviews etc.

**EST-2.4 ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MODELING**

**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, collateral 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 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 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. EIA by Canter
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, Hameswar Dayal Konark Publishers, Pvt., Ltd.
9. Environmental Impact Assessment, Canter, L.W., 1977, McGraw Hills, New York

**EST‑2.5 INSTRUMENTAL METHODS OF ANALYSIS**

**UNIT I INTRODUCTION:**

Type of Instrumental methods of Analysis – accuracy, precision, types of errors Uncertainties in Instrumental measurements – Sensitivity and detection limit for instruments. Measurement of pH and Conductivity, Ion selective electrodes

 **UNIT II UV- VISIBLE SPECTROSCOPY INFRARED SPECTROSCOPY:**

 Electromagnetic spectrum- frequency - wave number– Absorptivity – deviations from Beer’s law – single & double beam spectrophotometer - Instrumentation –Photometric accuracy – Qualitative and quantitative analysis.

Infrared spectroscopy – Theory, Instrumentation & applications.

**UNIT III ATOMIC ABSORPTION AND EMISSION SPECTROSCOPY:**

AAS- Principle – Instrumentation – Interference – applications;

ICP-Theory, Instrumentation & applications; Flame photometer**-**Principle Instrumentation and applications.

**UNIT IV CHROMATOGRAPHY:**

Column, ion exchange, TLC, GLC, HPLC & HPTLC: Principles and applications, Instrumentation**:** detectors, columns, injectors - temperature programming- isocratic and gradient programming - qualitative and quantitative analysis

**UNIT V RADIOACTIVE TECHNIQUES:**

Radio activity- Half life decay, U.V flourimetry, laser fulorimetry, scintillation counters, α, β counters, gamma spectrometry.

**Textbook:**

1. **R.A. Day** 7 A.L. Underwood, Quantitative analysis, Prentice-Hall of India Pvt. Ltd., 1985.
2. Skoog & West, Fundamentals of Analytical Chemistry, 1982.
3. Hobert H. Willard, D.L. Merrit & J.R.J.A. Dean, Instrumental methods of analysis, C.B.S Publishers and Distributors, 1992.
4. Vogel, Textbook of quantitative inorganic analysis, 1990.
5. Ewing, Instrumental Methods of Chemical Analysis, 1992, Mc Graw Hill
6. Instrumental Methodology of Analysis by Chatwal Anand, Himalaya Publishing House.
7. Separation chemistry (2006), R.P Budhiya, PP424. New age international (p) Ltd,

**ESTL‑2.6 ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY LAB**

**I. General techniques of microbiology**

Enrichment, isolation and enumeration of **Microorganisms from the environment**

1. Isolation and enumeration of green algae
2. Isolation and enumeration of fungi,
3. Enrichment of purple non-sulfur bacteria

**Characterization of microorganisms**

1. Cultural characteristic
2. Staining
3. Biochemical tests
4. Macromolecular composition
5. Whole cell absorption spectrum

**Studies on the bacterial growth patterns and cellular contents**

1. Bacterial growth curve
2. Estimation of cellular contents of photosynthetic pigments

**Evaluation of antimicrobial chemical agents**

**Evaluation of microbiological quality of water**

## Photo production of hydrogen

**Production of violacein by ssf**

**Methods of microbial immobilization**

**Demonstration of phosphate solubilisation activity of microbes.**

 **Microbial fuel cells**

 **Photobiological production of hydrogen from industrial effluents.**

**ESTL-2.7 WATER AND WASTEWATER TREATMENT METHODS AND MODELING LAB**

**Unit operations for water treatment**

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

**Environmental Modeling**:

* Ground water Modeling Software Features
* Visual MOD FLOW
* MT3D model (Mass Transportation 3 Dimensions)
* SEAWAT model
* AERMOD/ISCST3 Air quality models.
* Demonstrative case studies.

**EST‑3.1 GLOBAL ENVIRONMENTAL ISSUES**

**UNIT I INTRODUCTION:**

Human environmental Interactions- Global Environmental Agreements & Movements - Stockholm and Beyond – Evolution of International Environmental Laws- making international , national environmental agreements, Environmental Movements: Global and national movements of Significance impact: RAMSAR Convention- Green Belt movement- Green Peace – Case studies Chipko movement- Narmada Bachao Andolan – Silent valley- Doon valley and related issues /

**UNIT II CLIMATE CHANGE AND GLOBAL WARMING:**

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 III** [**LAND DEGRADATION**](http://en.wikipedia.org/wiki/Land_degradation) :

[Land pollution](http://en.wikipedia.org/wiki/Land_pollution) • [Desertification](http://en.wikipedia.org/wiki/Desertification) - [Soil](http://en.wikipedia.org/wiki/Soil) — [Soil conservation](http://en.wikipedia.org/wiki/Soil_conservation) • [Soil erosion](http://en.wikipedia.org/wiki/Soil_erosion) • [Soil contamination](http://en.wikipedia.org/wiki/Soil_contamination) • [Soil salination](http://en.wikipedia.org/wiki/Soil_salination). Mining- reclamation of mined area. Desertification-case studies

**UNIT IV NATURAL DISASTERS AND THEIR MITIGATION:**

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

**UNIT V NUCLEAR AND CONTEMPORARY ISSUES:**

[Nuclear issues](http://en.wikipedia.org/wiki/Nuclear_power_debate) —[Nuclear power](http://en.wikipedia.org/wiki/Nuclear_power) • [Nuclear weapons](http://en.wikipedia.org/wiki/Nuclear_weapons) • [Nuclear and radiation accidents](http://en.wikipedia.org/wiki/Nuclear_and_radiation_accidents) • [Nuclear safety](http://en.wikipedia.org/wiki/Nuclear_safety), Green Buildings- [Genetic pollution](http://en.wikipedia.org/wiki/Genetic_pollution)- [Genetically modified food controversies](http://en.wikipedia.org/wiki/Genetically_modified_food_controversies). [Intensive farming](http://en.wikipedia.org/wiki/Intensive_farming) [Monoculture](http://en.wikipedia.org/wiki/Monoculture). Health and Diseases- Epidemics and Famines.

**Textbooks:**

1. Global environmental issues: a climatological approach by [David D. Kemp](http://www.google.co.in/search?tbs=bks:1&tbo=p&q=+inauthor:%22David+D.+Kemp%22), Taylor and Francis.

**EST-3.2 BIODEGRADATION AND BIOREMEDIATION**

**UNIT – I: BIODEGRADATION:**

What is biodegradation? Acclimation, detoxification activation, bio-availability, effect of chemical structure on biodegradation, recalcitrance, predicting products of biodegradation, cometabolism and biotransformation. Factors affecting biodegradation., 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 – II: BIOREMEDIATION:**

Introduction, 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 – III: 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. Constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, restoration of coal mines a case study.

**UNIT – IV: BIOTECHNOLOGY FOR INDUSTRIAL POLLUTION CONTROL:**

Biotechnological application for pollution reduction in Paper and pulp industry, tannery industry. Agriculture, carbon sequestration from industrial stack emissions & automobile exhaust.

**UNIT – V: BIOTECHNOLGOY FOR HAZARDOUS WASTE MANAGEMENT & RESTORATION OF DEGRADED LANDS:**

Hazardous wastes, biotechnology for hazardous waste management, cyanide detoxification, detoxification of oxalate, urea. Reforestation through micropropagation casurina for tropical reforestation on adverse sites, development of stress tolerant plants; use of mycorrhizae in reforestation, reforestation of soils contaminated with heavy metals.

**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.

1. Biodegradation and Bioremediation 1999 (2nd editon). Martin Alexander, Elsevier Science & Technology.
2. Environmental Microbiology 2001. Raina M. Maier, Ian L. Pepper, Academic Press.
3. Bioremediation engineering.. J.T.Cookson, Mc.Grwhill Inc.

**EST-3.3 SOLID & HAZARDOUS WASTE MANAGEMENT**

**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 – labeling and handling of hazardous wastes. Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, Vermicomposting, fermentation. 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 landfills - Site selections, design and operation. HW reduction, recycling and reuse, Regulatory aspects of HWM/HWM rules.

**UNIT IV** **BIOMEDICAL AND RADIO ACTIVE WASTE MANAGEMENT:**

Classification, collection, segregation Treatment and disposal of biomedical waste. 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 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.

**EST- 3.4 GIS, GPS AND ITS APPLICATIONS**

.**UNIT I: FUNDAMENTALS OF GIS:**

A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, 4 M’s, Levels of measurement.

**UNIT II: GIS DATA INPUT AND DATA STRUCTURES:**

Data input methods: Keyboard entry, manual digitizing, Scanning and automatic digitizing. GIS data types. Data Structure Raster Data Structures, Vector Data Structures, Comparisons between Data Structures.

# UNIT III DATA QUALITY, ANALYSIS AND OUTPUT

Data Quality - 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;

**UNIT IV: GLOBAL POSITIONING SYSTEM (GPS):**

Introduction, Background, The space segment, the control segment, the user segment, the performance of GPS, Factors influencing GPS accuracy, GPS positioning. GPS signal characteristics, signal structure, signal coverage, signal propagation, Differencing of GPS data and single differenced data. GLONASS, Data Pre-processing, Advantages and limitations of GNSS.

**UNIT V: GIS AND GPS APPLICATIONS:**

GIS and GPS applications in the field of environmental management: Land-Water-Forest Resources, Solid Waste management, Transport- Infrastructure-Commercial- Social- Environmental Planning, Disaster management, etc.

**Text books:**

1. Textbook of Remote Sensing and Geographical Information Systems M. Anji Reddy, BS Publication.
2. Fundamentals of GIS by MICHAEL N DEMERS. Published By john Wiley & Sons Inc.
3. Geographic Information Systems: A
Management Perspective by Stan Arnoff.
4. Essentials of GPS by NK Agarwal, Spatial Network Pvt Ltd,Hyderabad.

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2. Fundamentals of GIS by MICHAEL N DEMERS. Published By john Wiley & Sons Inc.
3. Geographic Information Systems: A
Management Perspective by Stan Arnoff.
4. Essentials of GPS by NK Agarwal, Spatial Network Pvt Ltd,Hyderabad.

### EST-3.5 ENVIRONMENTAL HEALTH AND SAFETY

**UNIT – I: INTRODUCTION TO SAFETY & HEALTH MANAGEMENT**:

Sequence of accident occurrence and theories. 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: BEST WORK PRACTICES IN INDUSTRIES**:

Hazards in Chemical Operations, Material Handling Hazards, Lifting Machinery & Pressure Vessels, Material Safety Data Sheets, Classification of Chemicals, chemical storage practices, Radiation Safety, Petroleum Storage Requirements, Pesticide Safety. Best industrial practices in Electrical, Mechanical, Fire and Machine Guarding, Personal Protective Equipment, Noise Abatement Methods.

**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**:

Definitions of Hazards, Risks, Evolution of Methodical Analysis, System safety Analysis techniques, Performance measurement, Operational Reviews - Internal & External.

**UNIT – V: OCCUPATIONAL SAFETY MANAGEMENT STANDARDS & ACTS:**

OHSAS 18001 Standards and its Elements, CE Certificate, Social Accountability Standards, System implementation & benefits. Factory’s Act & Rules – Central and state, Construction Safety Regulations, Petroleum Rules 2002, Electrical Act & Rules.

**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.

**ESTL-3.6 BIODEGRADATION AND BIOREMEDIATION LAB**

 **Biodegradation**

**Qualitative Analysis of**

1. Starch Degradation
2. Cellulose degradation
3. Gelatin hydrolysis
4. Nitrobenzene degradation
5. Aniline degradation
6. Lipid degradation
7. Casein hydrolysis

**Biodegradation of Carbohydrates (Starch)**

1. Quantitative Estimation of starch by Iodine Method
2. Biodegradation of starch in activated sludge

**Biodegradation of protein (Gelatin)**

1. Biodegradation of Gelatin in Activated sludge

**Biotreatability Studies:**

1. OECD guidelines for determining inherent biodegradability of chemicals

# Molecular Techniques

1. Isolation of genomic DNA v) Transformation
2. Isolation of Plasmid DNA vi) SDS-PAGE
3. Agarose gel DNA electrophoresis vii) Cloning
4. Restriction digestion

**Photobiological production of hydrogen from industrial effluents**.

**Biocolorant production from agricultural waste**

**ESTL-3.7 RS and GIS LAB**

1. Study of toposheet and base map preparation
2. Visual interpretation and digital analysis of satellite data for extraction of thematic information
* **Road network**
* **Drainage**
* **Watershed**
* **Slope**
* **Land use/land cover**
* **Geomorphology**
1. Scanning / digitization of maps using AutoCAD
2. Demonstration of GIS software and its application
3. Data entry, manipulations and analysis using ARC/INFO
4. Digital image processing using ERDAS

**M. Sc- ENVIRONMENTAL BIOTECHNOLOGY**

# COURSE STRUCTURE

**I YEAR**

**I SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECTCODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EBT-1.1 | Ecology and Toxicology | 4 | - | 4 |
| EST-1.2 | Environmental Chemistry | 4 | - | 4 |
| EBT-1.3 | Environmental Microbiology | 4 | - | 4 |
| EBT-1.4 | Cell and Molecular Biology | 4 | - | 4 |
| EBT-1.5 | Bio-Chemical, Biophysical and Instrumental Techniques | 4 | - | 4 |
| EBTL-1.6 | Environmental Microbiology Lab | - | 8 | 8 |
| EBTL-1.7 | Environmental Pollution Monitoring Lab | - | 8 | 8 |
| Total Credits(5 Theory + 2 Lab) |  |  | **36**  |

**II SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECTCODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EBT-2.1 | Principles of Biochemistry  | 4 | - | 4 |
| EBT-2.2 | Microbial Biotechnology | 4 | - | 4 |
| EBT-2.3 | Recombinant DNA Technologies  | 4 | - | 4 |
| EBT-2.4 | Environmental Pollution and Treatment Technologies | 4 | - | 4 |
| EBT-2.5 | Chemical and Biochemical Engineering | 4 | - | 4 |
| EBTL-2.6 | Water and Waste water treatment Lab | - | 8 | 8 |
| EBTL-2.7 | Biochemistry Lab | - | 8 | 8 |
| Total Credits(5 Theory + 2 Lab) |  |  | **36**  |

**II YEAR**

### III SEMESTER

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECTCODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EBT-3.1 | Biostatistics and Bioinformatics | 4 | - | 4 |
| EBT-3.2 | Environmental Modelling | 4 | - | 4 |
| **EBT-3.3** | **Biodegradation and Bioremediation** | 4 | - | 4 |
| EST-3.4 | Environmental Impact Assessment  | 4 | - | 4 |
| EST-3.5 | Occupational Health and Safety  | 4 | - | 4 |
| EBTL-3.6 | Biodegradation, Bioremediation and Molecular Biology Lab | - | 8 | 8 |
| EBTL-3.7 | Biostatistics, Bioinformatics and Environmental modelling Lab | - | 8 | 8 |
| Total Credits(5 Theory + 2 Lab) |  |  | **36**  |

**IV SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECTCODE | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| EBTP-4.1 | Project Work | -  | - | 36 |
|  | Total Credits |  |  | **36** |

**L- No. of Lectures per week; P- No. of Practical’s per week.**

**EBT- 1.1 ECOLOGY AND TOXICOLOGY**

**UNIT – I: PRINCIPLES AND SCOPE OF ECOLOGY**: Definition, Basic concepts of Ecology, climatic factors – light, temperature, precipitation, Edhaphic factors- soil profile, soil formation, soil classification and soil conservation, Biotic factors- relationship among organisms- positive and negative interactions, acclimation, limiting factors, ecological indicators, energy balance, photosynthesis, respiration.

**UNIT – II: ECOSYSTEMS ECOLOGY:** Structure and functions, abiotic and biotic components, energy flow, food chain, food web. Ecological pyramids – pyramids of numbers, biomass and energy. Study of pond, forest, desert and crop land ecosystems, Productivity and energy flow, ecological efficiency, Biogeochemical cycles

**UNIT – III: POPULATION AND COMMUNITY ECOLOGY:** Population growth and regulation, Concepts: birth rate, death rate, life tables, survivorship curves, population growth, functions, carrying capacity, population pyramids, Impact of population growth on environment, Community structure, Concepts: dominance, diversity, spatial structure, ecological niche, assembly rules, guilds, ecotones, Community change, Concepts: disturbance, ecological succession, phenology

**UNIT – IV: BIODIVERSITY AND ITS CONSERVATION**: Definition, species, genetic and ecosystem diversity, biogeographical classifications, India as megadiversity nation, hot spots. Threats to biodiversity-habitat loss, poaching, man-wildlife conflict. IUCN categories of threat, extinct and endangered species. Conservation strategies – in situ and ex situ conservation, national parks, wild life sanctuaries, conservation reserves, gene banks.

**UNIT – V: ENVIRONMENTAL TOXICOLOGY**: Environmental toxicants – Heavy metals, pesticides, their effects on human beings. Indices of toxicity – threshold dose, LD50 and LC50, MIC & IC50 Dose – response relationship. Forensic toxicology. Factors affecting toxicity of a chemical agent, Tissue toxicity, interference in enzyme activity, interference in synthesis of nucleic acids and proteins. Detection – Testing chemical agents for their carcinogenic, mutagenic and taratrogenic action. AMES test, antidotal procedures – elimination of toxic agent by haemodialysis, peritoneal dialysis, use of complexing agents.

**Books:**

1. D.K. Asthana & Meera Asthana- Environment: problems and and solutions. Chand & Co., New Delhi. (1998).

2. Eugene Odum, Murray Barrick, Gary W. Barrett- Fundamentals of Ecology. Brooks/cole (2005).

3. P. D. Sharma- Ecology and Environment. Rastogi Publications. (2005)

4. Ed Ernest Hodgson A Text Book of Modern Toxicology, , Wiley publications

**EST-1.2 ENVIRONMENTAL CHEMISTRY**

**UNIT - I: FUNDAMENTALS OF CHEMISTRY:**

Stoichiometry, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

**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 – LD50, LC50, 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, a global perspective (2nd Edition) by Gary W. Vanloon & Stephen J. Duffy – Oxford University press. 2005.

2. Chemistry for environmental Engineering and science Fifth edition by Clair N. Sawyer, Perry L. Mecarly, Gene F. Parkin, Tata megrahil edition. 2002.

3. Environmental Chemistry by Ajay Kumar Bhagi, G.R. Chatwal, Himalaya Publishing house. 2010.

 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 Prakashan, Meerut. 2010.

6. Fundametals of Environmental chemistry, 2nd ed. 2008, CRC Press, Stanley E. Manahan, *University of Missouri, Columbia, USA*.

**EBT-1.3 ENVIRONMENTAL MICROBIOLOGY**

**UNIT – I: MICROBIAL DIVERSITY AND TAXONOMY:**

Introduction; Prokaryotes versus eukaryotes- Eukaryotic and Prokaryotic cell structure, three domains of life. General characters, importance and harmful effects of a) Protozoa b) algae, c) fungi, d) bacteria, e) virus. General Concepts of microbial taxonomy, phenetic classification, numerical taxonomy, Phylogenetic classification-polyphasic taxonomy of prokaryotes, Ecological, Morphological, Physiological, biochemical, genetic and molecular characterisation. Classification and identification schemes.

**UNIT – II: MICROBIAL GROWTH AND 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 condtions. Nutritional types based on energy source, principal carbon source, electron donor. Proto and auxotrophs, copio and oligotrophs, phago and osmotrophs. Isolation, cultivation (aerobic & anaerobic) and preservation of microorganisms. Physiology of growth, bacterial growth curve, methods for determining bacterial numbers, mass and cell constituents. Exponential growth and generation time. Bacterial growth in batch and continuous culture (chemostat and turbidostat), synchronous growth.

**UNIT – III: EFFECT OF ENVIRONMENT AND CONTROL OF MICROORGANISMS:**

Effects and microbial adaptations to environmental conditions – Temperature, oxygen, desiccation, extreme cold, ionic effect, osmotic pressures, radiant energy, hydrostatic pressures. General concepts, Inhibition of growth and killing, sterilization and disinfection, antisepsis, and sanitation. Desirable characteristics and mode of action physical agents (moist and dry heat, radiation and filtration), chemical agents. Classes of disinfectants: Phenol and Phenolics alcohol, halogens (Cl2, Chloramines, B2, I2, tinctures of iodine, iodophores) surfactants (soaps and detergents) alkylating agents (formaldehyde, glutaraldehyde, β-propiolactone and ethylene oxide), Heavy metals (mercury, silver and copper containing compounds). Factors affecting sterilization and disinfection (moisture, organic matter, temperature, pH). Evaluation of antimicrobial activity.

**UNIT – IV: BIOINDICATORS AND BIOSENSORS:**

Bioindicators, Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality. Determination of microbiological quality of recreational and potable waters, indicator organisms, coliforms and *E.coli*, fecal streptococci, clostridia, heterotrophic plate counts etc. lichens as air pollution indicators. Biosensors components, advantages and limitations, biocatalysis based, bioaffinity based and microorganism based biosensors; Transducers-potentiometric, conductometric, amperometric, optical, piezoelectric, and thermoelectric based biosensors. Glucose, ammonia gas, alcohol, BOD, methane and mutagen sensors. Applications of biosensors in environmental monitoring.

**UNIT – V: QUALITY CONTROL AND QUALITY ASSURANCE IN MICROBIOLOGY:**

What are quality control and quality assurance? Standard operating procedures, Quality Assurance of pre-analytical, analytical and post analytical stages of microbiological procedures. Staff & qualifications; Quality Control of culture media, personnel; External quality assessment and internal quality assessment.

**Text books:**

1) **Brock Biology of Microorganisms** 2010, (Twelth Edition) Michael T. Madigan, John M. Martinko and Jack Parker Prentice Hall publication.

2**) Microbiology** 2008 (Seventh edition) Lansing M Prescott, John P.Harley and Donald A. Klein Mc Graw Hill publication.

3) **General Microbiology** (Seventh Edition) Schlegel. Cambridge University Press publisher

**Reference books:**

1) Microbiology Davis, B>D., Dulbecco, R., Eisen, H.N and Ginsberg, H.S. Harper and Row Publishers, Singapore., 1992.

2) Environmental Microbiology, 2000, Maier, R.M. Pepper, I.L and Gerba, C.P. Academic press.

3) Review articles published in current opinion in microbiology, microbiological reviews, Advances in Microbial physiology, Bacteriological reviews etc.

**EBT-1.4 CELL AND MOLECULAR BIOLOGY**

**UNIT – I: CELL BIOLOGY:**

Ultra structure of eukaryotic cell, cell cycle and regulation, Cell division, mitosis and meiosis, prokaryotic cell division, active and passive transport across membranes, gated ion channels, osmoregulation and homeostasis. Signal transduction, molecular mechanism of signal transduction.

**UNIT – II: GENETIC MATERIAL AND DNA REPLICATION:**

Structure of DNA, Chromosomal and plasmid DNA – chromosome structure and gene organisation in prokaryotes and eukaryotes, Semi conservative model, an overview of bacterial and eukaryotic DNA replication – replication origins and termini, DNA unwinding, synthesis of leading and lagging stands, proteins and enzymes of replication, Rolling circle model

**UNIT – III: GENE EXPRESSION:**

Biosynthesis of RNA in prokaryotes and eukaryotes, enzymes & proteins involved, promoter selection & role of RNA polymerases and ancillary factors, post transcriptional modification – 5`cap, 3`poly A tail, gene splicing, Triplet Codons, deciphering the genetic code, degeneracy of the code, termination codons, prokaryotic and eukaryotic protein synthesis - initiation, elongation and termination factors

**UNIT – IV: GENE REGULATION**

Repression and induction, positive and negative control-repressor-apo repressor and activator, attenuation– lac and Trp operons. Alteration of gene content or position (gene amplification, diminution, gene rearrangements) transcriptional regulation-chromosome packing, individual gene regulation, post transcriptional splicing, regulation of RNA stability, post translational regulation,

**UNIT – V: MUTAGENESIS AND CHROMOSOMAL CHANGES:**

Definition, Types of mutation-Point mutations – base pair substitution (transition and transversion) frame-shift mutation, missense, non-sense, silent and suppressor mutations. Molecular mechanism tautomerism, chemical mutagens (base analogoues, HNO2, hydroxylamine, alkylating agents, dyes) physical agents (UV and X-rays); DNA Repair Systems - various repair systems – photo reactivation, excision repair, post-replication repair, SOS response, Heteroploidy (euploidy and aneuploidy) chromosomal aberrations (deficiency, additions, inversion and translocation)

**Textbooks:**

1) Cell and Molecular Biology 2009 (6th edition). Karp, G.John Wiley and sons, Inc., New York

2) Cell and Molecular Biology (eigth edition). De Robertis, EDP and De Robertis, Jr.EMF BI Waverly Pvt., Ltd.

3) Cell and Molecular Biology 2000 (4th edition). Harvey Lodish, **David Baltimore** Freeman publishers.

4) Genetics 2008 (3rd edition). M. W. Strickberger Macmillan Publishing Company.

5) Molecular biology of gene VI (2007) 6 edition. James D. Watson, [Tania A. Baker](http://www.amazon.com/Tania-A.-Baker/e/B001H6OS90/ref%3Dntt_athr_dp_pel_2), Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Inglis CSHLP. Benjamin Cummings publishers

# EBT-1.5 BIO-CHEMICAL, BIO-PHYSICAL AND INSTRUMENTAL TECHNIQUES

**UNIT I MICROSCOPY:** Principles & Working of light, phase contrast, dark field, fluorescence, polarization microscopy, con focal microscopy, SEM, TEM.

**UNIT II CENTRIFUGATION:** Theory of centrifugation and application to biological systems. Types of rotors, selection of rotors, zonal/continuous flow, buoyant, density centrifugation. Sedimentation rate, sedimentation constant, sedimentation diffusion equilibrium, molecular weight determination. Types of centrifugation; Ultra centrifugation, differential centrifugation.

**UNIT III RADIOACTIVE TECHNIQUES, AUTOMATIC ANALYZERS, SYNTHESIZERS & OTHER TECHNIQUES:** Use of Radioactive and stable isotopes and their detection in biological systems, half life-decay counters - scintillation counters, autoradiography. Automatic amino acid analyzer, protein sequencer & synthesizer. Nucleic acid synthesizer & sequencer, thermal cycler. Lyophilyzation and its applications to biological systems. Cell sorter and their applications.

**UNIT IV: UV – VISIBLE, INFRA RED, FLAME AND ATOMIC ABSORPTION & NMR SPECTROSCOPY:** Introduction to instrumental methods: Type of Instrumental Methods - errors and minimization of errors, Instruments for Analysis - Sensitivity and detection limit for instruments Absorptivity - Apparent deviations from Beer's law - double beam spectrophotometer operation - Sources of radiation - Detectors - Photo Metric Accuracy - Chemical applications. Principles and applications of Flame photometry and atomic absorption spectroscopy**.** NMR,FTIR- Theory, instrumentation and applications.

**UNIT V CHROMATOGRAPHY AND ELECTROPHORESIS:** Column, ion exchange, TLC, GLC and HPLC: Principles and applications, Instrumentation**:** detectors, columns, injectors - temperature programming- isocratic and gradient programming - qualitative and quantitative analysis. Different methods of electrophoresis for proteins, nucleic acids, PFGE, PAGE and SDS - PAGE electrophoresis determination of molecular weight.

**Text Books:**

1. Quantitative analysis 1995 (7th edition). R.A.Day & A.L.Underwood, Prentice - Hall of India Pvt., Ltd.
2. Fundamentals of Analytical Chemistry 2003 (8th edition). Skoog, Douglas A.; West, Donald M. Saunders College Publishing, New York.
3. Instrumental Methods of Analysis 1992 (2nd edition). Hobert H.Willard, D.L. Merrit & J.R.J.A.Dean, C.B.S. Publishers and Distributors.
4. Text Book of quantitative inorganic analysis, 1990 (3rd edition). Vogal, ELBS and Longman. London.
5. Instrumental Methods of Analysis, 1992. Ewing, Mcgraw-Hill College.

6. Lehninger Principles of Biochemistry 2009 (5th edition). David L. Nelson & Michael M. Cox, W. H.

 Freeman publishers.

7. Cell and Molecular Biology (eigth edition). De Robertis, EDP and De Robertis,

 Jr.EMF BI Waverly Pvt., Ltd.

1. Istrumental methods of chemical analysis. Gurdeep Chatwal & Sham Anand., Himalaya publ., (2010) (5th revised edition)

9. Separation chemistry (2006), R.P Budhiya, PP424. New age international (p) Ltd,

**EBTL-1.6: ENVIRONMENTAL MICROBIOLOGY LAB**

## General techniques of microbiology

Media preparation. Sterilization, inoculation, Cultivation, isolation and enumeration, Anaerobic cultivation of Microorganisms.

## Enrichment, Isolation and Enumeration of Microorganisms from the Environment

Isolation and Enumeration of soil bacteria

Isolation and Enumeration of photolithoautotrophs by MPN Method

Isolation and Enumeration of Fungi

Enrichment of purple non sulphur bacteria.

1. **Characterisation of Microorganisms**

Cultural Characteristics

Measurement of Cell Size

Staining

Biochemical Tests – Indole production, Methyl red test, Voges proskauer test, Citrate utilization, Catalase test, Tripple sugar iron agar test.

Macromolecular Composition

Whole cell absorption spectrum

1. **Studies on Bacterial Cellular Contents**

a) Estimation of Cellular Contents of Photosynthetic Pigments (Bacteriochlorophylls and Carotenoids) in Anoxygenic Phototrophic Bacteria

1. **Evaluation of Antimicrobial Chemical Agents and bioassays**
2. Kirby – Bauer method
3. Determination of MIC
4. Determination of IC50
5. **Effects of Environment on Microorganisms**
6. Oligodynamic effect
7. Effect of PH, Temperature and Oxygen tension on Microbial growth.
8. **Growth of Microorganisms**
9. Bacterial growth curve
10. Biphasic growth curve
11. Determination of growth rate & doubling time
12. **Determination of microbiological quality of water**

a. Standard Plate Count

b. Standard Coliform Test

c. MPN Test

d. PA Test

e. Fecal Coliform test

f. Enumeration of Fecal Streptococci

g. Membrane Filtration Technique

h. 7 h FC Test

i. H2S Strip Test

**IX. Biosensors for environmental monitoring – BOD Biosensor.**

**EBTL -1.7 ENVIRONMENTAL POLLUTION MONITORING LAB**

**Water/wastewater pollution monitoring:**

1. pH and Conductivity
2. Turbidity
3. Colour and odour
4. Hardness by EDTA Method
5. Alkalinity
6. Estimation of Nitrate - Nitrogen by PDA method
7. Ammonical - Nitrogen
8. Nitrite - Nitrogen
9. Estimation of Phosphates
10. Sulfate by Spectrophotmetirc Method
11. Dissolved Oxygen
12. Biological Oxygen Demand
13. Chemical Oxygen Demand.
14. Fluorides by SPADNS Reagent.
15. Heavy metals by AAS.
16. Estimation of NOX.
17. Estimation of SOX.
18. Estimation of Particulate matter.
19. Total solids and Total dissolved solids

**II. SOIL ANALYSIS**

1. **Estimation of following parameters:**

**Physical Parameters**

1. Moisture content, c) Bulk density, e) Water holding capacity

b) Electrical conductivity, d) Specific gravity

**Chemical Parameters**

1. pH f) Calcium k) Chlorides
2. Nitrogen (Kjeldahl) g) Magnesium l) Sulphates
3. Nitrates h) Sodium m) Alkalinity
4. Total Phosphorous i) Potassium n) Heavy metal

e) Phosphates j) Organic matter

**EBT-2.1 PRINCIPLES OF BIOCHEMISTRY**

**UNIT – I: WATER, pH AND BUFFERS:**

Water- The solvent of life, Physical properties of Water; structure of water molecule, Interactions in aqueous solutions, Ionization of water; weak acids & bases; The pH scale; Buffers.

**UNIT** – **II:** **CARBOHYDRATES**

Introduction to thermodynamics; endergonic and exergonic reactions. Introduction, structure, classification and biological functions of Carbohydrates, metabolic pathways (anabolism, catabolism). Oxidation of carbohydrates [Glycolysis, EDP, aerobic (TCA cycle and ETC) and anaerobic respiration (Bacteria and Yeast Muscle cells), fermentation (Yeast-alcohol, homolactic fermentation, Cori cycle)]; Biosynthesis of carbohydrates (Gluconeogenesis, HMP shunt).

**UNIT - III: PROTEINS**

Amino acids: proteins (primary, secondary, tertiary and quaternary structures), Ramchandran plot; protein denaturation and folding. Catabolism of proteins (action of proteases and peptidases); Reactions involved in the metabolism of amino acids; amino acid oxidation- overview and urea cycle; Biosynthesis of amino acids- overview.

**UNIT - IV: LIPIDS**

Simple, derived lipids, compound lipids (phospholipids, glycolipids), fatty acids, oxidation of fatty acids (even chain [Knoops hypothesis] and odd chain fatty acids); Biosynthesis of lipids (long chain fatty acids, triacylglycerols).

**UNIT** - **V: ENZYMES AND ENZYME KINETICS:**

Introduction, structure and classification of enzymes, IUB nomenclature, EC numbers, enzyme specifictity, regulatory enzymes- allosteric enzymes, enzyme catalysis-acid-base catalysis, covalent catalysis, metal ion catalysis, Michaelis-Menten kinetics, kinetics for reversible reactions, Enzyme inhibition (Competitive, non-competitive, uncompetitive, irreversible), evaluation of kinetic parameters, microenvironmental effects on enzyme kinetics, enzyme deactivation.

**Text Books:**

1. Lehninger Principles of Biochemistry 2009 (5th edition). David L. Nelson & Michael M. Cox, W. H. Freeman publishers.

2. Harper’s Illustrated Biochemistry (28th edition). Murray, Granner, Mayes and Rodwell. Lang/McGraw Hill publishers.

3. Biochemistry 2005 (3rd Ed). Donald Voet, Judith G. Voet, Wiley publishers.

4. Biochemistry 2006 (3rd Ed). U. Chakrapani U. Satyanarayana. Books and

Allied (p) Ltd

5. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Horwood series in chemical science, Trevor Palmer, 5th Ed, Horwood, 2001

6. Biochemistry, 5th Ed, Jeremy M Berg, John L Tymoczko, and Lubert Stryer.

New York: W H Freeman; 2002.

**EBT-2.2 MICROBIAL BIOTECHNOLOGY**

**UNIT – I: MICROBIAL BIOFUELS:**

Scope and importance Renewable sources, energy from waste materials, production of non-conventional fuels – methane (biogas), hydrogen and ethanol. Use of microorganisms in petroleum augmentation and recovery; Bio-diesel from microbial sources. Microbial fuel cells.

**UNIT – II: 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; Probiotics and prebiotics; Microbial production of flavours and food colorants.

**UNIT – III: MICROBIAL TECHNOLOGY IN AGRICULTURE:**

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 – IV: INDUSTRIAL MICROBIOLOGY:**

Maintenance of Stock Cultures,Culture collection centres/microbial gene banks, inoculum build- up, industrial substrates, batch and continuous fermentation and solid substrate fermentation, immobilization technologies., Penicillin production, vinegar fermentation.VitB12 production;Amylase production.

 **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.

**EBT-2.3 RECOMBINANT DNA TECHNOLOGIES**

## UNIT – I: INTRODUCTION AND ENZYMES INVOLVED: Introduction to r – DNA technology and Genetic engineering, a brief history of development of r – DNA Technology. Steps involved - Isolation of DNA fragments/genes-Mechanical shearing, restriction endonucleases digestion, Enzymes involved-Restriction endonucleases, DNA – dependent DNA polymerase, RNA – dependent DNA polymerase (reverse transcriptase), DNA dependent RNA polymerase, alkaline phosphatase, terminal transferase, polynucleotide kinase, DNA ligase, S-1 nuclease.

**UNIT – II: VECTORS:** Definition, desirable characteristics in a vector; cloning and expression vectors, plasmid vectors for use in prokaryotes and eukarygotes; shuttle vectors (PBR and PUC series) bacteriophage vectors (T and Mix vectors) cosmid vectors, BAC and YAC vectors, M13 vector. Ti plasmids as vectors for plant cells. Use of linkers & adapters

**UNIT – III: GETTING DNA INTO CELLS:** Transformation – Transfection and *Agrobacterium* mediated gene transfer, electroporation, lipofection, microprojectile bombardment, micro injection, chemical mediated transformation; phage – mediated transfer, gene gun other latest methods, Cloning strategies-Cloning of genes: Construction of genomic and cDNA and libraries, Polymerase Chain reactions-method for amplification, ESTs, Differential display and subtractive approaches

**UNIT – IV: SELECTION, SCREENING AND ANALYSIS OF RECOMBINANTS:** Genetic selection and screening methods (use of chromogenic substrates, insertional inactivation, complementation of defined mutations and other methods, reporter genes), lethal synthesis, replica plating, delayed enrichment, limited enrichment, pencillin enrichment., screening using nucleic acid hybridization, polymerase chain reaction, DNA sequencing. DNA finger printing (RFLP, RAPD, Micro array. Promoter mapping, s1 nuclease mapping, Primer extension-chromosome walking, site directed mutagenesis. Application in human genes. Human genome sequencing & human microbiome sequencing.

**UNIT – V: TRANSGENICS, GENETICALLY MODIFIED MICROORGANISMS (GMOS) AND GENETICALLY ENGINEERED MICROORGANISMS GEMS):** Definition, Problems associated with foreign gene integration and expression, gene silencing; genes of interest; application of transgenic animals, plants and microbes; ethical issues, GMOs-application, ethical and legal issues, genetically modified microorganisms and their applications; risk groups; biosafety standards & measures; Expert committees (RDAC, GEAC, SBCC, DLC); environmental approval

**Textbooks:**

**1. Molecular biology of gene VI (2007)** **6 edition. James D. Watson,** Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Inglis CSHLP. Benjamin Cummings publishers.

1. Molecular cloning 2001 (3rd edition) – A lab manual. Joseph Sambrook, David Russell, CSHL press.
2. Instant notes in molecular biology 1998. Turner, P.C, McLennan A.G., Bates A.D., and White M.R.H., Viva books private limited. New Delhi.
3. Cell and Molecular Biology 2009 (6th edition). Karp, G.John Wiley and sons, Inc., New York

5. Cell and Molecular Biology (eigth edition). De Robertis, EDP and De Robertis, Jr.EMF BI Waverly Pvt., Ltd.

 6. DNA Cloning: A Practical Approach Volume 1: Core Techniques (The Practical Approach Series) (2nd edition)1995. D. M. Glover, B. D. Hames Oxford University Press, USA.

 **EBT-2.4 ENVIRONMENTAL POLLUTION AND TREATMENT TECHNOLOGIES**

**UNIT I WASTEWATER TREATMENT TECHNOLOGIES:**

Origin of Wastewater - Sources and classification of water pollutants, Methods of analysis. **Primary treatment**: Screening, Grit removal, Neutralization, equalization, Sedimentation, Flotation (oil & grease removal), **Secondary treatment**- Activated Sludge Process (ASP), Trickling Filters, RBC, FBR- IFBR (Aerobic & Anaerobic), Anaerobic digesters, up flow anaerobic sludge blanket reactor, SBR, aerobic ponds, facultative ponds, anaerobic ponds.

**UNIT II TERTIARY TREATMENT OF WASTEWATER**

**Tertiary treatment**- Coagulation, flocculation, adsorption, solvent extraction, ion exchange, ***Membrane separation Techniques***: Brief description of MF, UF, NF membranes. Reverse osmosis principle , Membrane materials , Types of membranes – Plate & frame , tubular, hollow fiber , 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 , Agitated Nutch filter driers. ***Nutrient removal***: Nitrification and denitrification process, phosphorous removal

**UNIT III SEWAGE TREATMENT AND DISPOSAL**:

Self purification of streams- BOD and its important- treatment methods- primary, secondary and tertiary levels- disinfections of treated sewage effluent- septic tank design- effluent disposal methods- disposal on land, sewage sickness- disposal by dilution- design of biological treatment units- sludge characteristics, unit operations in sludge disposal, conventional and high rate digesters- disposal of sludge- gas utilization.

## UNIT IV INDUSTRIAL WASTEWATER TREATMENT:

Sources, Characteristics, methodology and process for the treatment of industrial wastes of paper and pulp mill-sugar industry- beverage industry- tannery industry- textile mill waste industry- fertilizer plant- steel plant- oil refinery- pharmaceutical plant.

**UNIT V SOLID WASTE MANAGEMENT:**

Definition of solid wastes –– types of domestic solid wastes – collection – transportation – characteristics of solid waste–segregation – types of disposal methods – sanitary land fill – incineration – composting – Vermicompost – recovery of energy from solid wastes.

## Text Books:

1. Water Supply and Sanitary Engineering 1993. G.S.Bridie & J.S.Bridie, Dhanpat Rai & sons.

1. A treatise on Rural, Municipal, and industrial water management. KVSG Murali Krishna
2. Environmental sanitation (Social and Preventive medicine) 1998 (1st edition). Dr.P.V. Rama Raju & KVSG Murali Krishna.
3. Waste water treatment, Metcalf and Eddy.

# Reference Books:

1. Municipal and Rural Sanitation1987. Ehlers, V.M. & Steel,E.W.McGRAW‑HILLBook Company,IncV.edition.

2. Environmental Sanitation. Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc. Environmental Protection and Laws, Jadhav and Bhosale, V.M.Himalaya publishing House.

3. Environmental pollution and Toxicology 1994. Meera Asthana and Asthana D.K, Alka Printers.

# EBT-2.5 CHEMICAL AND BIOCHEMICAL ENGINEERING

**UNIT – I: FUNDAMENTALS OF CHEMICAL ENGINEERING:**

Brief overview, Concepts of unit operation & unit processes with examples, Units and Dimensions, Fluids Vs solids, Fluid Static’s-pressure measurement-different types of manometers with simple numeric problems, Steady flow-equation of continuity, Derivation of Bernoulli’s equation for one dimensional flow, its limitations and corrections and applications in flow meters.

**UNIT – II: FLUID MECHANICS:**

Introduction, Newton’s law of viscosity, flow curves for non-Newtonian fluids with examples from biotechnology, Flow patterns-laminar and turbulent, Reynold’s experiment- Reynold’s number, Pressure drop due to friction, relating Reynold’s number with friction factor, Packed beds and pressure drop through packed beds, Fluidization –Concept, significance in chemical industry and pressure drop across fluidized beds.

**UNIT – III: HEAT TRANSFER:**

Modes of heat transfer with examples, conduction, convection and radiation, definitions and governing laws, Convection and concept of heat transfer coefficient Thermal boundary layer and Prandtl number, Conductivity and resistivity, compound resistances in series, Heat transfer through cylindrical pipe, Analogy between momentum and heat transfer, Simple numerical problems on conduction, Convection**-**Natural and forced convection, dimensionless numbers in heat transfer, Concept of heat transfer coefficient and overall heat transfer coefficient, Radiation, combined heat transfer by conduction, convection and radiation, Heat exchangers-overview, evaporation, types of evaporators.

**UNIT – IV: DIFFUSION AND MASS TRANSFER:**

Definition, Fick’s law of diffusion, Analogy with momentum and heat transfer, Diffusivities of gases and liquids; Fundamentals of mass transfer; theories of mass transfer, Concept of mass transfer coefficients, Dimensionless numbers, Overview of separation operations with examples, Mass transfer equipment-distillation, liquid extraction, gas absorption, drying.

### UNIT – V: BIOREACTORS, BIOPROCESS CONTROL AND MONITORING:

###  Basic principles of bioprocess, advantages of bioprocess over chemical process, media formulation, sterilization of air, fibroid filters, batch and continuous sterilization systems; Types of bioreactors (CSTR,Fed batch,PFTR,dynamic reactor; Bioreactor design, Monitoring variables such as temperature, pressure, pH, on line measurement. Down stream processing and separation of cells, Disintegration of microorganisms, various methods of filtrations, reverse osmosis, chromatographic methods in purification; Online and Offline monitoring.

### Textbooks:

Unit Operations of Chemical Engineering 2001 (6th Edn.). W.L.McCabe, J.C.Smith and P.Harriot McGraw – Hill publishers.

Diffusion**-** Mass Transfer In Fluid Systems 2009 (3rdEd). E.L.Cussler, Cambridge University Press.

Mass –Transfer Operations (3rd edition). Robert E.Treybal Mc-Graw Hill publishers.

4 Transport Phenomena 2006 (revised 2nd edition). R. Byron Bird, Warren E. Stewart, Edwin N.

 Lightfoot. Wiley publisher.

**EBTL-2.6 WATER AND WASTEWATER TREATMENT METHODS LAB**

**Unit operations for water treatment**

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

# EBTL-2.7: BIOCHEMISTRY LAB

1. Qualitative analysis of Carbohydrates

2. Quantitative analysis of carbohydrates by Arseno-Molybdate method, Anthrone method.

3. Estimation of cellular carbohydrates by anthrone method

4. Quantitative estimation of Proteins by Lowry method

5. Quantitative estimation of Proteins by Biurette method

6. Qualitative analysis of amino acids

7. Quantitative estimation of Amino acids by Ninhydrin method Amino acids

8. Quantitative estimation of Ammonia by phenol hypochlorite method

9. Estimation of DNA by diphenylamine method

 10. Estimation of RNA by orcinol method

 11. Separation of amino acids by TLC and Paper Chromatography

 12. Column chromatography for separation of bacterial pigments.

 13. Agarose gel electrophoresis

 14. SDS-PAGE.

 15. Dialysis for purification of proteins

 16. Determination of nitrogenate activity by acetylene reduction assay.

 17. Immobilization

 18. Microbial fuel cells.

 19. Osazone test

**EBT-3.1** **BIOSTATISTICS AND BIOINFORMATICS**

**UNIT – I: MEASURES OF VARIABILITY & TESTING OF HYPOTHESIS:** Variability of range, Mean deviation, Variance, coefficient of variation, Standard deviation and standard error. Student t- test, level of significance of large sample tests for single mean and differences of mean. Single proposition and difference proposition- Chi square test for goodness of fit and chi square test of means. Applications of chi square test.

**UNIT – II: ANALYSIS OF VARIANCE (ANOVA) & CORRELATION AND REGRESSION:** Simple experimental design and the analysis of variance, completely randomized designs. Analysis of variance (ANOVA) - One way ANOVA and Two way ANOVA. Correlation, scatter plot, concept of coefficient correlation (r), properties (without proof), Interpretation of (r). Regression- linear regression, fitting of lines of regression, regression coefficient. Experimental designing and planning of an experiment.

**UNIT –III: BIOINFORMATICS & DATABASES:** Definitions of Bioinformatics and Computational Biology. Introduction to databases: Nucleic acid (NCBI, DDBJ & EBI) & Protein Databases (PIR SWISSPROT/tremble & UNIPROT), Specific databases (EcoCyc, BRENDA & KEGG etc.), Literature Databases: MEDLINE (Pubmed), OMIM. Retriving Information from databases: Entrez and SRS, File formats and the need of file formats.

**UNIT – IV: SEQUENCE ALIGNMENTS AND SCORING MATRICES:** Introduction to identity, similarity, Homology, Sequence Alignment methods: Alignment programs, Pairwise sequence alignment, Heuristic alignment concept and tools (BLAST- all flavors), Global Vs Local alignment, Dot plots, Multiple sequence Alignment- algorithms, Phylogenetic studies: Methods & Tools, Dendrograms, Phylograms and Cladograms; PAM and BLOSUM matrices. Tree of life and the Human origins.

**UNIT – V: GENOMICS & PROTEOMICS:** Sequence feature of genes and genome: Promoters, Transcription binding sites; Gene prediction and tools for gene finding and prediction; Whole genome sequencing and human genome project and related browsers: VISTA, UCSC, Ensembl and NCBI Map viewer; Methods for Protein Structure Predictions: Ab initio, threading and comparative modeling; Brief introduction to Protein docking and Drug designing; Protein Visualization tools (Rasmol & SPDBV).

**Recommended Books:**

1) Statistical methods 2001 (30th edition) S.P. Gupta. S. Chand Publications

2) Business Statistics 2008 (15th edition). S.P Gupta & M.P Gupta Sage publications, New Delhi.

3) Programming in ANSI C 2008 (4th edition). E. Balaguruswami Tata Mgraw Hill publisher.

4) Fundamentals of Biostatistics 2004 (1st edition). Khan and Khanun. Ukaaz

Publications/bsp Books Pvt. Ltd.

5) Bioinformatics: A Practical guide to the analysis of genes and proteins 2001. Andreas

D. Baxevanis, B. F. Francis Ouellette, John Wiley and Sons.

6) Bioinformatics: Sequence and Genome Analysis 2004 (2nd edition).David W. Mount

 Cold Spring Harbor Laboratory Press.

7) Beginning Perl for Bioinformatics 2001. James Tisdall, O'Reilly Media, Inc.

8) Fundamental Concepts of Bioinformatics 2002 (1st edition). Dan e. Krane and Michael L. Raymer, Benjamin Cummings.

9) Introduction to Bioinformatics 2002. Arthur M. Lesk, Oxford University Press, USA.

10) Bioinformatics Computing 2002 (1st edition). Bryan Bergeron, Prentice Hall.

**EBT-3.2 ENVIRONMENTAL MODELLING**

**UNIT – I: WATERSHED MANAGEMENT AND MODELLING:**

Philosophy and concept of watershed, technology vectors and social dynamics, role of remote sensing and GIS, GIS data base for watershed management, research approach, model watershed, soil mapping, hydro-geo-morphological mapping, groundwater prospects map, drainage mapping. Groundwater modelling concepts.

**UNIT – II: WATER QUALITY MAPPING:**

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.

**UNIT – III: NATURAL DISASTER 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, hazard mapping of landslide, case study: Kohima area.

**UNIT – IV: SALT WATER INTRUSION AND OCEANSAT MONITORING:**

Introduction, saline water intrusion (SWI), applications of Geo-informatics, case study: Pennar basin, GIS database, spatial database, attribute data base creation, generation spatial distribution maps of water quality, SWI model development. AVHRR land data sets for environmental monitoring and modeling, ocean color monitoring by OCEANSAT.

**UNIT – V: MODELLING SOFTWARE:**

AERMOD software, ISCST models, Groundwater modeling software MODFLOW MT3D, SEAWAT models.

**Text books**:

1. Environmental modelling 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 modelling software (Internet).

**EBT-3.3 BIODEGRADATION AND BIOREMEDIATION**

**UNIT – I: BIODEGRADATION:**

What is biodegradation? Acclimation, detoxification activation, bio-availability, effect of chemical structure on biodegradation, recalcitrance, predicting products of biodegradation, cometabolism and biotransformation. Factors affecting biodegradation., 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 – II: BIOREMEDIATION:**

Introduction, 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 – III: 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. Constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, restoration of coal mines a case study.

**UNIT – IV: BIOTECHNOLOGY FOR INDUSTRIAL POLLUTION CONTROL:**

Biotechnological application for pollution reduction in Paper and pulp industry, tannery industry. Agriculture, carbon sequestration from industrial stack emissions & automobile exhaust.

**UNIT – V: BIOTECHNOLGOY FOR HAZARDOUS WASTE MANAGEMENT & RESTORATION OF DEGRADED LANDS:**

Hazardous wastes, biotechnology for hazardous waste management, cyanide detoxification, detoxification of oxalate, urea. Reforestation through micropropagation casurina for tropical reforestation on adverse sites, development of stress tolerant plants; use of mycorrhizae in reforestation, reforestation of soils contaminated with heavy metals.

**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.

1. Biodegradation and Bioremediation 1999 (2nd editon). Martin Alexander, Elsevier Science & Technology.
2. Environmental Microbiology 2001. Raina M. Maier, Ian L. Pepper, Academic Press.
3. Bioremediation engineering.. J.T.Cookson, Mc.Grwhill Inc.

**EST-3.4 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)**

**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, collateral 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 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 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. EIA by Canter
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, Hameswar Dayal Konark Publishers, Pvt., Ltd. Environmental Impact Assessment, Canter, L.W., 1977, McGraw Hills, NewYork

### EST-3.5 OCCUPATIONAL HEALTH AND SAFETY

**UNIT – I: INTRODUCTION TO SAFETY & HEALTH MANAGEMENT**:

Sequence of accident occurrence and theories. 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: BEST WORK PRACTICES IN INDUSTRIES**:

Hazards in Chemical Operations, Material Handling Hazards, Lifting Machinery & Pressure Vessels, Material Safety Data Sheets, Classification of Chemicals, chemical storage practices, Radiation Safety, Petroleum Storage Requirements, Pesticide Safety. Best industrial practices in Electrical, Mechanical, Fire and Machine Guarding, Personal Protective Equipment, Noise Abatement Methods.

**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**:

Definitions of Hazards, Risks, Evolution of Methodical Analysis, System safety Analysis techniques, Performance measurement, Operational Reviews - Internal & External.

**UNIT – V: OCCUPATIONAL SAFETY MANAGEMENT STANDARDS & ACTS:**

OHSAS 18001 Standards and its Elements, CE Certificate, Social Accountability Standards, System implementation & benefits. Factory’s Act & Rules – Central and state, Construction Safety Regulations, Petroleum Rules 2002, Electrical Act & Rules.

**Text Books:**

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

**EBTL-3.6 BIODEGRADATION AND BIOREMEDIATION LAB**

Biodegradation

1. Qualitative Analysis of biodegradation of

1. Starch
2. Cellulose
3. Gelatin
4. Nitrobenzene
5. Aniline
6. Lipid
7. Casein
8. Pectin
9. Naphthalene
10. Biodegradation of Carbohydrates (Starch)
11. Quantitative Estimation of starch by Iodine Method
12. Biodegradation of starch in activated sludge
13. Biodegradation of protein (Gelatin)
14. Biodegradation of Gelatin in Activated sludge

4. Determination of inherent biodegradability of chemicals

5. Soil microcosm studies for biodegration of thiophene-2-carboxylate

1. Land farming technology for hydrocarbon degradation
2. Photobiological production of hydrogen from industrial effluents.
3. Biocolorant production from agricultural waste
4. Constructed wetlands for sewage treatment
5. Root zone treatment for removal of heavy metals

**EBTL-3.7 BIOSTATISTICS, BIOINFORMATICS AND ENVIRONMENTAL MODELLING LAB**

**Biostatistics**

1. Determination of Central tendencies. a) Mean b) Median c) Mode

2. Determination of Geometric mean & harmonic mean.

3. Determination of measures of dispersion a) Mean deviation b) Standard deviation and coefficient of variation

4. Test of Significance- Application of following. a) Chi-Square test b) t-test c) standard error

5. Analysis of Variance (ANOVA) a) One way b) Two way

6) Correlation and Regression

**BIOINFORMATICS:**

1. Introduction to Computer programming-Introduction and types of languages for bioinformatics

2. Databases study- Uses of Environmental biotechnology Data bases and Diversity databases

3. File formats. FASTA.

4. Alignments-Pair wise alignment, Local and global alignments, Multiple sequence alignment.

5. Primer designing-(using Primer 3)

6. Phylogenitic Analysis- PHYML, PHYLIP, MEGA

**ENVIRONMENTAL MODELLING:**

Ground water Modelling Software Features

Visual MOD FLOW

MT3D model (Mass Transportation 3 Dimensions)

SEAWAT model

AERMOD/ISCST3 Air quality models.

Demonstrative case studies.

**M. Sc - GEOSPATIAL SCIENCE & TECHNOLOGY**

**COURSE STRUCTURE**

**I YEAR**

**I-SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT **CODE** | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| **GST 1.1** | Introduction To Geospatial Science & Technology | 4 | 0 | 4 |
| **GST 1.2** | Computer Programming | 4 | 0 | 4 |
| **GST 1.3** | Surveying Technology | 4 | 0 | 4 |
| **GST 1.4** |  Elements of Photogrammetry | 4 | 0 | 4 |
| **GST 1.5** | Remote Sensing | 4 | 0 | 4 |
| **GSTL 1.6** | Surveying & Thematic Mapping Lab | - | 8 | 8 |
| **GSTL 1.7** | Computer Laboratory – C , C++ | - | 8 | 8 |
|  | Total Credits (5 Theory + 2 Lab) |  |  | **36** |

**II -SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT **CODE** | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| **GST 2.1** | Microwave and Hyper spectral remote sensing | 4 | 0 | 4 |
| **GST 2.2** | Experimental Statistics | 4 | 0 | 4 |
| **GST 2.3** | Geodesy and GPS | 4 | 0 | 4 |
| **GST 2.4** | Digital Image Processing | 4 | 0 | 4 |
| **GST 2.5** | Geographical Information Systems | 4 | 0 | 4 |
| **GSTL 2.6** | Digital Image Processing Lab | - |  8 | 8 |
| **GSTL 2.7** | Field Spectroscopy Lab | - | 8 | 8 |
|  | Total Credits (5 Theory + 2 Lab) |  |  | **36** |

**II YEAR**

**III -SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT **CODE** | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| **GST 3.1** | Digital Photogrammetry | 4 | 0 | 4 |
| **GST 3.2** | Spatial Data Analysis & Modeling. | 4 | 0 | 4 |
| **GST 3.3** | Data Base Management Systems (DBMS) | 4 | 0 | 4 |
| **EST 3.4** | Environmental Impact Assessment | 4 | 0 | 4 |
| **GST 3.5** | GST For Natural Resources Management | 4 | 0 | 4 |
| **GSTL 3.6** | Digital Photogrammetry Lab | - | 8 | 8 |
| **GSTL 3.7** | GIS & GPS Lab | - | 8 | 8 |
|  | Total Credits (5 Theory + 2 Lab) |  |  | **36** |

**IV SEMESTER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUBJECT **CODE.** | **SUBJECT TITLE** | **L** | **P** | **CREDITS** |
| **GSTP 4.1** | Project Work | **-** | **-** | 36 |
|  | Total Credits |  |  | **36** |

**L- No. of Lectures per week; P- No. of Practical’s per week.**

**GST-1.1 INTRODUCTION TO GEOSPATIAL SCIENCE & TECHNOLOGY**

**UNIT I:**  **INTRODUCTION:**

Geospatial data, spatial data infrastructure, three important geospatial technologies, Spatial elements. Methods of spatial data generation.

**UNIT II: COORDINATE SYSTEMS AND DATUMS:**

Coordinates and coordinate systems, Datum’s and geodetic systems, Coordinate transformations. Geodetic datum’s, Geodetic reference system, choosing spatial frame work.

**UNIT III: GLOBAL POSITIONING SYSTEM:**

Introducing the Global Positioning System, Fundamentals of GPS signals and data, GPS mathematical models, GPS projects: some planning issues.

**UNIT IV: REMOTE SENSING & GIS:**

Definition and Scope, Remote Sensing, Principles, Remote Sensing data acquisition, Remote Sensing data analysis methods, Advantages and Limitations, Geographic Information Systems (GIS) and science, Fundamentals of Geographic Information Systems, Geographic data structures, Hardware and Software required.

**UNIT V: GIS & GST APPLICATIONS:**

Spatial data and modeling, Case studies relating Land and Water resources.GST for Environmental, Social, Local Government and Commercial applications.

**TEXT BOOKS:**

1. Textbook of Remote Sensing and Geographical Information Systems M. Anji Reddy, BS Publication. 3rd edition, 2008.
2. Manual of Geospatial Science & Technology edited by John D. Bossler (Taylor & Francis ), 1st edition, 2001.
3. Fundamentals of GIS by MICHAEL N DEMERS. Published By john Wiley & Sons Inc, 3rd edition, 2005.
4. Environmental Modeling with GIS, Michael F. Goodchild, Bradley O. Parks, Louis T. Stewart Scientific publication Co., 1993.
5. Geographic Information Systems: A
Management Perspective by Stan Arnoff, WDL publications, 1989.

**GST-1.2 COMPUTER PROGRAMMING**

**UNIT I:**

Basic Structures of C language, C tokens, Data types, declaration of variables, assigning values, arithmetic, relational and logical operator, increment and decrement operators, control operator, bit-wise operator, expressions, evaluation, input-output operators. IF and SWITCH statement, WHILE, DO-WHILE and FOR statements, C: Programs covering all the above aspects.

**UNIT II:**

 One dimensional and Two dimensional arrays, initialization, string variables, declaration, reading, writing, string handle functions, functions: Function declaration and definition- argument passing- call by value-call by reference-user-defined functions, variables & storage classes, example C Programs.

**UNIT III:**

Structure definition, initializing , assigning values, passing of structures as arguments, unions, declaring & initializing of pointers, pointer based expressions, arrays, strings.

Functions and structures, C program examples, file management in C, opening & closing, I/O operations.

**UNIT IV:**

An overview of Java, data types, variables and arrays, operators, control statements, Introducing classes, methods and classes, inheritance, packages and interfaces, exception handling.

**UNIT V:**

Multithreaded programming, I/O, string handling, inputs/outputs, Applet programming, AWT, graphics programming in Java.

**TEXT BOOKS:**

1. Programming in ANCI C - E. Balaguru Swamy, 5th edition, Tata Mc.Graw-Hill,2010.
2. Fundamentals of Computers - V.Rajaraman , 5th edition, Prentice-Hall.

**GST-1.3 SURVEYING TECHNOLOGY**

**UNIT I:**

Introduction, datum and Reference System, horizontal data and Vertical data, Survey operations, Field work, Office work.

Classification of Surveys:Geodetic surveys, Plain surveys and Shape of earth, Classification of plain surveys, Topographical surveys, Photogrammetric surveys, Engineering surveys, Hydrographic surveys, Mine surveys, Cadastral surveys.

**UNIT II:**

Principles and Methods of Surveys: working from whole to part, Economy of Accuracy, Consistency of accuracy, Independent checks, Direct methods of locating point C with respect to given points A and B.

Stages in Surveying, Control Survey, Planimetry and Height control by triangulation and Traverse, Height control by Spirit leveling.

**UNIT III:** Detail survey by Plane Tabling methods, Contour survey and Depiction of heights.

Detail survey by conventional methods: Methodology, Survey and depiction of details by plane tabling methods, contour survey, depiction of heights, Completion of Sections,

**UNIT IV:**

Surveying by other methods, Revision Survey, Blue print survey, Verification survey, Colour print survey

Office work: Pre field office work and post field office work, Map Design, Symbology, Colour combination, Visual balancing and final printing of maps.

**UNIT V:**

Modern trends in surveying and mapping: Global Positioning System (GPS) for ground control and extension, Total Station System for detail surveying. Digital Photogrammetry, Remote Sensing, Digital Cartography, Geographical Information System.

**TEXT BOOKS:**

1. Geoinformatics for Environmental Management by M. Anji Reddy, BS Publications,2nd edition, 2005.
2. Surveying and Mapping Volume I and II by David Clarke by Mc. Graw Hill
3. Elementary Surveying: An introduction to Geomatics, 12th edition(Amazon) by Charles D.Ghilani and Paul R. Wolf, prentice Hall publications 2008.

**GST-1.4** **ELEMENTS OF PHOTOGRAMMETRY**

**UNIT I:**  **INTRODUCTION AND AERIAL CAMERAS:**

Definition of photogrammetry, History of photogrammetry, Types of photographs, Organisation of Aerial photography, Geometry of vertical photograph, Scale of vertical aerial photograph, Displacement of image position due to height, Displacement of image position due to tilt.

Introduction, Types of aerial cameras, Classification single lens frame camera, Components of frame aerial camera, Fudicial marks, Principle point, Camera mounts, Camera controls, Automatic data recording, Camera calibration, Elements of interior orientation.

**UNIT II: STEREO PHOTOGRAMMETRY AND STEREOSCOPIC PARALLAX:**

Depth perception, Monoscopic depth perception, stereoscopic depth perception, Experiment for stereoscopic viewing, Stereoscopic viewing of overlapping aerial photographs, Stereoscope, pocket stereoscope, Mirror stereoscope, Procedure for use of stereoscopes, Steps for viewing stereo pair of aerial photographs, Y parallax, Vertical exaggeration in stereo viewing.

Definition of parallax, stereoscopic parallax, Methods of parallax measurement (monoscopic), Principle of floating mark, Stereoscopic methods of parallax measurement, parallax equations, Elevation by parallax differences, Approximate equation for elevation, Measurement of parallax differences, Parallax corrections, Parallax correction graph, Computation of flight height and air base, Error evaluation.

**UNIT III: FLIGHT PLANNING:**

Need for flight planning, Items for flight planning, Purpose of photography, Photo scale,Flying height, End lap and side lap, Base-height ( B-H ) ratio, Neat model, Flight map, Flight planning template.

**UNIT VI: CONTROL FOR AERIAL PHOTOGRAPHY AND ORIENTATION PROCEDURES**

 **FOR STEREOPLOTTING INSTRUMENTS:**

Definition, Classification (Horizontal,Vertical), Nature and characteristics of control points, Location and numbering, Bridging of strip, Bridging of blocks, Ground control provision, Post-pointing and pre-pointing.

Introduction, Basic concept, Interior orientation, Relative orientation, Absolute orientation.

**UNIT V: AERIAL TRIANGULATION:**

Introduction, Purpose of aerial triangulation, Principle of Aerial Triangulation, Classification of Aerial triangulation based on methods, Preparation for aerial triangulation, Independent Model Triangulation (IMT), Aerial Triangulation (Analytical method), Blocks of photos, Bundles adjustment.

**TEXT BOOKS:**

1. Geoinformatics for Environmental Management by M. Anji Reddy, BS Publications, 2nd edition,2005.
2. Paul, R. Wolf Elements of Phogrammetry, McGrew-Hill, International Book Company, Japan, 1993,2nd edition.
3. Remote sensing and image interpretation by Lillesand and Kiefer, John wiley and sons,6th edition,2007.
4. Elements of Photogrammetry by K.K.Rampal, Oxford and IBH publications 1982.

**GST-1.5 REMOTE SENSING**

**UNIT I: INTRODUCTION AND PHYSICS OF REMOTE SENSING:**

Definition, History of Remote Sensing. Basic components of Remote sensing, Electromagnetic Remote sensing process, Passive and active remote sensing.

Electromagnetic Spectrum, Energy source and its characteristics, Nature of EMR, laws governing energy interactions, Blackbody radiation principles, radiation quantities and terminology

**UNIT II: EMR ENERGY INTERACTION WITH GROUND AND ATMOSPHERE:**

 EMR Interaction With Earth Surface Materials -Spectral signature concepts – Spectral reflectance & emittance – Typical spectral reflective characteristics of water – vegetation, soil, minerals/rock, man-made structures

Atmospheric properties, solar radiant energy characteristics with atmosphere Atmospheric Scattering, Particulate scattering & absorption, Rayleigh’s & Mie’s theories. Sunlight & skylight & its spectral composition, Atmospheric Windows.

**UNIT III: SATELLITE SYSTEM PARAMETERS AND SATELLITES AND SENSORS:**

Keplers laws of orbital satellite motion, Instrumental Parameters, Viewing Parameters, Sensor Parameters, Imaging Sensor Systems

IRS, LANDSAT, SPOT, IKONOS, QUICKBIRD, RESURS, ADEOS, JERS, SPIN, ORBVIEW, OCEANSAT, NOAA, GOES, SEASAT, ASTER, CERES, MISR, MODIS, MOPITT, etc.,

**UNIT IV: THERMAL REMOTE SENSING:**

Thermal radiation Principles, Interpreting Thermal scanner imagery, Geometric Characteristics of Across track scanner imagery, Radiometric calibration of Thermal scanners, Temperature Mapping

**UNIT V: OVERVIEW ON IMAGE ANALYSIS AND PROCESSING:**

Image Interpretation strategy, Interpretation of Aerial photos, and Basic elements of Image interpretation, Interpretation of Satellite Imagery, Key elements in Visual Image Interpretation.

Introduction, Basic character of digital image, Preprocessing, Image registration, Image Enhancements, Spatial filtering, Image transformations, Image classifications.

**TEXT BOOKS:**

1. Textbook of Remote Sensing and Geographical Information Systems M.Anji Reddy, BS Publication, 3rd edition, 2008.
2. Remote Sensing by JAMES B. CAMPBELL Published by Taylor & Francis Ltd, 4th edition, 2007.
3. Remote sensing and Image interpretation by Thomas Lilliesand and Ralphw. Keifer Published by John Wiley &Sons, 6th edition, 2007.
4. Remote sensing-Principles and interpretation by Floyd F Sabins.Jr. Published by Freeman & Co., New York, 3rd edition, 2007.

**GSTL-1.6 SURVEYING & THEMATIC MAPPING LAB**

**Surveying**

Demonstration of conventional Instruments for field work, Total Station Survey in field, Downloading, Processing and generation of survey plots.

**Thematic Mapping**

Map reading and Interpretation, Understanding the map components. Determination of map scale, Extraction of various layered information from toposheets (Settlements, Water bodies, boundaries, Contours. etc)

**Preparation of themes**: Base Map, Slope, Watershed, Land Use / Land Cover, Geomorphology.

**GSTL-1.7** **COMPUTER LABORATORY – C, Java.**

Computer programmes with reference to various GST applications. Each student should develop and execute a minimum of 10 Program me’s each in **C** and **Java** including Graphics respectively and submit in the form a record.

**GST-2.1 MICROWAVE AND HYPER SPECTRAL REMOTE SENSING**

**UNIT I:**  **INTRODUCTION TO MICROWAVE REMOTE SENSING**:

 Definition, Radiometric Quantities, Radar System Components, Source of Radiation, Radar Wave Bands, RADAR Equation, Factors Affecting Microwave Measurement, Beam Polarization And Look Angle.

**UNIT II:** **SLAR**, **CHARACTERISTICS AND INTERPRETATION OF SLAR IMAGERY**:

Definition, Radar working principle, range resolution, azimuth resolution, swath width resolution and SAR systems.

Slant range scale distortion, ground range geometry, image displacement due to relief, layover, fore shorting, shadow and speckle.

Geometric characteristics, Electrical characteristics, Effects of polarization, Soil response, Vegetation response, urban area response.

**UNIT III:** **MICROWAVE SENSORS AND SATELLITES**:

passive microwave radiometers SEASAT, SIR, ALMAZ, ERS, ENVISAT, JERS, ALOS, RADARSAT and Applications of microwave remote sensing.

**UNIT IV:** **HYPER SPECTRAL REMOTE SENSING**:

Hyper spectral imaging, imaging spectrometers, principles of spectroscopy, hyper spectral vs multi spectral imaging. spectral reflectance’s, spectral libraries, absorption process, analysis of spectral curve.

**UNIT V: SATELLITES AND APPLICATIONS**:

Hyper spectral satellite systems viz., AVIRIS, HYMAP, HYPERION and Applications of Hyper Spectral Remote Sensing in the field of Environmental management.

**TEXT BOOKS:**

1. Textbook of Remote Sensing and Geographical Information Systems M.Anji Reddy,

 BS Publication, 3rd edition, 2008.

2. Remote sensing and Image interpretation by Thomas Lilliesand and Ralphw. Keifer

 Published by John Wiley &Sons.6th edition, 2007.

3. Remote sensing-Principles and interpretation by Floyd F Sabins.Jr. Published by

 Freeman & Co., New York, 3rd edition, 2003.

**GST-2.2 EXPERIMENTAL STATISTICS**

**UNIT I: INTRODUCTION AND FREQUENCY DISTRIBUTION:**

Types of proof, Generality of Applications of statistics, Examples of statistical problems

Raw data, Arrays, Frequency Distributions, Class interval and Class limits ,Class boundaries, Size ,width of a class interval ,class mark, general rules for forming frequency distributions,

Histograms and frequency polygons, relative frequency distributions, cumulative frequency distributions and 0gives, Relative cumulative-frequency distribution and percentage 0gives, frequency curves and smoothed 0gives,types of frequency curves

**UNIT II: MEASUREMENTS AND THEIR ANALYSIS:**

Introduction, Sample Versus Population, Range and Median, Graphical Representation of Data, Numerical Methods of Describing Data, Measures of Central Tendency, Standard deviation and other measures of Dispersion.

**UNIT III: RANDOM ERROR THEORY AND CONFIDENCE INTERVAL:**

Introduction, Theory of Probability, Properties of the Normal Distribution Function, Probability of the Standard Error, Uses of Percent Errors, Moments, Skewness and Kurtosis

Introduction, Distributions used in Sampling Theory, Confidence Interval for the Mean, Sampling, its uses, some sampling distributions, Analysis of Variance

**UNIT IV: CORRELATION AND REGRESSION:**

Curve fitting and the method of Least squares, Correlation theory, Multiple and partial correlations, Linear regression, Multiple regression, R2, regression modeling.

**UNIT V: STATISTICAL TESTING AND STATISTICAL ANALYSIS :**

Tests of significance, Chi-square and F-test, Non parametric tests, t-tests.

Analysis of Time series, Statistical Process control and Process capability

**TEXT BOOKS:**

* 1. Theory and Problems of STATISTICS by Murray R. Spiegel and Larry J. Stephens, 7th edition,

Mc. Graw Hill, 2007.

* 1. Basics Statistics by B.L.Agarwal, 4 th edition, New age International Publications, 2006.
	2. Introduction to statistical Analysis by Wilfred J. Dixon and Frank J. Massey JR, 2nd edition, Mc.Graw Hill, 1957

**GST-2.3 GEODESY AND GPS**

**UNIT I: INTRODUCTION:**

Definition of Geodesy, Classification of Geodesy, Geometric Geodesy, - Physical Geodesy, Physical surface of earth, The Geoid, The Ellipsoid.

**UNIT II: ELLIPSOID OF REVOLUTION AND COMPUTATION OF THE ELLIPSOID:**

Mathematical properties, The Ellipse, Basic properties of ellipse, Flattening, Eccentricity, Relationship between eccentricity and flattening, Principal parameters of ellipsoid, Parameters of commonly used ellipsoid, Use of ellipsoid as regional datum.Co ordinate system of rotational ellipsoid-Ellipsoid geographic co-ordinates, Spatial ellipsoidal coordinate system.

Need for mathematical surface, Reduction of baseline to mathematical surface, Reduction of baseline to reference ellipsoid, Effect or height of a point observed on the azimuth of a line, Convergence of meridians, Forward and backward Azimuths, Plane curves and geodesic line, Calculation of coordinates.

**UNIT III: GRAVITY, SATELLITE GEODESY AND MAP PROJECTION:**

Expressions for gravity and potential, Geoid undulations and deflections of vertical, Measurement of gravity on earth, Reduction of gravity values.

Introduction, Artificial satellite, Satellite orbit, Celestial coordinate system, Geodetic position from known orbit, Coordinate transformation in equatorial plane, Range observation from three satellite positions.

Geometry of map projections, Evolution of map projection, Development of projection surfaces, Characteristics of map projections, Equidistant projections with one standard parallel, Equidistant projections with two standard parallel, Equal area projections with straight meridians, Projections with all parallels standard, Conformal projections with straight meridians.

**UNIT IV: GLOBAL POSITIONING SYSTEM (GPS):**

Introduction, Background, The space segment, The control segment, The user segment, The performance of GPS, Factors influencing GPS accuracy, GPS positioning. GPS signal characteristics, signal structure, signal coverage, signal propagation, Differencing of GPS data, single differenced data.

**UNIT V: GPS MATHEMATICAL MODEL AND GPS APPLICATION:**

GPS mathematical model, Pseudo range mathematical model, Preparation for data processing, Baseline data computation coordinate change and satellite positions GPS receivers, Fundamentals of GPS application for various results. Making sense of GPS Techniques, GPS project planning, Possible applications like high resolution contour data.

**TEXT BOOKS:**

1. Manual of Geospatial Science & Technology edited by John D. Bossler ( Taylor & Francis ), 2nd edition, 2010.
2. Essentials of GPS by NK Agarwal, Spatial Network Pvt Ltd,Hyderabad, 2nd edition, 2006.

**GST-2.4 DIGITAL IMAGE PROCESSING**

**UNIT I: DIGITAL COMPUTERS AND IMAGE PROCESSING:**

Introduction: Information Systems – Encoding and decoding, modulation, Satellite data – acquisition, storage and retrieval – generation of data products digital data formats. Computer basics: Hardware and Software, Networks, Image Display Subsystem, Color Display System, Hard copy System , Data Format for Digital Satellite Imagery, Image file Format and Data Compression .

**UNIT II: PRE-PROCESSING OF REMOTE SENSING DATA AND IMAGE ENHANCEMENT**

 **TECHNIQUES:**

Cosmetic Operations- Missing Scan Lines, De –stripping Methods, Geometric Corrections and Registration. Coordinate Transformations, Atmospheric Correction Methods, Illuminations and View Angle Effects, Sensor Calibration and Terrain Effects and radiometric correction methods.

Introduction to image enhancement, Human Visual Systems, Contrast Enhancement- Linear Contrast Stretch, Histogram Equalization, Guassian Stretch, Pseudo Color Enhancement- Density Slicing, Pseudo Color Transform.

**UNIT III: IMAGE TRANSFORMS AND IMAGE FILTERING TECHNIQUES:**

Introduction, Arithmetic Operations- Image Addition, Subtraction, Multiplication and Division. Empirically Based Image Transforms- Perpendicular Vegetation Index, Tasselled Cap Transformations, NDVI. PRINCIPAL COMPONENT ANALYSIS: Standard PCA, Noise Adjusted PCA, Decorrelation Stretch, Hue -Saturation and Intensity Transform, Fourier Transform

Introduction to image filtering, Low Pass Filters- Moving Average Filters, Median Filters, Adaptive Filters, High Pass Filters- Image Subtraction Method, Derivative Based Method, Frequency Domain Filters, Filtering for Edge Enhancement

**UNIT IV: IMAGE CLASSIFICATION AND ACCURACY ASSESSMENT:**

Introduction**,** Geometrical Basis of Classification, Unsupervised classification, Supervised Classification Training Samples, Statistical Parameters and Classifiers, Other Approaches to Image Classification, Feature Selection, Contextual Information

Image classification accuracy assessment, Performance analysis, Various Band Data for Land use, Land Cover Classification System with Case Studies.

**UNIT V: IMAGE CLASSIFICATION AND GIS INTEGRATION:**

Image Classification and GIS, Integration and Linkage. Software: ERDAS, EASI /PACE, Geomatica and ENVI.

**TEXT BOOKS:**

1. M. Anji Reddy - Digital Image Processing, B.S. Publications, Hyderabad
2. John, R. Jensen, Introductory Digital Image Processing – Prentice Hall, New Jersey, 1986, 3rd ed.
3. Robert, A. Schowengergt. Techniques for image processing and classification in Remote Sensing, 1983.
4. Hord, R.M. Digital Image Processing, Academic Press Pub. 1982.
5. Paul. M. Mather- Computer Processing of RS Images, 4th edition, 2004,Wiley Black well Publications.

**GST-2.5 GEOGRAPHICAL INFORMATION SYSTEMS**

# UNIT I: INTRODUCTON TO FUNDAMENTALS OF GIS:

Introduction, Definitions of GIS and related terminology, The Evaluation of GIS, Components of GIS, Geospatial data, Spatial data infrastructure.

**Map language**

Introduction, Map as a model, Spatial elements and terminology, Classification of maps, Map scale, Spatial referencing system, Computers in map production, Trends in computer construction, General software’s in map production and Open source GIS.

**UNIT II: FUNDAMENTALS OF GIS:**

A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels of measurement.

# UNIT III: DATA INPUT METHODS, EDITING AND QUALITY:

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

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; Modeling errors, Point data error models, Line and area data error models, Models for dot and pixel counting; Error evaluation by graphical methods.

# UNIT IV: SPATIAL DATA MODELLING:

Introduction; Stages of GIS data modeling; Graphic representation of Spatial Data, Raster data representation, Vector data representation, spatial data models; Raster GIS models: Types of raster GIS models, Compact raster data models; Vector GIS models, Spaghetti model, Topological model, Shape file, Compact vector data models; Comparison of Raster and Vector Models.

**UNIT V: GIS APPLICATIONS:**

Remote sensing and GIS Linkage, integration of multiple datasets in GIS, Possible applications and Case studies.

**TEXT BOOKS:**

1. Text book of Remote sensing and GIS by M. Anji Reddy, BSP Publications, Hyderabad, 3rd edition.
2. Manual of Geospatial Science and Technology Edited By John. D. Bossler, Taylor And Francis, London, 2nd edition, 2010.
3. Geographical Information Systems by Demers, 3rd edition, Wiley-india publications 2008.

**GSTL-2.6 DIGITAL IMAGE PROCESSING LAB**

 **Image Processing on various software**

* To view the data available in a tape / to load data from tape to disk / Selection and extraction of Study area.
* Geometric Correction.
* Image rectification
* Merging lines, columns and bands, Filtering Techniques, Edge Enhancement, Histogram calculation

 Generation of training sets-

* Generating Confusion Matrix- Separability Analysis
* Computation of training set statistics- Supervised classification- Creation of lookup table
* Legend creation-
* Unsupervised Classification
* Texture Analysis
* Map Composition and Output Generation

**GSTL-2.7 FIELD SPECTROSCOPY LAB**

* **Hyper spectral imaging**
* **Development of Spectra for**:
* Concrete
* Vegetation
* Soil
* Water etc,.

**GST-3.1 DIGITAL PHOTOGAMMETRY**

**UNIT I: IMAGE ACQUISITION AND SCANNERS:**

Introduction, Geometry of frame and Digital photography, use of Photogrammetric quality scanners, various image improvement techniques, storage and data compression of Digital images.

**UNIT II: PHOTOGRAMMETRIC WORKSTATIONS AND CONFIGURATION:**

Introduction, DPWS configuration, various photogrammetric applications s/w, input data for digital photogrammetry & its viability, digital photogrammetric operations; I.O, R.O & A.O parallax measurement with 3D mouse concept. Stereoscopic visualization: colour analytic, optical method & polarized method.

**UNIT III: MATHEMATICAL CONCEPT:**

Co linearity & Co planarity condition, Epipolar geometry, Automatic image matching techniques.

**UNIT IV: DIGITAL SURFACE MODELS:**

Definitions of DEM, DSM, DTM, DEM. Specification, Errors in DEM, TIN & GRID based surface generation, format of DEM, Application/ Use of DEM.

**UNIT V: DIGITAL ORTHO PHOTOGRAPHS:**

Introduction of digital orthophotos, applications/use of orthophoto, orthophoto limitation, Seem line, mosaicking.

**TEXT BOOKS:**

1. Elements of Photogrammetery by Paul R. Wolf, Mc. Graw Hill, 4th edition.
2. Digital Photogrammetry by M. Kasser and Y. Egels, Taylor and Francis Ltd, 2002.
3. Digital Photogrammetry – An addendum to Manual of Photogrammetry by Tina Cary, Jhon Jenson and Maury Nyquist by American Society of Photogrammetry and Remote Sensing(USA).

**GST-3.2 SPATIAL DATA ANALYSIS & MODELING**

**UNIT I: VECTOR DATA ANALYSIS AND RASTER DATA ANALYSIS:**

Buffering, Overlay, Distance Measurement, Pattern Analysis, Map Manipulation.

Data Analysis Environment, Local Operations, Neighborhood Operations, Zonal Operations, Physical Distance Measure Operations, Other Raster Data Operations , Comparison of Vector- and Raster-Based Data Analysis .

**UNIT II: TERRAIN MAPPING AND ANALYSIS, VIEWSHEDS AND WATERSHEDS:**

Data for Terrain Mapping and Analysis, terrain Mapping, slope and Aspect, Surface, Curvature, Raster Versus TIN.

View shed Analysis, Parameters of View shed Analysis, Application of View shed Analysis, Watershed Analysis, Factors Influencing Watershed Analysis, Applications of Watershed Analysis

**UNIT III: SPATIAL INTERPOLATION, GEOCODING AND DYNAMIC SEGMENTATION:**

Elements of Spatial Interpolation, Global Methods, Local Methods, Kriging , Comparison of Spatial Interpolation.

Geocoding, Application of Geocoding, Dynamic Segmentation, Application of Dynamic Segmentation.

**UNIT IV: PATH ANALYSIS AND NETWORK APPLICATIONS:**

Path Analysis, Application of path Analysis, Network, Putting Together a Network, Network Application.

**UNIT V: GIS MODELS AND MODELING:**

Basic Elements of GIS Modeling, Binary Models, Index Models, Regression, Models, Process Models.

**TEXT BOOKS:**

1. Fundamentals of GIS by MICHAEL N DEMERS. Published By john Wiley & Sons Inc.,3rd edition, 2008.
2. Environmental Modelling with GIS, Michael F. Goodchild, Bradley O. Parks, Louis T. Steyaert 1993, Scientific Publications Co.
3. Introduction to Geographic Information Systems By Kang-Tsung Chang (TATA McGRAW-HILL EDITION), 2007.
4. Ormsby T.E.Napoleon,R.Burke,C.groessl,L.Feaster 2004.Getting to know Arc GIS Desktop,ESRI Press, 2008.
5. Burke R.T.Tilton,A.Arana 2003 Getting to Know ArcObjects.ESRI Press

**GST-3.3 DATABASE MANAGEMENT SYSTEMS (DBMS)**

**UNIT I: INTRODUCTION:**

Database System Applications- Database System versus File System- Components of DBMS- View of Data- Data Models- Database Languages- Leading Commercial Databases- Database Users- Data-Administrator- Database-Administrator- Transaction Management- Database System Structure, E-R model, Relational model, Constraints-keys.

 **UNIT II: RELATIONAL DATABASES:**

***SQL:*** Basic Structure- Simple SQL queries- Set Operations- Aggregate Functions- Null Values- Nested Sub queries- Views- Complex Queries- Modification of the Database- Embedded SQL. **Integrity & Security:** Domain Constraints- Integrity and Referential Integrity Constrains- Assertions- Triggers- Security and Authorization- Authorization in SQL.

**UNIT III: DATABASE STORAGE:**

***Storage & File Structure:*** Overview of Physical Storage Media- Magnetic Disks- Storage Access- File Organization- Organization of records in Files- Data-Dictionary Metadata).**Indexing & Hashing:** Basic Concepts- Ordered Indices- B+ -Tree Index Files- B-Tree Index Files- Static Hashing- Dynamic Hashing.

 **UNIT IV: TRANSACTION AND CONCURRENCY CONTROL:**

Transaction Concept- Multiple Users and Concurrent Executions,Lock-Based Protocols, Timestamp-Based Protocols.

**UNIT V: RECOVERY SYSTEM:**

Failure Classification- Storage Structure- Recovery and Atomicity- Log-Based Recovery- Check Point- Shadow paging- Recovery with Concurrent Transactions.

**TEXT BOOKS:**

1. Database System Concepts by Silberschatz- McGraw Hill Editon,6th edition.
2. Database Management Systems by Gerald V Post- Tata Mc-Graw Hill edition,2001.
3. Database Management Systems by Ramakrishnan- Tata Mc-Graw Hill edition**,** 2002.

**GST-3.4 ENVIRONMENTAL IMPACT ASSESSMENT**

**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, collateral 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 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 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. EIA by Canter
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, Hameswar Dayal Konark Publishers, Pvt., Ltd.
9. Environmental Impact Assessment, Canter, L.W., 1977, McGraw Hills, New York.

**GST-3.5 GST FOR NATURAL RESOURCES MANAGEMENT**

**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 GIS. 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.

**TEXT BOOKS:**

1. Good child : Environmental Modeling With GIS, 1993.
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, 1996.
5. RS in Geology by Siegal, Published by Wiley, 1980.
6. RS in Forest Resources by John. A. Howard, Chapman and Hall, 2009.

**GSTL-3.6 DIGITAL PHOTOGRAMMETRY LAB**

* Digital Photogrammetric Stereo Workstation: hardware, viewing system, measurement system,
* feature extraction:
* vector information: breaklines for automatic digital terrain model extraction, connection to CAD systems
* Systems and Microstation with ERDAS PRO600
* Automatic generation of terrain models: image matching procedures, analysis Semi-automatic building extraction: matching procedures, measurement of simple and complex building structures
* Patternisation: Export Symbols from Microstation to ERDAS
* Typical end product Orthophoto production and ortho mosaicing: handling of image blocks, geometric radio-metric adjustment and tools, examining typical problems in different data sets

End Products : map composition and layers (3D)

**GSTL-3.7 GIS & GPS LAB**

**GPS Lab:**

Alignment survey by handheld GPS, Processing of GPS survey data with GIS software, Surveying and data capture by using DGPS and data Processing, Contour Development with DGPS processed data.

**GIS Lab:**

* **Scanning, Digitization** ,
* **Integration of remote sensing and GIS**:
1. Creation of Personal Geo-database, Feature Dataset and Feature Classes using Arc Catalog.
2. Geo-referencing of Raster Image using Arc Map.
3. On Screen Digitization using Arc Map.
4. Editing of Spatial Features using Arc Map.
5. Addition of Tabular Data to Feature Class & their editing.
6. Defining Domains in a Feature class for adding field values.
7. GPS linkage and attribute data entry.
8. Creation, Validation and Modification of Topology.
9. Viewing of GIS data using Arc Catalog/Arc Map.
10. Selection of features.
11. Labeling using Arc Map.
12. Symbolization using Arc Map.
13. Creation of Graph using Arc Map.
14. Generation of Report.
15. Creation of Layout using Arc Map.