

**SYLLABUS PRESCRIBED FOR
THREE YEAR P.G. COURSE IN
MASTER OF ENGINEERING (PART TIME)
CIVIL ENGINEERING
(ENVIRONMENTAL ENGINEERING)
SEMESTER : FIRST**

1 SCEE 1

**ENVIRONMENTAL SCIENCES AND CHEMISTRY
SECTION – A**

The Nature and scope of Environmental Problems :- Interaction of systems, Environmental disturbances, public awareness and action, Quantification of Environmental problems.

Climatology and Meteorology:- Introduction, Basic atmospheric properties, Energy outputs and inputs, wind stability and turbulence, water in the atmosphere, climate.

Ecology :- Introduction, Energy flow in Ecosystems, food chain and trophic level, elements of limnology, Eutrophication.

Global Atmospheric change :- The green house effect and stratosphere ozone depletion, Global temperature, the green house effect, carbon dioxide, chlorofluorocarbons, the green house gases, changes in stratospheric ozone.

General Chemistry: - Law of mass action, Stoichiometry, Gas Laws.

Physical Chemistry: - Types of solution, electrical conductivity and aqueous solution, ionic theory, electrical dissociation, Buffer solutions, Indicators, Solubility products, Common ion effect, Amphoteric hydroxides, chemical equilibrium and ways of shifting it.

SECTION- B

Organic Chemistry and Biochemistry : Organic compounds of interest to environmental engineers (Details of preparation and chemical reactions involved are not required)

General preparation of the functional groups of organic compounds.

Enzymes, classification, Enzyme catalysed reactions.

Break down and synthesis of carbohydrates, fats, protein under aerobic and anaerobic reactions.

CNP cycle under aerobic and anaerobic reactions.

Concept of B.O.D., C.O.D., T.O.C.

Colloids, Dispersion of Colloids, General and electro kinetic properties of colloids, colloidal solutions and mixtures.

Environmental Chemistry :- Water structure and anomalous behavior of water, Chemistry involved in water treatment processes like coagulation, disinfection, softening, fluoridation, defluoridation, Iron and its control

Composition and characterization of sewage, sewage sludge and gas analysis.

Chromatography :- Principles and uses in Environmental Engg.

Reference Books:

- 1) Introduction to Environmental Engg. and Science By Gilbert M Masters.
- 2) Environmental Science By Alam Singh, Vol-I, II, III.
- 3) Environmental Science & Engg. By Henry.
- 4) Fair G M, Geyr J C, Okun D A, Water and Wastewater Engineering, Vol, I & II, John Wiley & Sons, New York.
- 4) Chemistry for Environmental Engg. By Sawyer & McCarty.

1SCEE 2

**ENVIRONMENTAL MICROBIOLOGY
SECTION A**

1. Introduction to microbiology : Classification of microorganisms, prokaryotic cells, eukaryotic cells. Characterization of microorganism, microorganism of importance. Distribution of biological forms, interrelationship application in the field of Environmental Engineering.
2. Bacteria : Distribution, cytology, forms size, morphology and file structure of bacteria, nutritional requirements, metabolism, growth of bacteria, growth patterns, food microorganism relationship, Aerobic, Anaerobic growth. Factor affecting growth, generation time.
3. Bacteriology of water : Pathogens and indicator of pollution, method of isolation, enumeration and differentiation. Presumptive, confirmative and completed test for E-coli, most probable number, Membrane filter technique, indicators of pollution, sampling method, frequency, precautions.
Microbiology of food : Microorganisms associated with milk and food, diseases transmitted, food poisoning,
4. Enzymes : Nature of enzymes, mode of actions, effect of temperature, pH, salts and heavy metal, extra cellular and intracellular enzymes classification, source of enzymes, enzymes formation.
5. Fresh water biology : Flora and fauna in rivers, distribution, limnology, biological cycles, oxygen concentration, nutrient concentration, oxygen depletion, oxygen sag reaeration, Lake eutrophication and its prevention.

SECTION B

6. Algae, Fungi Protozoa and viruses : General, introduction to these groups, their role in environmental Engineering and their classification, identification, observation nutrition, reproductions, their control.
Viruses : Occurrence, special features, diseases caused by them, culturing, control of viruses.
7. Bacterial culture : Isolation of microorganisms, staining procedures, pure and mix cultures, culture characteristics, different medias, selective methods, interference, gram positive and negative bacteria laboratory culturing techniques, equipments used, microscope, autoclave, incubator, test chamber.
8. Microbiology of waste water treatment : Microorganisms, fundamental theory, theory of operations, oxygen requirements and environmental factors associated with following waste treatment methods.
 - Activated sludge process
 - Tricking filter
 - Oxidation pond
 - Sludge digestion
 - Cesspools, septic tank and imhoff tank
9. Air microbiology : Types of microorganisms, Air borne diseases, sampling of air, microbial content of air, control of airborne diseases.
10. Control of microorganisms : Death of bacteria, Pattern of death, effect of temp pH, toxic substances on growth of bacteria, Antagonism and synergism. Control of microorganisms by physical agents, Control of microorganisms by chemical agents.

1 SCEE 3 ENVIRONMENTAL SCIENCES AND CHEMISTRY - LAB

Determination of :-

1) Conductivity 2) pH (indicators and pH meter) 3) Turbidity 4) Hardness (Calcium and total by EDTA method) 5) Sulphate 6) Chlorides 7)Chlorine demand and Chlorine residual (Available, Break point dose) 8) Nitrogen all types 9) DO, BOD 10) COD, TOC 11) Iron and Manganese 12)Acidity and Alkalinity 13) Fluorides 14) Solids (Fixed, suspended and Volatile) (ANY TEN)

1 SCEE 4 ENVIRONMENTAL MICROBIOLOGY - LAB

Study of instruments, Heterotrophic plate count, preparation of differential media isolation of bacteria by various methods, staining of bacteria, enumeration of bacteria by various methods, M.F. technique, Control of microorganisms.

SECOND SEMESTER

2 SCEE 1

WATERSHED MANAGEMENT

SECTION A

1. INTRODUCTION : The hydrological cycle, storage, concept of storage, the watershed
2. WATER AND ENERGY : Energy movement, quality of energy, the geometry of energy, the energy budget, Instruments and limitations, the role of water in energy sphere.
3. WATER IN VEGETATION : Processes, interception, Transpiration, Evapotranspiration, calculations by using water budget, Evapotranspiration, models, storage.
4. Hydrology in water resources development, statistical analysis of rainfall and runoff, different distributions methods, Estimation of Unit Hydrograph-flood flow formulae, Storm hydrograph, Storage and regulation of runoff-safe yield of streams, Estimate of storage requirements.

SECTION B

5. HYDROLOGY OF GROUND WATER : Common aquifers-Exploration for ground water, hydraulics of ground water flow- Measurement of permeability of formations, flow nets and their constructions, Boundary conditions – Unconfined and Confined, steady and unsteady flow into wells and infiltration galleries – Evaluation of formulation constant interference, Method of images – Types, design, construction and maintenance of wells and infiltration galleries, Development of wells – well strainer – functions and selections, field tests – Hydraulics of salt water intrusions and their prevention , Ground water recharge.
6. WATERSHED DEVELOPMENT AND MANAGEMENT : Definition, Need and scope, characterization of watershed criteria survey, Basic data collection and interpretation, Establishment of watershed research stations. Watershed resource evaluation and management. Irrigation technology. Integrated farming system. Project formulation and economic analysis.
PERSPECTIVE ON WATERSHED MANAGEMENT: Methodologies for modifying the water resource environment, watershed management and large scale changes.
7. PRACTICE OF WATERSHED MANAGEMENT: Rehabilitation, Protection and Enhancement
NON POINT SOURCES OF POLLUTION : The legal basis, the process of non point source pollution control, Best management practices principles, Best management practices on wet lands.

- 8 RAIN WATER HARVESTING : Necessity, Methods of rain water harvesting, Requirements for design of project, community participation, Role of NGO's, Government and Municipal Corporation, Limitations, quality assurance of stored water.

Reference Books :-

1. Watershed Hydrology by Peter E. Black.
2. Water Resources Systems, Planning and Management by R. N. Chaturvedi.

2SCEE2

ADVANCED WATER TREATMENT

SECTION A

Standards for treated waters. Surface waters. Effects of storage on water quality. Limnology. Water ecology, Thermal stratification. Seasonal Change, lake overturns. Algae, Control measures, quality of underground Waters. Nature and source of impurities. Examination of waters.

Requirements of water treatment facilities. Unit operations, Gravity systems, pumping systems. Period of design, Fluctuations in demand. Intake structures.

Principles of sedimentation and floatation. General equations for settling or discrete particulates. Hindered settling, efficiency of an ideal basin, short-circuiting. Sludge moisture content – specific gravity relationship. Up flow and sludge blanket tanks – mathematical model of the unit processes.

Theories of chemical coagulation. Nature of colloids. Zeta potential. Coagulant and their specificity. Design of mechanical flocculators. Mean velocity gradient “G”, “Gt” effect of temperature and other variables. Power consumption. Mathematical Modeling.

SECTION B

Theory of filtration. System Parameter and mathematical modeling, size and shape characteristics of granular filtering materials. Preparations of filter sand, Hydraulics of filtration through homogeneous and stratified beds. Performance of slow, rapid, high-rate multi-layer and composite filters. Up flow, two way filter, dual media filter.

Pressure filters. Diatomaceous earth filters. Micro-strainers. Filterability Index.

Principles of disinfection. Factors affecting disinfection. Halogens: Chlorine, Iodine and Bromine.

Principles of aeration, System parameters and mathematical model. Methods of aeration. Theories of adsorption. Freundlich equation. Removal of taste and odor by adsorption. Removal of colour. Effects of fluorides. Fluoridation. Removal of fluorides.

Industrial water treatment: Boiler feed water. Softening of water. Reuse of water and conservation of water in industry.

Methods of Iron and Manganese removal. Use of aeration, oxidation, ion-exchange and other methods and their control.

Theory of corrosion, and corrosion control.

Reference Books:

1. Water and Waste water Engineering by Fair Geyer and Okun, John Wiley and Sons
2. Water and Waste water Technology by Mark J. Hammer, John Wiley and Sons
3. Water Supply and Sewerage by E. W. Steel and McGhee, McGraw Hill Company.
4. Manual on Water Supply & Treatment, CPHEEO, New Delhi.
5. Physico-Chemical Processes for Water Quality Control by Weber, John Wiley & Sons, 1972.

2SCEE3

ADVANCED WASTEWATER TREATMENT

SECTION-A

1. INTRODUCTION: Objectives of waste water treatment, Purpose of advanced wastewater treatment, Wastewater quantity and transport and waste water characteristics. Alternative flowcharts, function and basic principles involved in different units of conventional wastewater treatment plant.

2. PROCESS ANALYSIS: Reaction and reaction kinetics, Mass balance, Reactors and their hydraulic characteristics, Practical aspects of reactor design.

3. PHYSICAL AND CHEMICAL TREATMENT: Screening, Grit removal, flow equalizations and mixing. Flocculation, sedimentation, flotation. Detailed principles and design aspects of Screening, Grit chamber and Sedimentation tank.

SECTION-B

4. PRINCIPLES OF BIOLOGICAL TREATMENT: Kinetics of biological growth, introduction to suspended and fixed film reactors. Concepts of gas transfer and solids separation, Nitrogen and Phosphorus removal from waste water. Concepts of aerobic and anaerobic treatment of waste water. Design of Activated Sludge system using biological process dynamics. Complete design details of Activated Sludge Process. Modifications of ASP. Process concepts and design aspects of Trickling Filters, Rotating Biological Contactors (RBC), Fluidized bed reactor/treatment.

5. SLUDGE TREATMENT AND DISPOSAL: Aerobic and Anaerobic digestion of sludge, sludge stabilization, dewatering, conditioning and disposal.

6. TERTIARY TREATMENT: Principles of tertiary treatment, theory of adsorption and factors affecting adsorption. Concepts and different methods of dissolved solids removal. Basic principles of Reverse Osmosis, Ultra-filtration, Electro dialysis, Desalination.

REFERENCE BOOKS:

1. Wastewater Engineering: Treatment, Disposal & Reuse, By Metcalf & Eddy Inc. Sixth Ed. 2002, McGraw Hill.
2. Introduction to Environmental Engg., By. P.A. Veslind, PWS, Publishing Company, Boston, 1997.
3. Wastewater Treatment and disposal, By S.J. Arceivalla, Marcel Dekker, 1981.
4. Wastewater Treatment Plant Planning, Design and Operation, By S.R. Quasim, Holt, Rinehart & Winston N.Y.
5. Activated Sludge Process: Theory and Practices, By N.F Grey, Oxford University Press, 1990.

THIRD SEMESTER

**3 SCEE1 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT
SECTION A**

1. Development and Environment, need for EIA, concept of EIA, elements of EIA, nature of impacts – primary, secondary, tertiary, short-term, long-term, local and regional, reversible & irreversible impacts
2. Overview of impacts – directly & indirectly measurable impacts w.r. to air, noise & water,
3. Screening and scoping in EIA, terms of reference for conducting EIA, methodologies of EIA-checklists, matrices, overlays, cost benefit analysis, & networks
4. Framework of EIA – scope of EIA, baseline data collection, prediction of impacts, evaluation of impacts, batelle environmental evaluation system, environmental quality monitoring.

SECTION B

1. Environmental legislation – basic concepts, critical issues, civil liability, various enactment and their provisions – Water Act (1974, 1988), Air Act (1981, 1988), Environmental Protection Act 1986, Role of State & Central boards of pollution control, local Govt., social action groups.
2. Environmental Audit – definition, concept of EA, types of environmental audit, benefits of environmental audit, scope & objectives, environmental statement, procedural aspects of conducting environmental audit, pre-audit phase, on-site audit phase & post-audit phase.
3. Sustainable development & environmental management, carrying capacity based developmental planning process, concept of carrying capacity, assimilative and supportive capacity, Environmental Management in India.
4. Resource Management
Types of resources - terrestrial (soil) resources, minerals, plants & animals (biotic) resources, marine, fresh water, air & bioenergy resources, resource utilization-renewable and non-renewable resources, optimal use of resources, depletion of resources – causes & effects.

Reference Books:

- 1) Environmental Impact Assessment : Rau & Woofes.
- 2) Environmental Impact Assessment : W.F. Canter, McGraw Hill.
- 3) Proceedings of Indo-British Workshop on EIA of Petrochemical Industries and Environmental Audit, Jan. 1994, IAEM, Nagpur.
- 4) Handbook on Pollution Control Acts, Central Pollution Control Board, New Delhi.
- 5) The New Environmental Age by R. K. Sapra, S. Bhardwaj, Ashish Pub. House, New Delhi.

3 SCEE 2 AIR POLLUTION AND CONTROL

SECTION A

- I Elements of air pollution: History of air pollution, Natural versus polluted atmosphere, Air quality, Sources of air pollution.
- II Effects of air pollution: Effect on human health, on vegetation and animals, on material,
- III Measurement and monitoring of air pollution: Atmospheric Chemistry, Ambient air sampling, Ambient air pollutants, air pollution-monitoring & surveillance.

SECTION B

- IV Meteorology of Pollution : Physics of atmosphere, . Meteorological bases of Atmospheric pollution, Transport & dispersion of air pollutants, air pollution modeling & prediction, Wind rose
- V Regulatory Control of air pollution: Air quality criteria & standards Elements of Regulatory Control
- VI Engg. Control of air pollution: Engg. Control concept, control device & systems ,Control of stationery sources, ,Control of mobile sources, source sampling & monitoring.

Reference Books:

- 1) Air Pollution, Vol. I To IV – A. C. Stern.
- 2) Fundamentals Of Air Pollution – Stern, Wohlers, Bouble, Lower.
- 3) Air Pollution & Control – P. P. Mowli & N. Venkata Subbayya.
- 4) Air Pollution – Rao & Rao.
- 5) Air Pollution Sienfeld J. H.
- 6) Air Pollution – Perkins.
- 7) Air Quality Monitoring – A Course Manual By NEERI, 19981.
- 8) Mechanical handbook
- 9) Mechanical Handling - Jolley, F. Raby, & H. Walder.
- 10) Fundamentals of Air pollution – R. W. Boubel, D. L. Fox, A. C. Stern

3 SCEE 3 AIR POLLUTION AND CONTROL - LAB

- 1) To measure CO % & NO % of the exhaust gases from vehicles or gasoline engine.
- 2) Determination of SPM, RSPM, SO₂
- 3) Statistical Calculations of observed air pollution data.
- 4) Design of Bag filter for controlling dust pollution in particular industry – case study.
- 5) Design of cyclone separator.
- 6) Study of Air Quality Monitoring Instruments & Equipments.
- 7) Determination of wind velocity, wind direction, temperature, cloud cover, humidity & preparation of wind rose diagram.

3 SCEE 4 DESIGN PROBLEM - LAB

A project report on Design of Complete Water Treatment Plant or Sewage Treatment Plant or Industrial Waste Water Treatment Plant including detailed drawing and cost economics will be prepared by a group of not more than 3 Students.

Examination will be based on Viva-Voce on report submitted.

FOURTH SEMESTER**4SCEE1 INDUSTRIAL WASTEWATER TREATMENT****SECTION A**

Problem of Industrial Waste Water:

Variation in quality and quantity of industrial waste water. Effects of discharge of industrial waste water on streams; land and municipal sewers. Benefits of water pollution control by doing treatment of industrial waste.

Indian standards for discharge of treated waste water on land, into municipal sewer and natural water courses.

Sampling procedure. Experimental evaluation of physico-chemical or biological treatment methods for treatment of the wastewater.

Approaches to minimization of problem of industrial waste water, Good house-keeping, equalization, neutralization, precipitation, mixing of different effluent streams, recycle of effluent streams, process modifications in terms of raw materials or chemicals used general approach to planning of industrial waste water treatment and disposal. Cleaner Technologies of production for waste minimization.

SECTION B

Different aspects and choices of various alternatives such as:

- 1) Treating different effluent streams separately.
- 2) Treating different streams jointly after mixing them partly or fully.
- 3) Including/excluding domestic waste along with the industrial waste.

General approach for handling and treatment of industrial waste water with following special characteristics.

Shock loads, presence of colours, toxic metal/ions, refractory substances, e.g. A B S and other detergents, growth inhibiting substances such as insecticides, waste rich in nutrients (N.P.K. etc.), waste rich in oil & grease, high suspended solids, high BOD, high temperature, acidity, alkalinity etc.

Experimental evaluation of physico-chemical or biological treatment processes for treatment of the waste water.

Process line diagrams, characteristics and treatment of industrial waste of: -

Pulp and paper, textile, tannery, food, Canings, sugar mill, distillery, dairy, pharmaceutical, electroplating etc. industries.

Reference Books:

- 1) Waste Water Treatment, Disposal and Reuse-Metcalf and Eddy.
- 2) Pollution Control in Process Industries – S. P. Mahajan.
- 3) Liquid Waste of Industry – Theory, Practices and Treatment Nemcrow.
- 4) Industrial Water Pollution Control- W. W. Eckenfelder.
- 5) Natural Systems for Waste Management and Treatment – S.C. Reed, E.J. Middlebrooks, R. W. Crites.

- 6) The Treatment of Industrial Waste – Purse Lievre E.B.
- 7) Water Quality Management by W.W. Eckenfelder
- 8) Biological Treatment of Waste Waters : W.W. Enkenfelder

4 SCEE 2 ENVIRONMENTAL SANITATION & SOLID WASTE MANAGEMENT

SECTION – A

1. Concept of environment and scope of sanitation in rural areas. Principles involved in the protection of public health by engineering measures to control the environment Rural water supply.
2. Swimming Pool sanitation – quality standards, algae control
Fly and Mosquito Control – destruction of adult flies and prevention of fly breeding.
3. Food Sanitation – Public consideration, Causes of food poisoning, food storage,
4. Restaurant sanitation, Slaughter house sanitation, Milk plant sanitation, Sanitation of Hospital.

SECTION – B

5. Problems and impacts of solid waste in developing countries; Sources, types and composition of Municipal solid waste, quantity estimation and forecast, Management systems and planning.
6. Characteristics of solid waste – Sampling – physical, chemical and biological analysis. .
7. Collection of solid waste: On site handling and processing; Collection systems and service; Analysis of collection systems, collection routes; Management issues and concerns.
Transfer and transport, design requirements.
8. Composting – Process microbiology, Aerobic and anaerobic composting, parameters affecting, Design considerations, compost control, engineering design and operations.
9. Sanitary Landfill – Process mechanism, Classification, types, siting considerations, engineering design and operations.

Reference Books:

- 1) Ehlers and Steel; Municipal and Rural Sanitation.
- 2) Wagner E. G. & Lanoik J. N.; Water Supply for Rural Areas and Small Communities, Geneva WHO.
- 3) Manual for Rural Water Supply, Helvetas Swiss Corporation, Divyajyoti Prakashan, Jodhpur.
- 4) G. Techbanoglous, Elliasen; Solid Waste Engineering, Principles and Management Issues, Mc-Graw Hill Book Co.
- 5) Bhide A. D. and Sudaresan B. B.; Solid Waste Management in Developing Countries, INSDOC, New Delhi.
- 6) D. Joseph Hagerty, Joseph L. Pavoni & John E. Heer Jr.; Solid Waste Management, Van Norstrand Reinhold Environmental Engineering Science..
- 7) Frank Kreith; Handbook of Solid Waste Management, Mc-Graw Hill Inc.
- 8) Frank Flintoff; Management of Solid Waste in Developing Countries, WHO publication.

4 SCEE 3

ELECTIVE

(1) HAZARDOUS WASTE MANAGEMENT

SECTION – A

1. Introduction to Hazardous Waste :-
Definition, Problems, general awareness, Industry and Government's perspective. Risk Assessments, Environmental legislation.
2. Hazardous waste characterization and site Treatment.
Introduction, study of characterization, Assessment of Hazardous sites, waste minimization and Resource Recovery, chemical, physical and biological treatment to Hazardous waste. Thermal process.
3. Transportation of Hazardous wastes :-
Introduction of Hazardous wastes :-
Hazardous Wastes (Handling, Storage & Management) Rules, 1989 of MoEF.
Introduction, container for Hazardous waste, bulk transport, Non bulk transport.
4. Groundwater contamination :-
Effect on human health, Historical uses and abuses, hydrology, Detection, Control and Mitigation of groundwater contamination.
5. Process Techniques and Disposal :-
Selecting the process, siting the facility, integrated land fill system as Disposal sites, Developing a new facility, operating a landfill.

SECTION – B

6. Basic Disaster Management Aspects:-
The significance of Disaster, the Disaster threat, National Disaster Management policy, major requirement for coping with Disaster Management cycle, Disaster and National Development, Disaster legislation, counter disaster resources. International Disaster Organization, utilization of Resources.
7. Long-Term Measures :- Prevention, Mitigation.
8. Major factors for occurrence of Disaster impact
9. Response to Disaster impact
10. Major post impact factors, Disaster management support requirements.

Reference Books:

1. Hazardous Waste Management : Charles A. Wentz.
2. Hazardous Waste Minimization : Harry M. Preeman.
3. Hazardous Waste Chemistry, Toxicology and Treatment : Stanly E. Manahan.
4. Disaster Management : W. Nick Carter.

4 SCEE 3

ELECTIVE (2) NOISE POLLUTION CONTROL SECTION A

- I Introduction, Noise pollution, Nature of noise, Characteristics of noise, NEI, Sound pressure levels, and propagation of noise.
- II Source of noise, Types of sources of noise, (mobile and non mobile) comparison of noise and Air pollution standards. Assessment and measurement of sound control facilities, Monitoring procedures.
- III Effects of noise on people and various protective equipments Like earplugs, earmuffs, etc. Basic principles of noise control, general noise control factors sources of vibrations.

SECTION B

- IV Noise in Home & its control, control of Existing noise outside the home, Noise from construction and Civil Engineering works and its control. Noise from industry and its control.
- V Road traffic noise and its control subjective rating of Automotive vehicles noise characteristics of vehicle guidelines for vehicular noise, relation between noise and engine combustion system Aircraft and Airport noise.
- VI Legal Aspects of noise pollution, prediction and Assessment of Impacts on the noise Environment due to stationery and mobile noise sources. Existing legal provisions for controlling noise, International noise level standards.

Reference Books:

- 1) Noise Pollution - P. R. Trivedi, Gurdeep Raj
- 2) Environmental Noise Pollution and its Controls - G. R. Chatwal, M. C. Mehra, M. Satake

4SCEE3

ELECTIVE

(3) ENVIRONMENTAL BIOTECHNOLOGY

Basic concepts of Microbial Biochemistry of carbohydrates, proteins and lipids; structure of nucleic acids.

Biodegradation, biotransformation, microbial associations, significance of monitoring bacterial, viral and protozoan pathogens, gene probes, biosensors, immunoassay.

Basic concepts of genetic engineering, chromosomal DNA, plasmid DNA, replication of DNA, genetic code.

Transformation, transduction, conjugation, mutation, recombinant DNA techniques, biotransformation of biomass/organic waste into value added chemicals and energy.

Single cell proteins, microorganisms involved and biochemical changes of different pollutants present in liquid wastes. Types of reactors.

Reference Books:

1. Concepts in Biotechnology- Edited by Balsubramanian et al.
2. Text book of Biotechnology- Dubey.

4SCEE3

ELECTIVE

(4) REMOTE SENSING AND GIS IN ENV. ENGG.

Fundamental principles of Remote Sensing; Electromagnetic energy and its atmospheric interactions ; Remote sensing systems.

Elements of Remote sensing systems; Indian remote sensing program.

Data products and types; Interpretation techniques; Digital image processing; Image rectification, enhancement and classification.

Geographical information system, concept and characteristics.

Raster and Vector data, attribute generation and analysis.

Integrated applications of Remote Sensing and GIS in Environmental engineering, Viz. Resources management, monitoring and evaluation, modeling.

Reference Books:

1. Sabnis F.- Remote Sensing, Principles and interpretation -WH & Freeman & Co. NY.
2. Gupta R. P.- Remote Sensing
3. Jensen J. R.- Introductory Digital Image Processing -Pentice Hall NZ.

FIFTH & SIXTH SEMESTERS

5 SCEE 1 & 6 SCEE 1

SEMINAR AND DISSERTATION

A Dissertation on Recent Trends in Environmental Engineering to be submitted.

Seminar shall be delivered on the dissertation submitted.

Marks shall be based on Seminar and Viva-Voce on dissertation.
