M.Sc. I – SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES-101 T (Paper I): ENVIRONMENTAL CHEMISTRY

Unit I

1. Fundamentals of Environmental Chemistry
2. Atmospheric Composition and Structure
3. Chemical processes in the formation of inorganic and organic particulate matters
4. Thermo chemical and photochemical reactions in the atmosphere
5. Oxygen and Ozone chemistry- Green House Effect- Global warming

Unit II

1. Soil physico-chemical and biological properties (texture, structure, inorganic and organic components, composition)
2. Types of soils – Nutrients in soil
3. Sources of pollutants -Effects of pollutants on soil health and productivity
4. Industrial effluents and their interactions with soil components
5. Impact of degradation of pesticides and synthetic fertilizers- Soil standards- Soil pollution control

Unit III

1. Hydrological Cycle-Water Characteristics -Aquatic Environments (Ponds, Lakes, Rivers)
2. Lake Thermal Phenomena- Oligotrophication and Eutrophication
3. Biogeochemical cycles (N, C, P, S)
4. Radioactive pollution sources -Biological effects of ionizing radiations- Radiation exposure
5. Standards and Protection -Disposal of radioactive waste

Books Recommended

1. Environmental Chemistry, A.K.De, Wiley Eastern Ltd.,1987
2. Environmental Chemistry, R.C.Rasswell, Edward Armold Press, 1980
3. Fundamentals of Environmental Chem. Stanley E. Manahan
4. Limnology –Wetzel
5. Photochemistry and spectroscopy, J.P.Simmons, Wiley ,1971
6. Environmental Chemistry –B.K.Sharma

M.Sc - ENVIRONMENTAL SCIENCE
(Practical Syllabus)
ES 105 P (PAPER I)- ENVIRONMENTAL CHEMSITRY

A. WATER

1. Alkalinity
2. Chloride
3. Dissolved Oxygen
4. Total hardness
5. Turbidity
6. Phosphate
7. Sulphate
8. Fluoride

B.SOIL

9. Moisture Content
10. Organic matter
11. Soil Salinity
12. Chloride
13. Phosphate
14. Potassium
15. Alkalinity

M.Sc. 1 — SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES 102 T (Paper-II): CLIMATOLOGY

Unit I

1. Definition and Scope, importance of climatology, Subdivisions of climatology
2. Meteorology -Climatic controls-Air masses-classification
3. Insolation and Heat budget. Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind
4. Clouds- classification of clouds, weather and tools of weather forecasting
5. Precipitation process — forms and Types of precipitation -Convictional, Orographicand Frontal

Unit II

1. Major climatic regions of the world based on latitude, Distribution of vegetation.
2. Classification of climates-Thornthwaite's and Koppen's classification
3. Weather, Weather forecasting, Types and methods, Satellites in weather forecasting
4. Climatogram studies of different climatic zones. (Tropical,Temperate and Polar climates)
5. Limiting Climate Change- Adaptations and Mitigation

Unit III

1. Climates of India, Indian Monsoon -Classical theory, Recent theory of origin of Indian Monsoon,Seasonal Changes in India.
2. Pseudomonsoon areas of the world, the climatic significance of monsoons.
3. El Nino, La Nina, Frontogenisis, Frotolysis
4. Local winds -Land breeze, sea breeze, Mountain and valley breezes, hot local winds, cold local winds.
5. Impact of Climate change on Agriculture, Animal Husbandry, Housing and Urban Planning.

Books Recommended

1. Climatology - D.S.Lal, (2009)
2. General climatology - Howard and Critchfield (2008)
3. Principles of Physical Geography - A.Das Gupta and A.N.Kapoor (2001)
4. Essentials of Meteorology: An Invitation to the Atmosphere -C. Donald Ahrens (2015)
5. Introduction to Climatology and Meterology - Dessalegn Gemeda (2015)

M. Sc - ENVIRONMENTAL SCIENCE
(Practical Syllabus)
ES 106 P (PAPER II) – CLIMATOLOGY

1. Graphic representation of the structure of atmosphere; physical layering and compositional layering.
2. The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles.
3. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph.
4. Isotherms: world mean temperatures-January to July. India mean temperatures - January to July.
5. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point.
6. Condensation: observation and identification of various types of clouds. Depicting sky picture
7. Precipitation: measurement of rainfall using rain gauge.
8. Atmospheric pressure measurement: fortin' s mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July.
9. Study of climatograms
10. Analysing the climatic changes of a given area.

M. Sc. I – SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES-103 T (Paper-III): AIR POLLUTION AND CONTROL

Unit I

1. Sources and classification of air pollutants – Photochemical Smog.
2. Effect of air pollution on crops, animals and human health.
3. Toxicity symptoms on vegetation – Defense mechanism against air pollutants in plants- Sensitive and tolerant plant species to air pollutants.
4. Air pollution tolerance index.
5. National and International Policies on air pollution.

Unit II

1. Sampling and monitoring of air pollutants (gaseous and particulates) - Period, frequency and duration of sampling.
2. Principles and instruments for measurements of ambient air pollutants concentration and stack emissions.
3. Dispersion of air pollutants - Mixing height/depth, lapse rates.
4. Gaussian plume model-Turbulence plume behavior – Wind-rose dispersion model.
5. Indian National Ambient Air Quality Standards and Air Quality Index.

Unit III

1. Control devices for particulate matter: Principle and working of Settling Chambers - Centrifugal Collectors, Wet Collectors - Fabric Filters - Electrostatic Precipitator.
2. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion.
3. Automobile pollution sources - Effect on human beings and Control at source -
4. Noise pollution sources- Effects on human health – Control measures.
5. Indoor air pollution sources – Health Effects- Control methods.

Books Recommended

1. Air Pollution, H.C.V, Rao, 1990.
2. Air Pollution, M.N.Rao, Mc Grace Hill, 1993.
3. Air Pollution and Control, P.Pratapmouli. G.N.Venkatasubbaya, Divya, Jyothi Prakasham, Jodhpur, 1989.
4. Meteorology of Air Pollution, R.S.Scores, Ellis Hardood Pub, 1990.
5. Fundamentals of Air Pollution, 2nd Ed Arthur C. Stern Acad. Press, 1984.

M.Sc - ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES 107 P (PAPER III) - AIR POLLUTION AND CONTROL

1. Sulphur Dioxide
2. Nitrogen Dioxide
3. Particulate matter (SPM & RSPM)
4. Sound Measurement
5. Air pollution tolerance index (APTI)
6. Air quality index (AQI)
7. Ozone Measurement
8. Indoor Air Quality
9. Humidity and Weather
10. Carbon dioxide absorbed by plants

M.Sc. I — SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES 104 T (Paper-IV): ENVIRONMENTAL INSTRUMENTATION AND ANALYTICAL METHODS

Unit-I

1. Electrochemical Methods –Specific ion selective electrode.
2. Glass electrode for H^{+}/Na+ ions.
3. Solid membrane electrode for Fluoride.
4. Liquid Membrane Electrode for calcium enzyme.
5. Substrate electrode for NH_3- Gas sensing electrodes for SO_2,NH_3,CO_2,O_2

Unit -II

1. Principal of analytical methods: Titrimetry.
2. Gravimetry- Bomb Calorimetry-.
3. Chromatography (Paper Chromatography, TLC, GC and HPLC).
4. Flame Photometry- Spectrophotometry (UV-VIS,AAS, ICP-AES,ICP-MS), Electrophoresis.
5. XRF, XRD, NMR, FTIR,GC-MS.

Unit -III

1. Microscopy – Principles and application.
2. Compound microscope- Bright field, Dark field microscope, Phase contrast microscope, Florescence Microscopy.
3. Transmission and Scanning Electron Microscope (TEM & SEM).
4. Statistical Analysis- Probability, Sampling, Measurement and Distribution of attributes.
5. Distribution- Normal, t and $X^{2,}$ Chi square test, student t test and ANOVA.

Books Recommended

1. Mass spectrometry of pesticides and Pollutants, Safe and Hot zinger, 1977.
2. Standard methods for the examination of water &wastewater, APHA,AWWA & WPCF,1985.
3. Chemical Analysis, Kenneth A.Rubinson
4. Anal Chem, Gary D.Christan
5. Instrumental Methods of Analysis, 6th Ed.Willered Merit & Dean CBS Publications, New Delhi

M.Sc - ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES 108 P (PAPER IV) – ENVIRONMENTAL INSTRUMENTATION AND ANALYTICAL METHODS

1. Gas Chromatography (GC)
2. High Pressure Liquid Chromatography (HPLC)
3. Fluorescence Microscope
4. UV-VIS Spectrophotometer
5. Colorimeter
6. Chromatography (TLC)
7. Flame Photometer
8. Electrical Conductivity
9. Scanning Electron Microscope (SEM)
10. Statistical analysis

M.Sc. II – SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES-201 T (Paper I): ENVIRONMENTAL MICROBIOLOGY

Unit I

1. Microorganisms and the Environment - Environmental Microbiology – Scope – Significance -Origin of life
2. Classification of organisms - Prokaryotes and Eukaryotes
3. Distribution of microorganisms in different environments - Soil - Water and Air
4. Planktons - Phyto and Zoo planktons – Classification –Composition - Seasonal Distribution
5. Extremophiles –Biofilms - Microbial Mat

Unit II

1. Microbial Nutrition- Common nutrient requirements - Nutritional types of Micro-Organisms
2. Culture Media -Types of Media – Selective- Differential - Enriched and Enrichment
3. Isolation of Pure cultures - Growth curve - Batch culture -Continuous culture of microorganisms
4. The Chemostat and Turbidostat - Influence of Environmental factors on growth
5. Microbial diseases - Water, Food and Air borne diseases and control measures

Unit III

1. Microbial association and its application- Soil microbial communities - Soil microorganism association with plants – Rhizosphere - Actinorhizae - Mycorrhizae
2. Contaminated water treatment with microorganisms - Heavy organic loaded water - Heavy metal contaminated water - Xenobiotic contaminated water
3. Aeromicroflora-Micro organism in the atmosphere – Fungal Aerosols, Bio-aerosols-Pollen allergens
4. Microbes in production of SCP - Fermentation and its products
5. Microbial services in green house gases mitigation - Microbial ecology of green house gas (methane) producing and consuming bacteria from different ecosystems - Case study: Microbes new emerging areas.

Books Recommended

1. Microbiology: LM. Prescott, John P Harley, Donald A.Klein 4th Ed. WCB/McGraw — Hill.
2. Microbiology of the Atmosphere: Gregary, P.H. Wiley & Company.
3. Microbiology - Fundamental and Applications: Ronald m. Atlas and Richard Bartha. 4th Ed. Aim Print of Addison Wesley Long Man Inc

M.Sc - ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES 205 P (PAPER I) - ENVIRONMENTAL MICROBIOLOGY

1. Qualitative and Quantitative estimation of Phyto and Zooplanktons.
2. Phytoplanktons: Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae
3. Zooplanktons: Daphnia and Cyclops.
4. Basic Instruments useful in Microbiology
5. Media preparation for Bacteria and Fungi
6. Isolation and identification techniques of Micro organisms
7. Isolation of Microbes from infections (plant)
8. Microbes in contaminated water treatments
9. Preparation of slides in Air micro flora
10. Preparation of slides in Soil micro flora
11. Preparation of slides Water micro flora
12. Food borne diseases
13. Microbial enzyme estimation
14. Lignolytic enzymes estimation
15. Study of Zone of inhibition

M.Sc. II – SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES-202 T (Paper II): ECOLOGY AND ECOSYTEM DYNAMICS

Unit I

1. Ecology –Principles –Concepts and levels of ecology
2. Ecosystem- Structural and Functional components – Energy flow in ecosystem- Food Chain-Food Webs- Trophic Levels – Ecological pyramids and Ecosystem Services
3. Population Ecology- Characteristics of Population ecology- Positive and negative interactions
4. Concept of Carrying Capacity- Population Growth and Regulations
5. Concept of 'r' and 'k' species

Unit II

1. Biological Diversity – Definition of Community ecology – Characteristics features
2. Distribution (vertical and horizontal)- Qualitative, Quantitative and Synthetic characters
3. Raunkiers and Braun – Blanquett concepts of Phytosociology
4. Community interactions including prey-predator relationship – Biological invasions
5. Lotka Voltera Model – Gaussian Model

Unit III

1. Biomass and Productivity – Definition of biomass – Concepts of biomass
2. Biomass utilization – Biomass as a source of energy
3. Definition of productivity – Types of productivity – Primary and Secondary productivity
4. Methods of measurement of biomass and productivity
5. Ecological Efficiencies

Books Recommended

1. Fundamentals of Ecology E.P Odum,1971 V.B Saunders Co Philadelphia
2. Concepts of Ecology E.J Kormondy , 1976 .Concept of Modern Biology Ser.Prentice Hall
3. Productivity in Freshwater Ecosystems. Vollenvender

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ES 206 P (PAPER II) - ECOLOGY AND ECOSYTEM DYNAMICS

1. Biomass estimation of Grassland ecosystem
2. Biomass estimation of Pond ecosystem
3. Biomass estimation of Forest ecosystem
4. Measurement and Productivity in Pond ecosystem
5. Measurement and Productivity in Grassland ecosystem
6. Measurement and Productivity in Forest ecosystem
7. Study of Phytosociological parameters – Abundance –Frequency- Relative frequency
8. Density- Relative density – Cover – Relative Cover
9. Dominance –Raunkiers Biological spectrum
10. Simpson Index, Shannon Index, Jaccard Index

M.Sc. II – SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES-203 T (Paper III): WASTEWATER TREATMENT TECHNOLOGY

Unit I

1. Need for wastewater treatment- Sources of wastewater- Domestic, Municipal sewage, Agriculture and Industrial
2. Characterization of domestic and industrial wastewater by OM, COD, BOD, TOC
3. Treatment of wastewater – Primary treatment (sewage) Screens- Grit Chambers- Oil separation- Primary sedimentation
4. Primary treatment (industrial)- Segregation- Equalization- Neutralization- Sedimentation- Flotation- Oil separation
5. Wastewater disposal methods and tolerant limits

Unit II

1. Secondary treatment (Biological treatment methods) -Principle of biological treatment
2. Waste stabilization ponds- Aerated lagoons- Activated sludge process
3. Trickling filters- Sludge digesters- Sludge conditioning – Dewatering methods
4. Sludge drying beds- Vacuum filtration- Filter process- Centrifugation
5. Sludge disposal methods

Unit III

1. Advanced wastewater treatment – Removal of suspended solids- Dissolved solids
2. Nitrogen removal- Phosphorous removal- Adsorption – Refractory organics and their treatment
3. Reuse and recycle of wastewater- Wastewater treatment from specific industries sources
4. Characteristics and methodology for the treatment of industrial wastewater
5. Treatment methods for Sugar industry- Distilleries- Tannery- Paper and pulp mills

Books Recommended

1. Wastewater Treatment – Donalk N.Sundaram and Herbet E. Prentice Hall Inc. Englwood Chiffs.
2. Wastewater Treatment – 2nd Ed.M. Narayana Rao & Amal K. Datta
3. Water Treatment Specification – Frank rose, Mc Growl Hill 1985
4. Wastewater Treatment – Metcall and Eddy

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ES 207 P (PAPER III) - WASTEWATER TREATMENT TECHNOLOGY

Sewage waste

1. Organic matter (OM)
2. Chemical Oxygen Demand (COD)
3. Biological oxygen Demand (BOD)
4. Total Organic Carbon (TOC)
5. Sodium Absorption Ratio (SAR)
6. Total Dissolved Solids (TDS)
7. E. Coli

Agricultural Waste

8. Nitrogen
9. Phosphorous
10. Potassium

Industrial Waste

11. Total Suspended Solids (TSS)
12. Sulphates
13. Chemical Oxygen Demand (COD)
14. Biological oxygen Demand (BOD)
15. Heavy Metals (Cu, Zn, Pb, Cd, Hg, Fe, Mn)

M.Sc. II – SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES-204 T (Paper IV): GEO ENVIRONMENT

Unit I

1. Introduction to geo-environment- Fundamental concepts of Environmental Geology- Earth Systems- Cycles in Earth Systems
2. The Energy cycle – geothermal and tidal energy - Rock cycle – Heat transfer- Plate tectonics- Rock families
3. Assessing geological hazards and risks – Types of Hazards
4. Volcanic activity – Effects and prediction of volcanic activity
5. Landslides- Causes- Identification- Prediction and mitigation

Unit II

1. River flooding – Nature and extent of flood hazard – Preventive measures
2. Geology of waste management – onsite and landfill
3. Surface impoundment and deep well disposal
4. Scope of disposal problem in geologic environment
5. Pollution of groundwater –Preventive measures

Unit III

1. Environmental case studies – Silent valley – Narmada project- Tehridam
2. Bhopal gas tragedy- Impact of Mathura refineries on Tajmahal
3. Large Dams and Environmental problems
4. Coastal hazards- Tropical cyclones- Tsunami – Coastal erosion
5. Environmental impacts of mining on groundwater and sea water intrusion

Books Recommended

1. Barbara,W.M.Brian .J.S.Stephen, C.P- Environmental Geology, John Wiley and Sons Inc.
2. Keller – Environmental Geology
3. Lundgran ,Lawrence- Environmental Geology- Prentice Hall
4. David K Todd – Groundwater Hydrology, McGraw Hill
5. Howard .A.D and Remson- Geology in Environmental Planning Mc Graw Hill, New York, 1987.
6. Dix. H.M- Environmental Pollution, John Wiley , New York 1981.

M.Sc - ENVIRONMENTAL SCIENCE
(Practical Syllabus)
ES 208 P (PAPER IV) - GEO ENVIRONMENT

Megascopic Identification, Properties, Uses and Distribution

Rocks	**Minerals**
1. Basalt	9. Quartz
2. Dolerite	10. Orthoclase
3. Granite	11. Muscovite Mica
4. Sand Stone	12. Olivine
5. Limestone	13. Magnetite
6. Shale	14. Hornblende
7. Quartzite	15. Augite
8. Marble	

M.Sc. III-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES -301 T (Core Paper –1): WATER TREATMENT AND SOLID WASTE MANAGEMENT

Unit I

1. Water Health and Sanitation- Water borne diseases
2. Need for public water supply schemes (Urban and Rural)
3. Sources of water - Surface sources - Sub surface sources- Selection of water for Protected water supply
4. Water Demand and Quality
5. Design Period -Per Capita Demand -Population Forecast- Fire Fighting-Industrial and other needs

Unit II

1. Drinking water quality- Standards CPHEEO-BIS-WHO guidelines -Need for water treatment.
2. Conventional Water Treatment Methods - Slow sand filters -Rapid sand filters – Pressure Filters
3. Criteria for good disinfection-Chlorination- Ozonization -UV rays
4. Water softening by deflouridation-Removal of Iron-Manganese -Colour- Control of taste and odours
5. Urban Local Bodies-Service Level Bench Marks (SLB's) for water supply and Solid Waste Management

Unit III

1. Solid Wastes-Types- Source - Dumping of garbage from Houses, Hotels and hospitals
2. Deposition of xenobiotics in soil-Effects on soil and public health
3. Solid wastes disposal – Incinerators -Sanitary Land Filling
4. Pit Dumping –Composting- Recycling
5. Municipal Solid Waste Management and Handling Rules 2000- Bio-medical waste management Rules 2016- Plastic Waste Management Rules 2022

Books Recommended

1. Text books of Water Supply & Sanitary Engineering: S.K. Garg, Oxford IBH Publ.
2. Water Supply and Sanitary Engineering: H.S. Birdi New Delhi.
3. Environmental Engineer's Hand Book. Vol 1,2,3 (Ed.) Bela G. Liptak, Chilton Book Company, Radnor, PennsylVania, 1975.
4. Standard methods for the Examination of water and waste water- 19th Ed. 1995. Andrew and Eaton - APHA.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES -305 P (Core Paper –1): WATER TREATMENT AND SOLID WASTE MANAGEMENT

1. Calculate the Design Period, Per Capita Demand and Population Forecasting
2. Coagulation by chemical methods (Aluminium Sulphate, Ferrous Sulphate)
3. Sedimentation by Gravitational method Volume Index (SVI)
4. Water treatment by Filtration (Sand/Activated Carbon)
5. Disinfection by Chlorination
6. Solid waste – Identification and classification
7. Characterization of Municipal Solid Waste
8. Characterization of coal/fly ash/metal
9. Preparation of Vermi-composting by various organic materials
10. Service Level Benchmarks (SLB's) for Water and SWM of Municipalities

M.Sc. III-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES- 302 T (Core Paper –2): REMOTE SENSING AND GIS

Unit I

1. Fundamentals and Principles of Remote Sensing (Optical/Microwave)
2. Physical principles - Aerial photography -Image systems –Satellites- Sensors -Data Generation and Products Data Indexing
3. Principles of image interpretation -Visual image Interpretation- Image Elements- Visual Interpretation Aids
4. Digital Processing- Image Enhancement-Image Classification and Image processing systems
5. Advantages and limitations of visual and digital interpretation for environmental studies

Unit II

1. Application of remote sensing - Urban landscape mapping - Industrial land use
2. Remote sensing for vegetation-Spectral Characters of Vegetation
3. Land Scape Ecology- Remote Sensing for Vegetation Change
4. Remote Sensing for Surface Water -Biophysical Characteristics -Remote Sensing for Soil Properties (Soil Texture ,Moisture Content, Soil Organic Matter)
5. Remote Sensing for Flood Mapping - Flood Damage Assessment - Drought Assessment -Watershed Management

Unit III

1. GIS and GPS System- GIS Concepts -Spatial and Attribute Data - Data Structures- Vector and Raster Data
2. Map Features -Data Inputting -Data Storage -Data Manipulation- Data Analysis, Output Generation -Hardware and Software requirement
3. Application of GIS for Environmental Studies
4. GIS as Decision Support System - GPS: Concepts - Available Constellations - Accuracy - Types of Errors
5. Types of GPS Machines -Applications for Environmental Studies -Interface of GPS Data with GIS

Books Recommended

1. Remote sensing and Image interpretation. Thomas M. Lillesand and Ralph W. Keifer, John Wiley & Sons Inc. New York.
2. Introduction to Remote Sensing, James B. Campbell, Tylor& Francis Ltd, London.
3. Fundamentals of GIS Micheal N. Demers.
4. Remote sensing applications in applied geosciences by Sumitra Mukherjee, Milton Book Company.
5. Environmental Geography, H.M. Saxena, Milton Book Company

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES -306 P (Core Paper –2): REMOTE SENSING AND GIS

1. Study of toposheet and base map preparation
2. Description of satellite and sensor details of the imagery used for thematic mapping
3. Land use/land cover map preparation
4. Scanning/digitization of maps
5. Digital image display and image enhancement
6. Image Registration- Ground Control Points from toposheets (GCP)
7. Geo Referencing
8. Image classification for land use/land cover using ERDAS
9. Digital Mapping: GIS software, ARC GIS and Geo-Server
10. Application of Global Positioning System (GPS)

M.Sc. III-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS

ES - 303 T (Elective Paper –I-A): BIODIVERSITY AND CONSERVATION

Unit I

1. Biodiversity-Definition – Biodiversity Types - Global Biodiversity
2. Bio-geographical classification of India
3. Value of biodiversity- Direct use value - Consumptive value- Millets Benefits
4. Endemism and Biodiversity -Key stones species, Umbrella species, Flagship species
5. Loss of biodiversity- Peoples Biodiversity Registers (PBR's)

Unit II

1. India as a mega biodiversity nation
2. Bio-wealth of India – Forests- Deserts –Wetlands –Mangroves-Coral reefs -Rivers and lakes
3. Identification of Hot spots - Hot spots of India.
4. Extinct – Rare- Endangered- Threatened Flora and Fauna of India
5. IUCN Red List categories - Red Data Book and its significance - Conventions – CBD, CITES

Unit III

1. Conservation of biodiversity
2. Principles of conservation In-situ conservation - Protected areas -National parks- Wild life sanctuaries-Biosphere reserves- Sacred groves
3. Ex-situ conservation - Botanical gardens -Zoo parks
4. Role of NBPGR -NBAGR in the conservation of bio diversity
5. Policies on biodiversity conservation in India

Books Recommended

1. Global Biodiversity Assessment V.H.Heywood and RT Watson, Cam.univ.pre-1995.
2. Biodiversity principles and conservation Kumar and Asija Agrobios India-2000.
3. Essential Environmental studies S.P.Misra and S.N.PandeyAne Books India -2008.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES - 307 P (Elective Paper –I-A): BIODIVERSITY AND CONSERVATION

1. Important value index (IVI)
2. Similarity and Dissimilarity index
3. Diversity index
4. Identification of Endemic plant species
5. Identification of Medicinal plants
6. Identification of Exotic plants
7. Economic value species
8. Vegetation and Biodiversity
9. Identification of Millets and its importance
10. Preparation of Peoples Biodiversity Registers of a Village

M.Sc. III-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS

ES - 303 T (Elective Paper –I-B): DISASTER MANAGEMENT

Unit I

1. Definition of Disaster, Hazard, Vulnerability, Risk
2. Causative factors of disaster
3. Classification of disasters
4. Disaster management -Components of disaster management cycle
5. Risk management- Risk identification- Risk reduction- Preparedness, Prevention and Mitigation

Unit II

1. Important sectors in disaster management- health and medical care
2. Role of Communications, insurance, social work, NGO's, media, fire services
3. Police and paramilitary services - Armed forces for disaster management
4. Application of Remote Sensing and GIS in disaster management
5. Levels of disasters in India

Unit III

1. Survey and assessment of after-effects of a disaster
2. Causes, perception, management of various natural disasters like Flood-Landslides, Earthquakes, Tsunami
3. Causes and management of Coastal erosion-Cyclones-Volcanism-Forest fire
4. Crisis management-Quick response – Relief –Recovery- Development
5. Best practices and Policies on disaster management

Books Recommended

1. Singh, K.K. &. Singh, A.K. 2010. Natural and manmade disasters: vulnerability, preparedness and mitigation, Vol(1&2), M.D. publications. Pvt. Ltd. New Delhi.
2. Strahler, A.N. and Strahler, A.H. 1973. Environmental Geoscience – Interaction between natural systems and man: -Santa Barbara, California, Hamilton Publishing.
3. Talwar, A.K. &Juneja, S. 2009. Flood Disaster Management, Commonwealth publishers, New Delhi.
4. Vaidya, K.S. 1987.Environmental Geology, Tata McGraw-Hill Publishers.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES - 307 P (Elective Paper –I-B): DISASTER MANAGEMENT

1. Preparation of environmental zonation map for landslide.
2. Preparation of hazard zonation map for earthquakes.
3. Case studies on recent natural environmental and man-made hazards: tsunami and oil disaster
4. Study of various hazard prediction models.
5. Preparation of a plan for environmental hazard mitigation.
6. Geo-informatics Application in Disaster Management
7. Table Top and Mock Exercises based on Incident Response System
8. Early Warning Systems Techniques in Disaster Management
9. Study the Vulnerability mapping through map or imagery
10. Study the Risk assessment of Hazard

M.Sc. III-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS

ES -304 T (Elective Paper –II-A): RESOURCE MANAGEMENT

Unit I

1. Energy Resource -Source of Energy -Renewable and Non-renewable -Solar energy Wind energy-Tidal energy- Hydroelectric-Nuclear energy- Bio-energy
2. Biomass and Biogas-Eco-technology - Sustainable development
3. Mineral resources –Types- Mineral exploration-Methods of minerals extraction
4. Impact of over- Exploitation of minerals-Environmental effects of extraction
5. Fossil Fuels – Classification- Composition, and Characters of the energy content of Coal, Petroleum and Natural Gas

Unit II

1. Water resource - Global water balance, ice sheets and Fluctuation of sea levels
2. Types of water, overutilization of Surface and Groundwater
3. Conservation of water- Rain water harvesting
4. Eutrophication and Restoration of Indian lakes
5. Wetland conservation-Watershed management

Unit III

1. Land Resources - Land as resource land degradation causes -Man induced Landslides
2. Soil erosion-Prevention of Soil erosion
3. Forest Resources- Forest Distribution-Deforestation - Causes of deforestation
4. Conservation of forest -Production forestry – Aforestation- Social forestry- Agro-forestry - Protection of Forestry Reforestation of Sacred Forest -Reserve Forest
5. Social movements - Chipko movement - Apikko movement

Books Recommended

1. PD Sharma. 1996 Ecology and environment
2. Misra. S.N. 2010 Pandey Essential Environmental studies

M.Sc. ENVIRONMENTAL SCIENCE
(Practical Syllabus)
ES - 308 P (Elective Paper –II-A): RESOURCE MANAGEMENT

1. Production of biogas
2. Production of Hydrogen gas
3. Production of vermicompost
4. Rainwater harvesting -estimation of the quantity of rain on the rooftop
5. Techniques of restoration of lakes
6. Techniques of conservation of Wetlands
7. Identification of different types of coal
8. Finding the calorific value of coal
9. Quantitative Estimation of Conversion of inorganic carbon to organic carbon by plants.
10. Quantitative estimation of Oxygen released into the atmosphere by plants.

M.Sc. III-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS

ES -304 T (Elective Paper –II-B): HAZARDOUS AND BIOMEDICAL WASTE MANAGEMENT

Unit I

1. Hazardous Waste-Types-Status -Impacts
2. Types of hazardous wastes-Characterization and listing
3. Status of hazardous waste generation -Disposal practices in India
4. Impacts of hazardous waste on Environment- Soil–Groundwater-Coastal
5. Impacts of hazardous waste on wildlife and human health

Unit II

1. Hazardous waste Treatment- Storage-Disposal Facilities
2. Waste processing- Secure landfill -Incineration -Recycling
3. Hazardous waste determination and disposal site selection
4. EIA and mitigation approaches for environmental impacts
5. Case studies and best practices

Unit III

1. Biomedical waste definition - Category of waste
2. Management –Segregation-Collection -Transportation
3. Treatment and Disposal system-Incinerator-Autoclave-Microwave
4. Worker safety in Handling Hazardous waste
5. Legislation in India: Biomedical Wastes (Management and Handling) Rules,1998

Books Recommended

1. Harry Freeman, Harry M. Freeman., Standard handbook of Hazardous waste treatment and disposal. Mc Graw Hill. (1998).
2. Hazardous Waste Management, LaGrega M.D., Buckingham P.L. and Evans J.C., Waveland Pr Inc., 2010, Reissue Edition
3. Harish K.(2001) Environmental Health Hazards. Sarup& Sons, New Delhi.
4. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
5. Ministry of Environment & Forest: Guidelines for Transport, Storage and Disposal of Hazardous Waste. New Delhi.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES - 308 P (Elective Paper –II-B): HAZARDOUS AND BIOMEDICAL WASTE MANAGEMENT

1. Examine physical and chemical characteristics of hazardous wastes
2. Composition of industrial hazardous wastes
3. Classify waste as hazardous or non-hazardous waste according to regulations
4. Classification and segregation of the biomedical waste
5. Waste disposal Best practices in hospitals
6. Sampling techniques for hazardous waste collection
7. study of color coding for segregation of hazardous waste
8. Mapping of percolation rate for different soil types
9. site suitability studies for hazardous waste disposal site
10. Studies on site suitability for installation of incarnation plants

M.Sc. IV-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES -401 T (Core Paper –1): ENVIRONMENTAL BIOTECHNOLOGY

Unit I

1. Biodegradation and Bioremediation- Degradation of Cellulose-Hemicelluloses - Lignin
2. Biodegradation of pesticides- Aromatic and Aliphatic Hydrocarbons
3. Bioremediation in-situ and ex-situ, Bioremediation of contaminated soils
4. Phytoremediation- Rhizofilteration-Phytoextraction- Phytotransformation Phytostimulation- Phytostabilisation
5. Bioindicators- Algae and macrophytes

Unit II

1. Biofertilizers and Biopesticides- Mass cultivation and application of Rhizobium, BGA, Azolla and Anabena
2. Blue-green algae - reclamation of alkaline and saline soils
3. Symbiotic cyanobacteria –Algalization-BGA and nitrogen fixation
4. Fungal biofertilizers - AM mycorrhiza and ectomycorrhiza, Vermicomposting.
5. Isolation and purification of important biopesticides: Trichoderma Pseudomonas-Bacillus thuringensis, Nuclear polyhodrosis virus

Unit III

1. Industrial Microbiology- Fermentation technology- Bio-fermentors -Major products of microbes -Alcohols, Antibiotics, Aminoacids and Organic acids
2. Immobilization technology -Methods of Immobilization and applications
3. Hydrogen Evolving bacteria - Methanogenesis
4. Biomining: Microorganisms in mineral recovery, indirect leaching, and direct leaching
5. Biosurfactants, definition, classification, types and their application in environment, petroleum recovery and other fields

Books Recommended

1. Microbial ecology fundamentals and applications - Ronald M. Atlas and RichardBartha 4thd Ed. Aimprint of Addison Wesley Longman Inc. - 1998
2. Environmental biotechnology principal and applications — Bnice. E. Rittmann and Perry L. Mc Carty McGraw Hill Int- 2001
3. Environmental biotechnology — SK Agarwal APH Pub. 1998.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES -404 P (Core Paper –1): ENVIRONMENTAL BIOTECHNOLOGY

1. Demonstration of agarose gel electrophoresis
2. Biosurfactant isolation and its characterization
3. Demonstration of the fermenter and its part and its functioning
4 Use of microbes in fermentation technology (Alcohols, Antibiotics)
5. Isolation of pure cultures in fermentation processes.
6. Cellulose and lignin-degrading enzymes
7. Experiment showing Phytoremediation
8. Bio-indicators: Use of Biological organisms
9. Role of Biofertilizers in the Environment Vermicomposting
10. Reclamation of soils

M.Sc. IV-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS
ES -402 T (Core Paper –2): ENVIRONMENTAL TOXICOLOGY

Unit I

1. Basic concepts of Eco-toxicology - Introduction to eco-toxicology - Principles of toxicology- Scope of toxicology
2. Types of toxic substances - Degradable and Non-Degradable
3. Factors influencing toxicity-Drug Toxicity
4. Biochemical basis toxicity – Mechanism of toxicity and receptor mediated events, Acute And Chronic toxicity
5. Toxic agents- Metals –Solvents -Vapours - Radiation -Chemical carcinogens- Food additives

Unit II:

1. Toxic substances in the environment - Sources and Entry routes
2. Transport of toxicants by air and water: Transport through food chain - bioaccumulation and biomagnifications of toxic materials in food chain.
3. Toxicology of major pesticides- Biotransformation – Biomonitoring -Concept and groups of bio-indicators
4. Environmental impacts of pesticides
5. Physiological and metabolic effects of chemicals on flora and fauna.

Unit III

1. Evaluation of toxicity -Methods and classification of toxic materials
2. Concepts of Bioassay- Types- Characteristics
3. Importance and significance of bioassay- Microbial bioassay for toxicity testing- Bioassay test models and classification.
4. Threshold limit value- LC_{50}- LD_{50}-Toxicity Testing -Concept of Dosimetry: lethal, sub-lethal and chronic tests
5. Dose response curves

Books Recommended

1. Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor &Francis Ltd
2. Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
3. Environmental Pollution and Toxicology – Meera Asthana and Astana D.K., Alka printers, 1990.
4. D.K Asthana Environmental: Problems and Solutions (2005)
5. Basic Toxicology, Frank .C. Lu, Hemisphere Publishing Corporation, New York, Washington (1993)

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES -405 P (Core Paper –2): ENVIRONMNETAL TOXICOLOGY

1. Effect of effluents containing heavy metals on seed germination
2. Determination of LC_{50} and LD_{50}
3. Methylene Blue Reduction Test (MBRT) for testing milk samples
4. Identification of residues of Pesticides on fruits/vegetables
5. Effect of sewage sludge containing heavy metals on seed germination
6. Determination of dust accumulation on leaf samples for polluted and control environment
7. Test of carbohydrates and proteins in food stuffs
8. Determination/estimation of adulterants in food samples
9. Toxic effect on chlorophyll content of the plants exposed to toxicants/pollutants
10. Study of symptoms and effects of heavy metals on plant growth

M.Sc. IV-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS

ES 403 T (Elective Paper III-A): ENVIRONMENTAL IMPACT ASSESSMENT

Unit I

1. EIA Definition -Need - Scope –Objectives - Concept And Origin
2. Types of EIA and EIA notification 1994
3. Stages of EIA - Environment Impact Evaluation and Statement
4. Project Screening, Scoping-Baseline data (Air, Water, Biological Environment) – Legal and other requirements
5. EIA methodologies – Checklist, Matrices and Networks, Cost Benefit Analysis

Unit II

1. Environmental Audit -Basics of Environmental Audit and its need
2. Types of Environmental Audits
3. Environmental Appraisal and Environmental Accounting
4. Life Cycle Assessment - Environmental audit: Pre-Post audit process
5. Eco labelling and EIA Format

Unit III

1. Prediction and Evaluation of Impacts - Application of Environmental Standards- ISO 14000 standards certification
2. Environmental Management Plan (EMP)- Environmental Monitoring Public Participation
3. Air (Prevention and Control of Pollution) Act 1981 and 1987
4. Water (Prevention and Control of Pollution) Act-1974 and 1988
5. Environmental Protection Act 1986- Wild Life Protection Act-1972 and 1991- Forest Conservation Act-1980

Books Recommended

1. Canter, L.W., (1996). Environmental Impact Assessment, Mc Graw Hill, New York.
2. Environmental Impact Assessment and Management by H. Kumar (1998)
3. Environmental Impact Assessment of Tehri dam by V. Govardhan.
4. Practical guide to Env. Impact Assessment, Belly Bowers and Marriott 1977.
5. Environment Impact Assessment - AK Shrivastava, APH Pul.-2003.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES -406 P (Elective Paper III-A): ENVIRONMENTAL IMPACT ASSESSMENT

1. EIA methods and variables
2. Cost – benefit analysis
3. Elements of ISO 14000 series standards
4. Environment auditing procedures and report writing
5. Environmental damage measurement methods
6. Safety components and planning
7. Risk assessment methods
8. Preparation of Environmental Impact Statement
9. Predicting techniques (impact prediction)
10. EIA Format

M.Sc. IV-SEMESTER ENVIRONMENTAL SCIENCE SYLLABUS

ES 403 T (Elective Paper III-B): URBAN ECOSYSTEMS AND GREEN CHEMISTRY

Unit I

1. Introduction to Urbanization- Urban Sprawl and environmental issues
2. Urban ecosystem- Commoditization of nature metros, cities and towns as sources and sinks of resources
3. Resource consumption and its social, cultural, economic and ecological perspectives
4. Urban transformation causes
5. Increasing challenges posed by modernity for the environment

Unit II

1. Natural spaces in a city – Scope –Importance - Threats to nature in the city
2. Organization and planning of green spaces such as Parks, Gardens and Public spaces
3. Concept of green belts; urban natural forest ecosystem as green lungs
4. Introduction to Green buildings- Urban Governance -Smart cities
5. Management of Urban Environment

Unit III

1. Introduction to Green Chemistry- Principles and recognition of green criteria in chemistry
2. Biodegradable and bio-accumulative products in environment
3. Green alternatives- Photodegradable plastic bags - Green practices to conserve natural resources (organic agriculture, agro-forestry, reducing paper usage and consumption)
4. Waste reduction instead of recycling – Carbon Credits
5. Role of advancement in science in developing environmental friendly technologies

Books Recommended

1. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
2. Richter, M. & Weiland, U. (ed.). 2012. Applied Urban Ecology. Wiley-Blackwell, UK.
3. Anastas, P.T. & Warner, J.C. 1998. Green Chemistry: Theory & Practice. Oxford University Press.
4. Arceivala, S.L. 2014.
5. Green Technologies: For a Better Future. Mc-Graw Hill Publications.

M.Sc. ENVIRONMENTAL SCIENCE

(Practical Syllabus)

ES -406 P (Elective Paper III-B): URBAN ECOSYSTEMS AND GREEN CHEMISTRY

1. Estimate the carbon credits of various activities
2. Identify the greenbelt areas, types of plants and measures for improvement
3. Determination of carbon footprint of solid waste
4. Prepare the green audit of selected areas
5. Identify the urban green space (parks and garden) and explore the types of plants with its importance
6. Preparation of briquettes from municipal solid waste
7. Reuse and recycle of construction and demolition waste
8. Reuse and recycling of plastic items
9. Study the types of biogas plant and biogas production from organic waste
10. Combustion efficiency evaluation –design of a biomass cook stove