DEPARTMENT OF ENVIRONMENTAL SCIENCE
University of Kalyani

PROPOSED SYLLABUS

FOR

M. Sc. COURSE IN ENVIRONMENTAL SCIENCE

(Session 2021 –2022, Semester wise Syllabus under CBCS System)

Semester-based Curriculum Structure under CBCS (w.e.f. Academic Session 2021-2022)

SEMESTER I

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 101	Ecology and Environmental Biology	(L + P)	4 + 2	50 + 25
COR 102	Environmental Chemistry	(L + P)	4 + 2	50 + 25
COR 103	Environmental Geology	(L + P)	4 + 2	50 + 25
COR 104	Environmental Geography	(L + P)	4 + 2	50 + 25
AECC	Environmental Awareness, activities, and documentation / Community Outreach activities and documentation / Term paper and scientific writing/ Communicative English / Lecture	(L)	2	25
	Total		**26**	**325**

SEMESTER II

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 205	Environmental Pollution and Waste Management	(L + P)	4 + 2	50 + 25
COR 206	Environmental Physics	(L + P)	4 + 2	50 + 25
COR 207	Environmental Toxicology and Physiology	(L + P)	4 + 2	50 + 25
COR 208	Land Degradation and Land Use Management	(L + P)	4 + 2	50 + 25
GEC (CBCS)	Applied Environment	(L)	4	50
	Total		**28**	**350**

SEMESTER III

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 309	Application of Remote Sensing and GIS	(L + P)	4 + 2	50 + 25
COR 310	Environmental Microbiology and Biotechnology	(L + P)	4 + 2	50 + 25
COR 311	Environmental Statistics	(L + P)	4 + 2	50 + 25
COR 312	Environmental Impact Assessment and Environmental Legislations	(L + P)	4 + 2	50 + 25
DSE 301 **(Any one)**	a) Human Ecology	(L + P)	4 + 2	50 + 25
	b) Environmental Management	(L + P)		
	c) SWAYAM	(L + P)		
SEC **(Any one)**	a) Research Methodology and Advanced Techniques in Environmental Investigation	(L)	2	25
	b) Mathematical methods and environmental modelling			
	Total		**32**	**400**

SEMESTER IV

Paper code	Paper	Theory/ Practical	Credit	Marks
DSE 402 **(Any one)**	a) Hydrogeology and Water Resource Management	(L + P)	4 + 2	50 + 25
	b) Soil Science	(L + P)		
DSE 403 **(Any one)**	a) Green Technology and Sustainability	(L + P)	4 + 2	50 + 25
	b) Environmental Technology	(L + P)		
DSE 404 **(Any one)**	a) Resource Management and Environmental Economics	(L + P)	4 + 2	50 + 25
	b) Landscape Ecology and Social Environment	(L + P)		
DSE 405 **(Any one)**	a) Wildlife biology and Management	(L + P)	4 + 2	50 + 25
	b) Radiation Hazard, Occupational Safety and Disaster Management	(L + P)		
Project/Dissertation			8	100
	Total		**32**	**400**
	Grand Total		**118**	**1475**

COR: Core Course, AECC: Ability Enhancement Compulsory Course, SEC: Skill Enhancement Course, GEC: Generic Elective Course, DSE: Discipline Specific Elective.

Semester I
Course : COR 101 (L)

ECOLOGY AND ENVIRONMENTAL BIOLOGY

Total no. of lectures: 30 **Full Marks – (10+40)**

1. Ecology:

Scope of ecology; origin of life and theories of organic evolution; Population ecology–growth curve and regulation, community–structure, functions and development, niche and habitat concept.

Ecosystem concept, structure, function and dynamics, energy flow, productivity, regulation, Ecosystems of India.

Ecological succession.

2. Environmental Biology:

Phenetics and Cladistics, Diversities of life forms (Plants, animals and microbes); Biodiversity categories, measurement methods, (computational methods); importance of biodiversity; causes and consequences of biodiversity loss; Biodiversity conservation–need and strategies of conservation practices (In-situ and Ex-situ); Biodiversity management policies (National and International efforts) in relation to biodiversity protection of a country; Bioprospecting and Biopiracy issues. Status of India's biodiversity and National action plan for protection of Biodiversity. Role of Botanical survey and zoological survey in biodiversity documentation and conservation.

Forest Ecology – Forest types of India and their distribution; Analysis of forest communities, values of forests, National and International efforts for forest conservation; people's biodiversity register, Forest Management Practices; Scope and Future of National Green Mission.

Aquatic Ecology – Aquatic ecosystems and their structure, composition and functions; Eutrophication, restoration of aquatic ecosystem in India; Wetlands of India – their status, values and conservation priorities, Ramsar sites in India, Biomonitoring of water quality.

Microbes and their relationship in relation to biogeochemical cycles; crop diseases and public health.

Coastal and Marine ecosystems – components, zonation, and ocean acidification.

References:

1. Fundamentals of Ecology–E. Odum.
2. Ecology–P. Collinvaux.
3. Ecology– R.E. Ricklefs and G.C. Miller.
4. Fundamentals of Ecology and Environmental Biology – S. C. Santra.

Course : COR 101 (P)

ENVIRONMENTAL BIOLOGY AND ECOLOGY PRACTICAL

Total no. of lectures: 15 **Full Marks – (5+20)**

1. General guidelines of Laboratory Safety and laboratory induction.
2. Qualitative and quantitative study of planktons.
3. Measurement of coliform load of surface water.
4. Measurement of primary productivity.
5. Phyto-sociological analysis of vegetation by quadrate study method / analysis of frequency, density, abundance/dominance, basal cover and important value index (IVI).
6. Assay of antimicrobial properties of plant extracts.

Pollen viability study.

7. Field Study (under normal and usual condition).

References:

1. Work book on Limnology–A.D. Adoni.
2. Botany Practical (Vol I and II)–S.C. Santra.
3. Microbiology: a laboratory manual (2005) - Cappuccino, J. G., and Sherman, N.
4. Biochemical methods (1996). Sadasivam, S. New age international.

Course : COR 102 (L)

ENVIRONMENTALCHEMISTRY

Totalno.oflectures:30 **FullMarks –(10+40)**

1. FundamentalsofEnvironmentalChemistry

Stoichiometry,Chemicalequilibria,Solubilityproduct,Solubilityofgasesinwater, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.

Order and molecularity of a reaction,Basic kinetic laws – first second,third order reactions;Determinationofrateconstant,TheArrheniusequation,Steadystate and equilibrium concept,EnzymeKinetics.

Lawsofphotochemistry;Quantum yield,FluorescenceandPhosphorescence,Photochemicalandphotosensitizedreactionsintheatmosphere,Chainreaction.

Classificationofelements,HSABprinciple,Stabilityofcomplexes,Coordination,organometallica nd organometalloidalcompounds,Structure-toxicityrelationship.

Conceptofchelates,chelation therapy.

Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur.

Bio-essential, trace, toxic metalsandtheirroleinlifeprocesses; Heme,Chlorophyll,CytochromeC.

2. AnalyticalMethodsinEnvironmentalQualityAssessment

Principles, instrumentation, applications and limitations of the following analytical techniques.

TitrimetryandGravimetry.

Spectroscopy : UV-Vis, AAS, Fluorimetry, ICPMS, ICP-AES, GC-MS, FTIR.

Chromatography : Gas Chromatography, HPLC, Ion Chromatography.Gelelectrophoresis, Ion meter.

X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF), Energy dispersive X-Ray Fluorescence (EDXRF).

Electron microscopy : SEM, TEM.

Nuclear Magnetic Resonance (NMR).

Laboratorycertificationandstandardization.

References:

1. 'Physicalchemistry'– P.W.Atkins–OxfordUniversityPress.
2. 'PrinciplesandPracticeofAnalyticalChemistry'–F.W.FrifieldandD.Keatey –Blackwell Science.
3. Vogel'sTextbookofqualitativeandquantitativeanalysis–ELBS.
4. 'Handbookofanalyticalinstruments'–Khandpur–TataMcGrawHill.
5. 'TheHeavyElements–Chemistry;EnvironmentalimpactandHealthEffects'–Jack
6. E.Fergusson,-PergamonPress.
7. 'ElementsofBioinorganicchemistry'– G.N.MukherjeeandA.Das.
8. EnvironmentalChemistry(3rd Ed.)A.K.De,WileyEdation.

9. 'InorganicChemistry'-Shriver and Atkins,OxfordPress,5th Edition.
10. 'Environmentalchemistry'–S.E.Manahan,-VillardGrantPress,USA.

Course : COR 102 (P)

ENVIRONMENTAL CHEMISTRY PRACTICAL

Total no. of lectures: 15 **Full Marks – (5+20)**

1. General guidelines of Laboratory Safety and laboratory induction.
2. Chromatography :Paper/column/thin layer/gas liquid chromatography– and their application in separation of amino acids/sugars/organic compounds.
3. Flame photometer: Application of flame photometry in estimation of Na, K etc.
4. Estimation of concentration of ions using spectrophotometric and spectrofluorimetric studies.
5. Preparation of standard curve and verification of Beer's law.
6. Analysis of organic and inorganic substances.
7. Stoichiometry determination and association constant calculation.
8. Quantum yield calculation.
9. Enzyme assay.
10. Adsorption study of toxicants.
11. Demonstration of analytical instruments: Atomic Absorption Spectrophotometer, UV-VIS Spectrophotometer, Spectrofluorimeter, Ion meter, Gel-Doc, Ultracentrifuge, Fluorescence microscope, Gas Chromatograph, Ion Chromatograph etc.

References:

1. 'Standard Methods for the examination of water and wastewater'–21st edition, 2005, APHA, AWWA.
2. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water pollution studies. Environmental publication (Karad, India).

Course : COR 103 (L)

ENVIRONMENTAL GEOLOGY

Total no. of lectures: 30 **Full Marks – (10+40)**

Origin of earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.

Geological time scale: An overview, paleoecology (Quaternary and phanerozoic, paleontology). Reconstruction of paleogeography, Paleoclimate.

Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements.

Common rocks and minerals: Major categories and their mode of origin. Physical and chemical weathering of rocks.

Geomorphological process: Process and forms (Fluvial, eolian, glacial, coastal and Karst), Controls on formation of landforms. Fundamentals of structural geology and tectonics.

Hydrological cycles and groundwater issues: (Aquifers, Aquitards, Darcy's law and hydraulic conductivity). Groundwater quality and contamination with reference to arsenic, fluoride and nitrate.

Natural hazards and its management: Drought, Flood, Earth quake, Landslide, Volcanism, Avalanche, Tsunami, And Cloud Bursts. Prediction of hazards and mitigation of their impacts.Difference between disaster and natural hazard.

Fossil fuel like coal, oil, gas, petroleum, and coal bed methane (CBD), Environmental issues of mineral exploration and exploitation, environmental impact of mining, eco-restoration in mining areas.

Geological considerations of engineering constructions: Dam, Road, and Rail link, Landslide area.

Concept of residence time and rates of natural cycles, Geophysical fields.

References:

1. Environmental Geology by E.A. Keller – Charles E. Merrill Publishing Company.
2. Environmental Geology by C.W. Montgomery – McGraw–Hill International.
3. Principles of Geomorphology–W.D. Thornburry– Wiley Eastern.

Course COR 103 (P)

ENVIRONMENTAL GEOLOGY PRACTICAL

Total no. of lectures:15 **Full Marks –(5+20)**

1. Thematicmapgeneration usingSOItoposheet and satellite imagery.Qualitativeandquantitativeanalysisoflandform anddrainagebasinsandtheirenvironmentalinterpretation.
2. Hand specimen study ofcommonrocksandminerals:microscopicstudyof common rocks.Modelstudyofstructuralfoldsandfaults.
3. Onefieldtour (under normal and usual condition) forappraisalofcommonlandforms,rocks/minerals/ mines/miningprocess;duration2-4days.

References:

1. Practical Geography: A systematic approach – Ashish Sarkar, Orient Black Swan Pvt. Ltd. 3rd edition.

2. Tyrrell, G. W. (2012). The principles of petrology: an introduction to the science of rocks. Springer Science & Business Media.

3. MacKenzie, W. S., Adams, A. E., & Brodie, K. H. (2017). Rocks and minerals in thin section: A colour atlas. CRC Press.

Course : COR 104 (L)

ENVIRONMENTAL GEOGRAPHY

Total no. of lectures: 30 **Full Marks – (10+40)**

1. Environmental Geography

Environmental geography– evolution and objectives.

Man-environmental relationships– hunting, gathering, fishing, mining, acquiring forestry.

Environmental degradation– Causes, effects, remedies. Drought and desertification, climate change, tsunamis, coastal inundations and floods, melting of polar ice.

Landuse and land cover, causative factors of land use change, case studies.

Biogeographic provinces of the world and agro-climatic zones of India.

2. Weather and Climate

Meteorology – Origin, composition and structure of atmosphere, Coriolis force, pressure gradient force, frictional force, geostrophic wind field, gradient wind,General circulation of the atmosphere, scales of atmospheric motions, selective absorber of atmosphere, atmospheric window, planetary boundary layer.

Solar Radiation – origin of solar radiation, characteristics of solar radiation, Energy budget of the earth, Earth's thermal environment and seasons.

Temperature – factors, characteristics, distribution, measurement.

Pressure – types, characteristics, measurement.

Humidity – Types, measurements.

Cloud – Types, Mechanisms of the formation of convective clouds, charge generation in a thunder cloud, thunder storm.

Precipitation – Types, regional distribution of precipitation.

Atmospheric disturbances – Structure of cyclones and anticyclones.

Indian Monsoon – components, Idealized model of summer monsoon circulation, rainfall pattern, western disturbance, El Nino, La Nina, droughts.

Climate – Types, climates of India, continental and oceanic influence, importance in crop production.

Numerical weather forecasting.

References:

1. An introduction to Physical Geography -A.N. Strahler, and Strahler, 1996, London, John Wiley and Sons.
2. Geography–S. Singh, 1991. Pragag Pustak Bhawan, Allahabad.
3. Climatology–D.S. Lal.

4. Physical Climatology– D.W. Sellers, 1965, Chicago, Checago University Press.
5. Atmosphere, Weather and Climate–R.G. Barry and R.J. Chorley, 1999, London, Routtedge.

Course : COR 104 (P)

ENVIRONMENTAL GEOGRAPHY PRACTICAL

Total no. of lectures: 15 **Full Marks – (5+20)**

1. Toposheet interpretation and map projection:
   a) Dimension and scale of Indian Topographical Map (SOI).
   b) Identification of features on Topographical Sheets.
   c) Geomorphometry (Dissection index, Ruggedness number, Stream frequency, Bifurcation ratio).
   d) Transect Chart (from cross sections).
   e) Thematic mapping using QGIS software.
2. Weather data interpretation:
   a) Pressure Conditions: Trends of Isobars, Pressure Gradient.
   b) Wind Conditions: Wind Direction, Wind Velocity.
   c) Sky Conditions: Nature of Clouds, Cloud Cover.

References:

1. Practical Geography – A. Sarkar, 2015, 3rd Edition, Orient Blackswan Private Limited, New Delhi.
2. Advanced Practical Geography - Pijushkanti Saha and Partha Basu, 2013, Books & Allied Ltd.

Course : AECC (L)

Total no. of lectures: 15 **Full Marks – (5+20)**

Environmental Awareness, activities, and documentation / Community Outreach activities and documentation / Term paper and scientific writing/ Communicative English/ Lecture.

Semester : II

Course : COR 205 (L)

ENVIRONMENTALPOLLUTION AND WASTE MANAGEMENT

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Air Pollution

Chemicalreactionsintheatmosphere:Formationoforganicandinorganicpollutants,Acidrainandphotochemicalsmog, Ozone chemistry, CFC's, Ozonedepletionanditsimpactonglobalclimate, Temperature inversion, Greenhouse effect, globalwarming and their consequences,El-ninoeffect,Nuclearwinter.

Airqualitystandards,Ambientairsampling,Analysisandmeasurement;Mitigativemeasures,Indoor air pollution and control strategies;Vehicularpollutionandautomotivestandard.

Airpollutionmanagement.

2. WaterPollutionandWaste Water Treatment

Water qualityandstandards.

WateracidityandCarbondioxideinwater.

Typesofpollutant–Organicpollutants,detergents,oilandpesticides.

WaterTreatment-Municipalwatertreatment-Physicalprocesses-chemicalprocessesandbiologicalprocesses-Unitoperations-Unitprocesses.

WastewaterEffluentstandards,Environmentalimpacts–Regulatoryrequirements–generationrates–characterization–ToxicityandBioassaytests.

Primary, secondary and Advanced/tertiary treatments - Activated Sludge, Trickling Filters, RotatingBiological Contactors, Activated Biofilters. Individual and Common Effluent Treatment Plants –Zeroeffluentdischarge systems.

Thermalpollution,OilPollutionandMarinePollution.

3. ToxicchemicalsandHeavymetal pollution:

Definition,Properties,fateandtransportofpollutantsintheenvironment.Pesticides and their classification and effects. Heavy metals- Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O_3, PAN, VOC and POP. Carcinogens in the air.

Chemicalspeciation:Hg,Se,Asetc.

4. Solid and Hazardous Waste Management

Types and Sources of solid and hazardous wastes–Need for solid and hazardous waste management–Legislations on management and handling of municipal solid wastes.

Hazardous wastes: Biomedical wastes, Radioactive wastes, Electronic wastes.

Waste processing –Biological and chemical conversion technologies–Composting-Thermal conversion technologies – Energy recovery– Solidification and stabilization of hazardous wastes.

Waste minimization –Waste audit.

Disposal in landfills–land fill bioreactors–leachate and landfill gas management–landfill remediation.

Swachha Bharat Abhiyan.

Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011.

References:

1. 'EnvironmentalChemistry'–S.E.Manahan,-VillardGrantPress,USA.
2. 'EnvironmentalEngineering'–H.S.Peary,D.R.RoweandG.Tchobanoglous,-McGrawHill.
3. 'EnvironmentalChemistry'–G.W.Vanloon,S.J.Duffy,-OxfordUniversityPress.
4. 'WaterPollution–Causes,Effects,andControl'–P.K. Goel,NewageInternational
5. 'AtmosphericChemistry'–J. Heichlen,A.P.NY.
6. 'EnvironmentalPollution'–H.M.Dix.
7. 'PollutionAbatement'–K.M.Clayton.
8. 'EnvironmentalEngineering'A.DesignApproach'– A.P.Sincero,G.A.Sincero'–PrinticeHalIndia.

Course : COR 205 (P)

ENVIRONMENTALPOLLUTION AND WASTE MANAGEMENT PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Physicochemicalanalysisofwaterandwastewater–pH, Conductivity, Turbidity,DO,BOD,COD.
2. DeterminationofMLSS,MLVSS,SVI,SDI.
3. Determinationofoil, grease and phenolicsfromwastewatersample.
4. Analysisofanions:Sulphate,Phosphate,Nitrate,Fluoride,Chloride using ion meter / Ion Chromatography/ Spectrophotometry.
5. Physicochemicalanalysisofsoil– pH, Conductivity, Texture,Hardness,Organiccarbon,Nitrate,phosphate, water holding capacity and bulk density.
6. DeterminationofHg/Pb/Cr/FeusingAAS/Photometry.
7. Airqualitymonitoring(Particulate matter, SOx, and NOx).
8. Measurementofphytotoxicityofmetalsthroughseedgerminationtest.
9. Fieldtrip (under normal and usual condition) forenvironmentalqualitymonitoring/Industryvisit.

References:

1. 'StandardMethodsfortheexaminationofwaterandwastewater'–21stedition,2005,APHA,AWWA.
2. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water

pollution studies. Environmental publication (Karad, India).

Course : COR 206 (L)

ENVIRONMENTAL PHYSICS

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Basics of Environmental Physics

Laws of thermodynamics, heat transfer process, mass and energy transfer across various interfaces, material balance, reversible and irreversible processes, Carnot cycle, Thermodynamic functions, Maxwell relations, Laws of thermochemistry.

2. AtmosphericStability

Conceptofairparcel,Temperatureinversion, mixing ratio, saturation mixing ratio, adiabaticlapseratefordryandmoistair,environmental lapse rate, potentialtemperatureandequivalent potentialtemperature,atmosphericstability.

3. Transportofpollution

EffectsofstructureandTerrainonthedispersionofplume,airpollutionconcentrationmodel-Fixedboxmodel,Gaussianplumemodel-Dispersionequationandlimitations.

4. Noise and measurement

Sources, weighting networks, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, L_{DN}, TNI), Noise control and abatement measures: active and passive methods. Vibrations and their measurement, impact of noise on human heath, Bioacoustics-perceptionofloudness,combinationoftones–Soundanalysis.

5. Radiation and radioactivity

Radioactivity, Sources, radioactive decay, Laws of radioactivity, radioactive pollution and control measures.

Radiation, scattering of electro-magnetic radiation, radiation and wind velocity, ionizing and Non-ionizing radiation, measurement of radiation, biological effects of ionizing radiation, radiation exposure and radiation standards, protection against radiation.

Radioisotopes and applications.

6. TechniquesinEnvironmentalphysics

CommonWeatherand DopplerRadar, Monostatic Radar,LASER, LIDAR,Biosensor-principleand application, radioactivity measurement counters.

References:

1. SolaractivityandEarth'sclimate–R.E.Benestad(Blindun,Norway).
2. RadiationBiophysicsE.L.Aplen(AcademicPress).
3. BiologicalthermodynamicsD./T.Haynil(CambridgeUniv.Press).
4. PhysicsoftheenvironmentandClimateGerandGuyo(JohnWileyandSons).
5. AtmosphericdynamicsJohnGaun(CambridgeUniv.Press).

Course : COR 206 (P)

ENVIRONMENTAL PHYSICS PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. (T-Φ) gramandanalysisofradiosondedata.
2. Determination of thermodynamic functions (enthalpy, entropy, and Gibb's free energy).
3. Estimation of relative humidity using dry bulb and wet bulb thermometry.
4. Estimation of electromagnetic radiation using electromagnetic field meter; Principles and applications.
5. Preparation of wind rose plots for meteorological data / air dispersion modelling using software.
6. Measurement of Noise pollution index, interference level and measurementofnoiselevel.
7. Field (under normal and usual condition) visitforstudyofmicroclimate, transport, anddispersionofpollutantsfrom industries.

References:

1. Rakshit, P. C. (1984). Elementary physical chemistry.

2. Practical Geography – A. Sarkar, 2015, 3rd Edition, Orient Blackswan Private Limited, New Delhi.

3. Réfrégier, P. (2004). Noise theory and application to physics: from fluctuations to information. Springer Science & Business Media.

4. Salby, M. L. (1996). Fundamentals of atmospheric physics. Elsevier.

Course : COR 207 (L)

ENVIRONMENTALTOXICOLOGY AND PHYSIOLOGY

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Environmental Toxicology

Toxicology – an overview; Dose – response relationship; potency vs toxicity, margin of safety concept, hypo and hypersensitivity.

Ecotoxicologyofenvironmental pollutants.

Biological factors that influence toxicity, chemical factors that influence toxicity.

Toxic elements, Heavy metal toxicity and their biochemical reactions.

Types of immunity, immunoglobulin structure, antigen-antibody reaction, MHC.

Allergyand other hypersensitivereactions, carcinogenesis – anoverview.

Advanced immunological and toxicological techniques (Radio immunoassay, ELISA, Immunofluorescence, and comet assay).

Forensic toxicology and its applications.

Industrial toxicology.

3. Environmental Physiology

Role of water, nutrient, and temperature in life – an overview.

Water stress in plants and animals; osmotic balance in aquatic plants and animals.

Temperature regulation in plants and animals.

Light stress: photoperiodic responses in plants and animals. Biological clock: an overview.

Endocrinology/hormones/growth substances in plants and animals.

Oxygen tolerance and stress enzymes.

Salinity tolerance and stress management in halophytes.

References:

1. Fundamentals of Ecology and Environmental Biology – S.C. Santra.
2. Ecology and Environment – P. D. Sharma.
3. Animal physiology, Adaptation and Environment - Knut Schmidt-Nielsen.
4. Environmentaltoxicology–Chandler.
5. Basictoxicology– FrankCLu.
6. Kuby Immunology, 7th Edition - Judith A. Owen, Jenni Punt, Sharon A. Stranford (2013).

Course : COR 207 (P)

ENVIRONMENTALTOXICOLOGY AND PHYSIOLOGY PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Measurementoftoxicitythroughbioassaytechniques (LD_{50} and LC_{50}).
2. Determination of antagonismofions.
3. Anatomicalstudiesofwaterstress adaptabilityinplants.
4. Quantification of secondary stress metabolites of plants – amylase,catalase.peroxidase, ascorbicacidoxidase, and phenolics.
5. Chromosomal aberration study of *Allium cepa* using toxicants.
6. Assayofphytohormone(Indole Acetic Acid)byspectrophotometricmethod.
7. Measurementofphenolicsandascorbicacidsinplants.

References:

1. BotanyPractical (Vol I)–S.C.Santra.
2. BotanyPractical (Vol II)–S.C.Santra.

Course : COR 208 (L)

LAND DEGRADATION AND LAND USE MANAGEMENT

Totalno.oflectures:30 **FullMarks - (10+40)**

1. Land Degradation

Land degradation– Occurrence, Causes, Types.

Waste Land–Types, causes, distribution, environmental effects of wastelands.

Desertification–Categories, genesis, regions affected by desertification, environmental effects of desertification and its control.

Management of wastelands–Problems and prospects.

Soil erosion, reclamation of degraded land.

Carrying capacity.

2. Land use Management

Land use –Concept, classification, factors.

Rural-Urban fringe - Concept, types, characteristics.

Urban sprawl - Concept, causes, characteristics, problems and management.

Land use model - Concentric zone model, Sinclair's model, Von Thunen model, Sector theory, Multiple nuclei theory.

Mapping of land use– Application of remote sensing and other tools.

Changes– Changes in land use over times - case study.

Planning–Land use planning and management of rural and urban land use.

Restoration– Technological approach for restoration of land use types.

References:

1. Assessment of Land Degradation: A Qualitative Approach – K.K. Singh, VDM Verlag Publisher.
2. Land Degradation: An Overview – E. Eswaran, R. Lal and P.F. Reich, Responses to Land Degradation. Proc. 2nd International Conference on Land Degradation and Desertification. New Delhi: Oxford Press.
3. Environmental Land Use Planning and Management – J. Randolph, Island Press.
4. Rural Settlement and Land Use – M. Chisholm, Routledge, UK.

Course : COR 208 (P)

LAND DEGRADATION AND LAND USE MANAGEMENT PRACTICAL

Totalno.oflectures:15 **FullMarks–(5+20)**

1. Land survey techniques: Principle, procedure, and applications.
2. Land use mapping of natural and cultural features with ground truth data of nearbyarea (under normal condition) using QGIS software.
3. Mapping of coastal geomorphological features using satellite data.
4. Area statistics of quantitative information.
5. Study of land use change pattern with temporal variation.
6. Model development on land use pattern–spatial entropy.

References:

1. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
2. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.

Course : GEC (CBCS)

APPLIED ENVIRONMENT

Totalno.oflectures:30 **FullMarks–(10+40)**

1. Environmental Resources

Resources:Renewableandnon-renewable,Resourceconsumption,SustainableDevelopment, Resource managementand conservation.

Forestresources:Useandoverexploitation,Mining,damsandtheireffectsonforestsandtribalpeople .Deforestationand afforestation-Case studies.

Surfacewater,Groundwater,Waterconservation,Watershedmanagement:Problemsandconcern, Rainwaterharvesting.

Land resources: land degradation, man induced landslides, soil erosion and desertification.Wetland conservationandWasteland management.

Biodiversity-Endemicspecies,BiodiversityHot-spot,Threatstobiodiversity,Conservationofbiodiversity.Renewableandnon-renewableenergysources andenergymanagement.

2. Pollution Studies

Atmosphericsegments,Airpollution,IndoorPollution,AutomobilePollution,Emissionstandard. Airpollutioncontrolstrategies.

Waterpollution,DrinkingandeffluentStandards,Wastewatertreatment,Solidandhazardouswaste management.

Soil pollution and its control strategies.Noisepollutionanditscontrolstrategies.

Radiation pollution, Nuclear accidents - Case studies.Cleanandadvancedtechnologiesforpollutionabatement.

3. EnvironmentalIssues

Photochemical smog and acid rain; Depletion of Ozone layer- Causes and consequences, El-nino, Globalwarmingand green houseemission, Climate changeand carbon mitigation.

Epidemic and Pandemic: National and global perspectives.

HumanpopulationandEnvironment.

4.Environmental Management Tools

Environmental Impact Assessment (EIA), Environmental Audit, Environmental Management System(EMS),EnvironmentallawsandProtectionactsofIndia.EnvironmentalMovements,Conventions,Protocols.

References:

1. Readinginresourcemanagementandconservation– I.burtonandK.W.Kates,1985,Chicago,Universityof Chicago Press.
2. Ground water–HermanBower.
3. Environmental Science,Cunningham,TMH
4. De,A.K.,"EnvironmentalChemistry",NewAge International.
5. Masters, G. M., "Introduction to Environmental Engineering and Science", PrenticeHall of India Pvt. Ltd.
6. S.C.Bhatia,Solidand HazardousWasteManagement,AtlanticPublishers.
7. EnvironmentalManagement,N.K. Oberoi.

Semester : III

Course : COR 309 (L)

APPLICATION OF REMOTE SENSING AND GIS

Totalno.oflectures:30 **FullMarks - (10+40)**

Principles of remote sensing: Electromagnetic radiations and their properties, interaction of earth surface features with EMR.

Physical basis of remote sensing: satellites (Indian remote sensing satellites and foreign satellites), sensors and platform, data collection visible to near infrared, fundamentals of microwave remote sensing, hyperspectral remote sensing.

Digital image processing and ground truthing.

Thematic information extraction using satellite data.

Application of remote sensing and GIS in land cover/land use planning and management (urban sprawling, vegetation study, forestry, natural resource), waste management and climate change. RS and GIS interface.

Thematic map preparation and spatial information, fundamentals of GIS, the components of geographical information system.

Raster and vector data structures.

References:

1. Introductory Digital Image Processing – J.R. Jensen.
2. Remote Sensing– Lillesand and Keifer.

Course : COR 309 (P)

APPLICATION OF REMOTE SENSING AND GIS
PRACTICAL

Totalno.oflectures:15 **FullMarks–(5+20)**

1. VisualinterpretationofstandardFCCdata.
2. Thematiclayercreation.
3. Digitalanalysisofsatellitedata (demonstration).
4. Digitizationofthematiclayers.Crossandoverlayanalysis (demonstration).
5. Digitalelevationmodel(DEM)generation (demonstration).

References:

1. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
2. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.

Course : COR 310 (L)

ENVIRONMENTALMICROBIOLOGY AND BIOTECHNOLOGY

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Environmental Microbiology

Classification of microorganisms, bacterial morphology and sub-cellular structures, staining techniques.

Factors controlling microbial growth, microbial growth kinetics, batch culture, continuous culture and synchronous culture.

Sources of microorganisms in environment, factors affecting the survivability of microorganisms in air, water, and soil.

Microbial nutrition, physical and chemical control of growth of microorganisms.

Pathogens and its impact on public health, microbial pathogenicity.

Nucleic acid – types, structure and functions, replication, transcription, and translation in prokaryotes.

2. Environmental Biotechnology

Understanding of Biotechnology – An overview.

Environmental biotechnology, concept, and broad outlines of various application areas – waste treatment, biodegradation of xenobiotic compounds, hydrocarbon degradation, biofuel production, biofertilizer, biopesticides production, and bioleaching.

Bioremediation: Concept, role of bioremediation in controlling various pollution problems – solid waste, wastewater (sewage and industrial effluents), heavy metals, radioactive substances, oil spillage.

Phytoremediation: Abatementof different typesofpollutionusingplants,types of phytoremediation, mechanism involved with case studies.

Integrated pest management: concept, technology involved in agriculture and forestry, Biopesticides application potential.

Biocomposting: – Microbial process involvement, vermicomposting.

Biomining: Extraction of Cu, Au, etc from Ore by microbes.

Biomethylation: Agro-industrial wastes.

Basic techniques in Genetic Engineering: Recombinant DNA technology and its application in strain improvement.

GM Crops and GMO: Environmental Implications.

Industrial microbiology – (production of wine, alcohol, acetone and antibiotics).

References:

1. Microbiology – Michael J. Pelczar Jr., E.C.S. Chan and Noel R. Krieg.
2. Principles of Microbiology – Roland M Atlas.
3. Prescott's Principles of Microbiology – Joanne Willey and Kathleen Sandman.
4. Environmental Biotechnology – A.K. Chaterjee.
5. Environmental Biotechnology (second edition) – Alan Scragg.
6. Environmental Biotechnology – Bimal C. Bhattacharyya, Rintu Banerjee.
7. Industrial Microbiology – L. E. Casida.

Course : COR 310 (P)

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Measurementofplantbio-molecules–Chlorophyll,ProteinandCarbohydrate.
2. Basic microbial techniques.
3. Isolation and characterization of microbes in air, water, and soil.
4. Microbial staining, observation and micrometry
5. Estimation of total DNA.
6. Gel–Electrophoresis : DNA/Protein separation technique.
7. PCRhandlingtechniques.

References:

1. BotanyPractical (Vol I and II)–S.C.Santra.
2. Cappuccino, J. G., & Sherman, N. (2005). Microbiology: A Laboratory manua . Dorling Kindersley (India). Pvt. Ltd. New Delhi, India, 1-453.
3. Sadasivam, S. (1996). Biochemical methods. New age international.

Course : COR 311 (L)

ENVIRONMENTALSTATISTICS

Totalno.oflectures:30 **FullMarks - (10+40)**

1. Datacollectionandsampling

Variables,Populationand sample, Samplingmethods,measurement of central tendency, parametersand statistics,Sampling error.

2. Presentationandlocationofdata

Frequencydistribution,Piegram,Bardiagram,Polygon,Histogram,Stemandleafplot, Venndiagram,Measuresofdispersion,Deviation,Variance.

3. ProbablityDistribution

Normaldistribution,skewness,kurtosis,recognitionofnormaldistribution, 't' distribution.

4. TestingofHypothesis

Nullhypothesis,levelofsignificance,alternativehypothesis,onetailandtwotailtests.

5. Nonparametricstatistics

ChisquaretestWilioxonsignedranktest,Utest.

6. Correlationandregression

Productmomentcorrelation,Spearman'srankcorrelation,simpleregressionanalysis.

7. MathematicalEcology

Classificationofmathematicalmodelling,processofmodelling,populationgrowthmodel,populationinteraction,Lotkaand Volteraprey predatorsystem,Leslie's matrix model, energyflow in multi ecosystem.

References:

1. Introductiontostatistics–C. Leach(J. WileyNewYork,USA).
2. MathematicalAnalysisformodellingJ.RosenblattandS.Bell(CRCPressLondon,UK).
3. StatisticsforEnvironmentalbiologyandToxicologyW.E.PiegroschandJ.A. Bailer(ChapmanandHallLondon,UK).
4. GeneralstatisticsW.ChaseandF.Bown(J. WileyNew York,USA).

Course : COR 311 (P)

ENVIRONMENTAL STATISTICSPRACTICAL

Totalno.oflectures:15 **FullMarks–(5+20)**

1. Graphicalpresentationofdata.
2. Frequencydistributionofdata.
3. Statisticalfluctuationsofdata.
4. Regressionanalysisofdata.
5. Useofstatisticalsoftware.

References:

1. Introductiontostatistics–C. Leach(J. WileyNewYork,USA).
2. MathematicalAnalysisformodellingJ.RosenblattandS.Bell(CRCPressLondon,UK).
3. StatisticsforEnvironmentalbiologyandToxicologyW.E.PiegroschandJ.A. Bailer(ChapmanandHallLondon,UK).
4. GeneralstatisticsW.ChaseandF.Bown(J. WileyNew York,USA).

Course : COR 312 (L)

ENVIRONMENTALIMPACTASSESSMENT AND ENVIRONMENTALLEGISLATIONS

Totalno.oflectures:30 **FullMarks –(10+40)**

1. EnvironmentalImpactAssessment

ConceptandscopeofEIA,principle andsalient features, EIAprocesses, methodologies,MOEFguidelines;Basicstepsof overallappraisalofdevelopmentprojects-baselinedatecollectionand generationfrom the field; Identificationand predictionof impactsof developmentproject;Evaluationofimpacts-different methods (checklist, adhoc, overlays, matrix,networkandBettleEnvironmentalEvaluationSystems)

PreparationEnvironmentalManagementplan(EMP)formitigation;Environmentalimpact statement; postprojectmonitoring– EnvironmentalAudit System;somecasestudiesofEIA/EMPandenvironmentalauditingsystem.

Industrial ecology, Industrial risk, hazard, and safety, occupational health hazards.

2. Environmentallaws,treaties, and regulation

International environmental summits and conventions, Concept of environmentallaws, pollution control acts, rules, notificationsin India, Environment related policy and it's resolution, WildlifeprotectionAct 1972, The water (Preventionand control of pollution) Act, 1974;ForestConservationAct1980,Air(Preventionandcontrolofpollution) 1981;TheEnvironmental (Protection)Act,1986;PublicLiabilityInsuranceAct,1991. Coastal Regulation Zone Notification, 1991, Biological Diversity Act, 2002, Municipal, Solid and Hazardous Waste (Bio-medical, Electronic, Plastic, etc) rules 2016 and amendments, National Green Tribunal Act (NGT), 2010, Sanctionandenforcementbodiesofenvironmentallaws-rolesofSupremeCourtandGreenBench ofHighCourtonenvironmentalprotectioninIndia, Case studies of NGT.

Vehicular emission norms in India.

Role of NGOs in environmental awareness and movements.

National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India',National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change).

National river conservation plan – Namami Gange and Yamuna Action Plan.

References:

1. EnvironmentalImpactAssessment–L.W. Canter.
2. EnvironmentalScience–S.C. Santra,NewCentralBook,Agency.
3. PollutionControlAct,rulesandNotifications–CBCB(2006).

Course : COR 312 (P)

ENVIRONMENTALIMPACTASSESSMENT AND ENVIRONMENTALLEGISLATIONS PRACTICAL

Totalno.oflectures:15 **FullMarks–(5+20)**

1. Baseline data (air, water, soil and noise) collection and identification of impacts from a study area.
2. Preparation of checklist of flora and fauna in surrounding areas of a proposed project for studying environmental impacts.
3. Socio-economical study (population, socio-economic status, health status, etc.) for preparing an EIA report.
4. Preparation of a draft Environmental /Energy Audit/ Environmental Compliance report of an industry.
5. Preparation of a draft EIA report for a developmental project/ an industry/ a mining project.

References:

1. EnvironmentalImpactAssessment–L.W. Canter.
2. EnvironmentalScience–S.C. Santra,NewCentralBook,Agency.
3. PollutionControlAct,rulesandNotifications–CBCB(2006).
4. Glasson, J., & Therivel, R. (2019). Introduction to environmental impact assessment. Routledge.

Course : DSE 301 (L) – 1a

HUMAN ECOLOGY

Totalno.oflectures:30 **FullMarks –(10+40)**

Human Populations, Resources and Environment Dilemma, Scope of Human Ecology, its importance in understanding conservation issues; People of India, diversity of culture and lifestyles.

Population resource region, Different modes of resource use and differences with respect to technology economy, social organization, ideology, and nature of ecological impact.

Demographic Transition, Human population growth/ structure and its implications for the natural environment, Interaction between Earth, Man and Environment.

Ecology and Economy of Rural Communities: Rural ecosystem structure.

Organization and function; Characteristics of rural subsistence economy, role of wild lands in subsistence economy, and the impact of market economy.

Social Development initiatives in India: Review of rural and tribal development programmes, and the impact of resource use practices and development programmes on local people and natural resources of the regions; Urbanenvironmentalproblemsandmitigation.

Debate of environment and development, concept of sustainable development, and environmental sustainability index.

Human resource manpower development, environmental education system, awareness, and environmental ethics.

Epidemiological survey of Goiter, arsenicosis, fluorosis, dengue, and Covid-19 pandemic.

National environmental movements - Salient Valley movement, Chipko movement, Narmadamovement, Appiko movement, Gandhamardhan movement, Tehri and Garwal Dam movement, Uttara Kannada movement andAlmattidispute.

References:

1. Ecology and Mankind–C.L. Govind.
2. Towards a Green World– A Agarwal and S. Narain, CSE, New Delhi.
3. Geography of Population – R.C. Chandna, Kalyani Publishers, New Delhi.
4. Human Ecology for Globalization: Human Ecology in Action – S. Kumar, Atlantic Publishers, New Delhi.
5. Human Ecology- Amos H. Hawley, The University of Chicago Press.

Course : DSE 301 (P) – 1a

HUMAN ECOLOGY PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Population data analysis using statistical techniques i.e., Frequency Distribution; Cumulative Frequency Distribution etc. and their graphical representation.
2. Ranking of population distribution using Rank Size graph (state wise / block wise etc).
3. Graphical illustration of age and sex wise distribution of population by Age-Sex Pyramid.
4. Study of Population Projection using mathematical method and growth component method.
5. Study of distribution of population over a geographical space by Nearest Neighbor Analysis.
6. Population data analysis using QGIS software.
7. Epidemiologicalsurveyof acute and chronicdiseases.

References:

1. Practical Geography – A. Sarkar, 2015, 3rd Edition, Orient Blackswan Private Limited, New Delhi.
2. Advanced Practical Geography - Pijushkanti Saha and Partha Basu, 2013, Books & Allied Ltd.
3. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
4. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.
5. Bonita, R., Beaglehole, R., & Kjellström, T. (2006). Basic epidemiology. World Health Organization.

Course : DSE 301 (L) – 1b

ENVIRONMENTAL MANAGEMENT

Totalno.oflectures:30 **FullMarks –(10+40)**

Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). EIA Guidelines. Impact Assessment Methodologies. Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost-benefit analysis. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System, EMS Standards (ISO14000 series).Occupational health hazards and safety managementsystems;OHSAS18000.EIA Notification, 2006 and amendments from time to time. Eco-labeling schemes. Environmental Compliance. Industrial management and corporatesocial responsibility.

Risk Assessment - Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management.

Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972 amendments 1991, Forest Conservation Act, 1980, Indian Forest Act, Revised 1982, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982, Environmental (Protection) Act, 1986 and Rules 1986, Motor Vehicle Act, 1988, The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity

(1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

UrbanEnvironmentalProblemsandmanagement strategies.
Natural hazard ; case studies.
EnergyManagement -Source,monitoring,conservationandmanagement , Energy audit and certification.

Trade,BusinessandEnvironmentWTO,TRIPS,CBDissues.
Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North- Eastern States.
Climate change - adaptability, energy security, food security and sustainability.

References:

1. EnvironmentalManagement–N.K.Oberoi.
2. GreenBusiness–EdSahay,Stough,Sonu,Goyal.

Course : DSE 301 (P) – 1b

ENVIRONMENTAL MANAGEMENT PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Estimation of water demand (domestic / institutional) and preparation of report.
2. Preparation of energy audit report in two areas (domestic and industrial).
3. Prepare questionnaire for Environmental Management System (EMS) of an industry.
4. Preparation of a draft EMS audit report as per ISO 14001:2015 (identification of risk factors to improve environmental performances).
5. Preparation of checklist for Integrated Management System (IMS) (ISO 9001 and ISO 14001).

References:

1. Safety, Health and Environmental Auditing A Practical Guide (2018) - Simon Watson Pain, Second Edition, ROUTLEDGE, Taylor and Francis, CRC Press.

SEC (Any one) - A

RESEARCH METHODOLOGY AND ADVANCED TECHNIQUES IN ENVIRONMENTAL INVESTIGATION

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Research Methodology:

Research: Meaning, Types, and Characteristics, Positivism and Post- positivistic approach to research. Methods of Research: Experimental, Descriptive, Historical, Qualitative and Quantitative methods.

Steps of Research, Thesis and Article writing: Format and styles of referencing.

Application of ICT in research.

Research ethics, Plagiarism, Copy right, Patent.

2. Analytical Techniques and Instruments:

Accuracy, Precision, Calibration, Method optimization; Interpretation of analytical data/results; Sampling Techniques -collection, treatment, preservation; High Volume Sampler, Microbial Techniques; Petrological Microscope, Fluorescent Microscope, Flame Photometer, Spectrofluorimeter, Atomic Absorption Spectrophotometer, Inductively Coupled Plasma Mass Spectrometer, Gel Electrophoresis, Chromatographic Techniques, Gas Chromatography, Ion Chromatography, HPLC, Mass Spectrometry, LCMS, GCMS, XRD, XRF.

3. Spatial Technologies:

Principles of Remote Sensing and GIS, Satellite Imagery, Toposheet Interpretation, Thematic Map Creation and GIS Analysis, Digital Image Processing (DIP) including Band Ratioing, Filtering using Filter Kernels and Image classification, Use of GIS software.

Field survey instruments: Principles, methodology, and applications.

References:

1. 'PrinciplesandPracticeofAnalyticalChemistry'–F.W.FrifieldandD.Keatey –Blackwell Science.
2. Vogel'sTextbookofqualitativeandquantitativeanalysis–ELBS.
3. 'Handbookofanalyticalinstruments'–Khandpur–TataMcGrawHill.
4. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
5. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.

SEC (Any one) - B

MATHEMATICAL METHODS AND ENVIRONMENTAL MODELLING

Totalno.oflectures:15 **FullMarks –(5+20)**

Partial differentiation with applications : Limit and Continuity, Partial Derivative, Taylors Theorem, Maxima and Minima.

Vector Calculus: Concept of transformation, Divergence and Curl of a vector function Gauss's Theorem, Green's Theorem.

Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Basic concept of probability theory, Sampling theory, Distributions - Normal, log-normal, Binomial, Poisson, t, 2 and F-distribution. Correlation, Regression, tests of hypothesis (t-test, 2-test ANOVA: one-way and two-way); significance and confidence limits.

Approaches to development of environmental models; linear, simple and multiple regression models, validation and forecasting. Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model.

Differential Equation: Linear equation.

Fourier Series and Integrals: Transformation, coefficients, even and odd functions.

Matrices : Linear operator, Matrix representation, Eigen values and Eigen functions.

References:

1. Introductiontostatistics–C. Leach(J. WileyNewYork,USA).
2. MathematicalAnalysisformodellingJ.RosenblattandS.Bell(CRCPressLondon,UK).
3. StatisticsforEnvironmentalbiologyandToxicologyW.E.PiegroschandJ.A. Bailer(ChapmanandHallLondon,UK).
4. GeneralstatisticsW.ChaseandF.Bown(J. WileyNew York,USA).

Semester IV

Course : DSE 402 (L) – 2a

HYDROGEOLOGY AND WATER RESOURCE MANAGEMENT

Totalno.oflectures:30 **FullMarks –(10+40)**

Soil genesis, transformation from rock to soil, pedology.

Distribution of water in earth, hydrology and hydrogeology, major basins, andgroundwaterregionsofIndia.

Groundwaterissues,groundwater fluctuations,effects of excessive use of groundwater.

Hydrologicalcycle, Reynold's Number, Darcy'slaw and it's validity, hydraulic conductivity.

Aquifers and its properties, Unconsolidated aquifer.

Surfaceandsub-surfacewaterrelationship.

Water conservation-development of watersheds.

Groundwaterexploration,conjunctiveuseofsurfaceandgroundwater, artificial recharge and rain water harvesting techniques.Differenttypesofrechargestructuresinvaryinghydrologicalenvironment.Hydrogeomorphological mapping, and water well drilling.

Waterdemandmanagement.

Groundwaterqualityandcontamination, groundwater tracers.

Ghyben-Herzberg relation between fresh-saline water.

References:

1. Hydrogeology–Todd.
2. WaterResourceManagement– HermanBouwer.
3. WaterresourcesEngineering–R.A. WurbsandW.P. James,PHI.

Course : DSE 402 (P) – 2a

HYDROGEOLOGY AND WATER RESOURCE MANAGEMENT PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Soil sampling techniques: collection, processing, and storage.
2. Soil texture analysis.
3. Determination of pH, conductivity, hardness, organic carbon and cation exchange capacity of soil.
4. Study of soil map.
5. Hydrogeomorphological mapping using satellite imageries and Survey of India (SOI) topohraphical sheets.
6. Delineation of perennial and ephemeral streams from satellite images and SOI toposheets. Identification of springs on the terrain.
7. Field study on water demand estimation.

References:

1. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water pollution studies. Environmental publication (Karad, India).
2. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
3. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.

Course : DSE 402 (L) – 2b

SOIL SCIENCE

Totalno.oflectures:30 **FullMarks –(10+40)**

Definitionand compositionofsoil.

Formationofsoil,origin,nature,andclassificationofparentmaterials.

Weathering including weathering reactions, erosion, transportation and deposition of sediments.

Identification and characterization of clay minerals.

Classificationofsoil.

Factorsaffectingsoilformation.

Physicalpropertiesofparentmaterials,soiltexture,Mineralsofsoil,soilcolloids,soilair,water, and soilorganism,soilnutrients.

SoilContamination:Soilcontaminationduetoapplicationofpesticideandduetothepresence of heavymetals,ruptureofundergroundstoragetanks.

Healthandecosystemeffectofcontaminatedsoil.

Soilerosionandsoilconservation.

Soil Pollution: Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components, cation exchange capacity). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil microorganisms and their functions - degradation of pesticides and synthetic fertilizers.

References:

1. TheNatureandPropertiesofSoils-NyleC.Brady.
2. CyclesofSoil–Stevenson,FJ.Wiley–InterScience.

Course : DSE 402 (P) – 2b

SOIL SCIENCE PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Soil sampling using soil augers, collection of representative soil sample, its processing and storage.
2. Determination of moisture content in soil by gravimetric method.
3. Determination of soil color by Munsell soil colour chart.
4. Determination of soil texture.
5. Determination of physicochemical parameters of soil.
6. Preparation of soil profile in the field.
7. Preparation of soil map using satellite data.

References:

1. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water pollution studies. Environmental publication (Karad, India).
2. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
3. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.

Course : DSE 403 (L) – 3a

GREEN TECHNOLOGY AND SUSTAINABILITY

Totalno.oflectures: 30 **FullMarks –(10+40)**

1. Environmental Technology

Concept of clean environment; Cleaner production, Abatement strategies and conventions.

Air pollution abatement strategies–use of technological devices; VOC control, green belt development.

Water pollution abatement strategies- Biotreatment technology.

Metal and radionuclide biotreatment, Defluoridation and arsenic removal techniques.

Waste water reuse and recycling.

Sludge treatment and disposal.

Industrial case studies: Thermal, Cement, Steel etc.

2. Green Chemistry and Sustainability

Introduction – Basic Principles – Green chemistry and Sustainability – Atom Economy Concept– Novel Synthetic Techniques– Use of Green Reagents, Green Solvents, Green Catalysts (Biocatalysts, Phase Transfer Catalysts, Nanocatalysts), Green Reactions– Microwave, Ultrasound, Hydrothermal etc.

3. Green Technology for Sustainable Development

Concept of Green Technology–Mass and Energy Balances–Safer and Greener Processes– Bioprocesses –Industrial Examples.

Green Solutions for Remediation: Green Biotechnology, Bioremediation.

4. Green Environmental Issues, Life Cycle Inventory and Assessment Concept

Ecological Footprint- Carbon Credit and carbon tax– Carbon Sequestration– Clean Development Mechanism (CDM)- Approaches to Green Computing.

Sustainable Habitat: Green Building, GRIHA Rating Norms.

Life Cycle Inventory and Assessment Concepts- Green Procurement.

Information Technology in Environmental Science.

5. Energy and Environment

Concept of renewable, nonrenewable, conventional and non conventional energy sources, Solar, OTEC, Geothermal, Nuclear, Wind, Magnetohydrodynamic power etc.

Bioenergy sources and future prospects.

References:

1. H.S.Peary,D.R.RoweandG.Tchobanoglous,(1985).EnvironmentalEngineering,McGrawHill.

2. MetcalfandEddy,Inc.,WastewaterEngineering–Treatment,DisposalandReuse–ThirdEdition,McGrawHill.
3. S.C.Bhatia.(2007).SolidandHazardousWasteManagement,AtlanticPublishers.
4. G.M.Masters.IntroductiontoEnvironmentalEngineering,PrinticeHallIndia.
5. APHA,AWWA,WEF.StandardMethodsfortheExaminationofWaterandWasteWater–21stEdition,2005.
6. Eckenfelder,W.W.,(1999).Industrial WaterPollutionControl,McGraw-Hill.
7. GradyJr.C.P.LandLinH.C.(1980).Biologicalwastewatertreatment:TheoryandApplications,MarcelDekker,Inc NewYork.
8. GeorgeTchobanoglous,HilaryTheisenandSamuelA.,(1993).Vigil,IntegratedSolidWasteManagement,McGraw-Hill, New York.
9. V.K.AhluwaliaandM.Kidwai.(2004).NewTrendsinGreenChemistry-AnamayaPublishers,NewDelhi.
10. RashmiSanghi,(2011).GreenChemistryforEnvironmentalRemediation.

Course : DSE 403 (P) – 3a

GREEN TECHNOLOGYAND SUSTAINABILITY PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Prepare worksheet of different green processes and practices used in Red/Orange/Green category of industry.
2. Prepare flowsheet with proper labels for Municipal water treatment / Industrial water treatment (ETP) / Sewage treatment (STP) plants.
3. Prepare structured questionnaire for waste management in a manufacturing industry.
4. Prepare worksheet of energy consumption based on site visit (Educational institution, office, health care unit etc).
5. Visit to any processing industry/farm/energy units and report preparation.

References

1. Metcalf, L., Eddy, H. P., & Tchobanoglous, G. (1991). Wastewater engineering: treatment, disposal, and reuse (Vol. 4). New York: McGraw-Hill.

Course : DSE 403 (L) – 3b

ENVIRONMENTAL TECHNOLOGY

Totalno.oflectures: 30 **FullMarks –(10+40)**

1. EnvironmentalTechnologyandPollutionControl

Concept of clean environment;Cleaner production; Basis and necessity for standards; Point andNon-pointpollution sources.

Airpollutionabatementstrategies–

useoftechnologicaldevices;VOCcontrol,greenbeltdevelopment.

Waterpollutionabatementstrategies.Biotreatmenttechnology.

MetalandradionuclideBiotreatment–

Defluorinationandarsenicremoval.Wastestabilizationpondsandlagoons-

Wastewaterreuseandrecycling.

Sludgetreatment anddisposal.

Industrialcasestudies:Thermal,Cement,Steeletc.andsafetymeasures.

Abatement strategies andconventions.

2. GreenChemistryand Sustainability

Introduction – Basic Principles – Green chemistry and Sustainability – Atom Economy Concept andits environmental significance– Novel Synthetic Techniques– Use of Green Reagents, GreenSolvents,Green Catalysts(Biocatalysts,PhaseTransferCatalysts,Nanocatalysts)–GreenLabTechnologies– Microwave,UltrasoundAssistedReactions,HydrothermalReactions.Environmentalsignificance andapplicationsinday-to-daylife.

3. Energy and Environment:

Fossil fuels: classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net-calorific value.

Principles of generation of hydro-power, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, solar energy (solar collectors, photo-voltaic modules, solar ponds).

Nuclear energy - fission and fusion, Nuclear fuels, Nuclear reactor – principles and types.

Bioenergy: methods to produce energy from biomass.

Environmental implications of energy use; energy use pattern in India and the world, emissions of CO_2 in developed and developing countries including India, radiative forcing and global warming. Impacts of large scale exploitation of solar, wind, hydro and nuclear energy sources.

References:

1. H.S.Peary,D.R.RoweandG.Tchobanoglous,(1985).EnvironmentalEngineering,McGrawHill.
2. MetcalfandEddy,Inc.,WastewaterEngineering–Treatment,DisposalandReuse–

ThirdEdition,McGrawHill.
3. S.C.Bhatia.(2007).SolidandHazardousWasteManagement,AtlanticPublishers.
4. G.M.Masters.IntroductiontoEnvironmentalEngineering,PrinticeHallIndia.
5. APHA,AWWA,WEF.StandardMethodsfortheExaminationofWaterandWasteWater–21stEdition,2005.
6. Eckenfelder,W.W.,(1999).Industrial WaterPollutionControl,McGraw-Hill.
7. GradyJr.C.P.LandLinH.C.(1980).Biologicalwastewatertreatment:TheoryandApplications,MarcelDekker,Inc NewYork.
8. GeorgeTchobanoglous,HilaryTheisenandSamuelA.,(1993).Vigil,IntegratedSolidWasteManagement,McGraw-Hill, New York.
9. V.K.AhluwaliaandM.Kidwai.(2004).NewTrendsinGreenChemistry-AnamayaPublishers,NewDelhi.
10. RashmiSanghi,(2011).GreenChemistryforEnvironmentalRemediation.

Course : DSE 403 (P) – 3b

ENVIRONMENTAL TECHNOLOGY PRACTICAL

Totalno.oflectures: 15 **FullMarks –(5+20)**

1. Physicochemical analysis of waste water.
2. Analysis of sewage sludge.
3. Principle, procedure and applications of bomb calorimeter.
4. Perform Jar test for optimum coagulant dose in waste water.
5. Prepare structured questionnaire for evaluation and optimization of parameters to increase the efficiency of an aeration tank in an industry.
6. Visit to any processing industry/farm/energy units and report preparation.

References:

1. Metcalf, L., Eddy, H. P., & Tchobanoglous, G. (1991). Wastewater engineering: treatment, disposal, and reuse (Vol. 4). New York: McGraw-Hill.
2. 'Standard Methods for the examination of water and wastewater'–21st edition, 2005, APHA, AWWA.

Course : DSE 404 (L) – 4a

RESOURCE MANAGEMENT AND ENVIRONMENTAL ECONOMICS

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Resources and conservation

Resources– Types, distribution, uses, methods of exploitation.

Resource surveys– Different techniques.

Management– Principles and Ways.

Conservation– Planning, strategies- National and regional action plan.

Natural Resources– policies for sustainable development and conservation.

2. Environmental Economics

Environmental Economics– Basic principles, Economy and Environment.

Application of economics to improve environmental quality–polluter pays principles, trade and environment.

Theory of externalities and public goods.

Environmental Kuznets Curve.

Consumerism – concept, poverty and globalization.

Basic concept of welfare and developmental economics.

Economic analysis– Cost effectiveness, cost-benefit.

Analytical tools–Alfred Weber's theory, Losch's theory, Isard model, Smith's theory.

Environmental valuation–Techniques for valuation (Hedonic pricing, Contingent valuation and Travel cost method, etc), case studies.

Natural resource as national capital – Resource economics, issues and challenges of Special Economic Zone (SEZ) and Exclusive Economic Zone (EEZ) in India.

International negotiations on climate change and North-South debate.

References:

1. ReadingsinResourceManagementandConservation–I. Burton,andK.W. Kates,1985,Chicago,UniversityofChicagoPress.
2. Ecodevelopment:Concepts,Projects,Strategies– B.Glaeser(ed)1984,Oxford,PergamonPress.
3. SustainableDevelopmentoftheBiosphere–W.C. ClarkandR.E. Munn(eds)1986,Cambridge,CambridgeUniversityPress.
4. TheHandBookofEnvironmentalEconomics– W. Daniel,1995,London,Blackwell.
5. EnvironmentalEconomics–D.W.Pearce1977,London,LongmanGroupLtd.

Course : DSE 404 (P) – 4a

RESOURCE MANAGEMENT AND ENVIRONMENTAL ECONOMICS PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Study of the relationship between environmental degradation and per capita income by Environmental Kuznets Curve.
2. Study of economic analysis of relative costs and environmental outcomes using Cost effectiveness analysis and Cost benefit analysis.
3. Time series analysis of Industrial production and associated environmental issues.
4. Graphical representation of income inequality using Lorenz curve.
5. Study of the level of individual human development in each country using Human Development Index (HDI).
6. Study of the measurement of gender equality using Gender Development Index (GDI).
7. Mapping of the distribution of forest resource, water resource and its changing pattern using QGIS software.

References:

1. ReadingsinResourceManagementandConservation–I. Burton,andK.W. Kates,1985,Chicago,UniversityofChicagoPress.
2. Ecodevelopment:Concepts,Projects,Strategies– B.Glaeser(ed)1984,Oxford,PergamonPress.
3. SustainableDevelopmentoftheBiosphere–W.C. ClarkandR.E. Munn(eds)1986,Cambridge,CambridgeUniversityPress.
4. TheHandBookofEnvironmentalEconomics– W. Daniel,1995,London,Blackwell.
5. EnvironmentalEconomics–D.W.Pearce1977,London,LongmanGroupLtd.

Course : DSE 404 (L) – 4b

LANDSCAPE ECOLOGY AND SOCIAL ENVIRONMENT

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Landscapeecology

Landscapeecology–Evolution,objectivesofstudybasictenets.

Landscapestructures–Patch,corridorandmatrix.

Landscapedynamics–Processesandchanges.

Landscapeboundaries– Functionalaspects,ecologicalflows.

Quantitativemethods– Fractals,spatialEntropy.

Applicationoflandscapeecologicalstudies(fieldstudy under normal and usual conditions)–

Planningprocessand management.

2. Socialenvironment

Feedbackmechanism–Populationdynamics,demographictransition.

Socialorganization–Society,Institutionalaspects.

Socialsystem– Complexadaptivesystem.

Environmentalknowledge– Ecologyandsocialconstruction.

Politicalecology–Determinantnarrativesof politicalecology.

EnvironmentalIdentity–Traditionalknowledge,applicationofknowledge.

References:

1. LandscapeEcology–R.T.T.FormanandM. Godron,AcademicPress
2. LandscapeEcology–NavezandLibermman,Spingerverlap.
3. ChangingLandscape:anEcologicalPerspective–I.S. ZonnevetelandR.T.T. Forman(ed.),Springerverlap.

Course : DSE 404 (P) – 4b

LANDSCAPE ECOLOGY AND SOCIAL ENVIRONMENT PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Geographic distribution of the vegetation across a landscape using Predictive Vegetation Modeling (PVM).
2. Quantification of spatial characteristics of patches / entire landscape mosaics using Landscape Metrics.
3. Analysis of changes in landscape pattern using QGIS software.
4. Analysis of extinction and colonization of local populations using Landscape connectivity and metapopulation dynamics.
5. Documentation of socio-economic data for local villages supported by ambient environmental quality.

References:

1. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
2. Jensen, J. R. (1986). Introductory digital image processing: a remote sensing perspective. Univ. of South Carolina, Columbus.

Course : DSE 405 (L) – 5a

WILDLIFE BIOLOGY AND MANAGEMENT

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Wildlifebiology:

Protected area network, Concept of wildlife, importanceof wildlife, endangeredspecies, conservation management ofwildlifeandtheirhabitats, concepts of vulnerable, endangered, and extinct species, causes of extinction, concept of extinction vortex, population viability analysis.

Institutionalsupportsystemsinunderstandingwildlifestatusofthiscountry.

Basicprinciplesofwildlifemanagement;roleofBiologyinmanagement;theneedforwildlifemanagement;Lion,Tiger, Rhino, Elephant,etc.andhabitatmanagementtechniques.

Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

Habitat fragmentation; Man – animal conflict : case studies.

Re-introduction of species: case studies.

2. Wildlifefarming:

Concept of wildlife trade, wildlife products, case studies.

3. Animal behavior

Basics of animal behavior, concept of instinct and learning, imprinting (visual, auditory and olfactory), concept of evolutionary stable strategies (ESS), sexual selection, animal communication and migration, concept of kin selection and group selection.

References:

1. WildlifeBiology-C.H.StevensionandArwin.
2. India'sWildlifeandWildliferesources–B. SeshadristerlingPublishingPvt.Ltd.

Course : DSE 405 (P) – 5a

WILDLIFE BIOLOGY AND MANAGEMENT PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Analysis of species diversity and habitat characteristics in a specific region.
2. Application of different bird census techniques; Identification and mapping of resident and migratory birds.
3. Identification of different parts and products of flora and fauna reported in the wildlife trade.
4. Methods of behavioural observation of mammals/ insects; Preparation of ethogram.
5. Identification of Horn / antler; Study of epidermal derivatives; comparative morphology of dentition and skull.
6. Pugmark Identification & characterization of common large mammals (carnivores and herbivores).
7. Population Estimation data collection using softwares.
8. Application of GIS in biodiversity mapping, man – animal conflict zonation mapping.

References:

1. Ali, S., & Ripley, S. D. (1983). Handbook of the birds of India and Pakistan. Compact edition. Oxford University Press and BNHS, Mumbai.
2. Ali, S. and SD Ripley (1995). The Pictorial Guide to the Birds of Indian Sub-continent. Oxford University Press and BNHS, Mumbai.
3. Slater, P. J., & Peter James Bramwell, S. (1999). Essentials of animal behaviour. Cambridge University Press.
4. Hemley, G. (1994). International wildlife trade: a CITES sourcebook. Island Press.
5. Menon, V. (2014). Indian mammals: a field guide. Hachette India.
6. Bubenik, G. A., & Bubenik, A. B. (Eds.). (2012). Horns, pronghorns, and antlers: evolution, morphology, physiology, and social significance.

Course : DSE 405 (L) – 5b

RADIATION HAZARD, OCCUPATIONAL SAFETY AND DISASTER MANAGEMENT

Totalno.oflectures:30 **FullMarks –(10+40)**

1. Radiation Hazard

RadiationHazards,RadiationDose,RelativeBiologicalEffectiveness,Monitoringofradiation,Laboratorycontaminationandprecautions, Shieldingmaterials, regulations.

2. Occupational Safety

Concept of occupational health and diseases - effects, risk, diagnosis and methods of prevention.

Personal Protective Equipment and Non-respiratory personal protective devices; Factories Acts and rules, Environmental Safety: Safety awareness, safety audit; case studies.

3. Disaster Management

Disaster- causes, impacts. Risk assessment and vulnerability analysis : case studies, Disaster preparedness and response – concept and nature, disaster preparedness plan (predictions, early warning and safety measures of disaster), Role of information technology, education, training, and awareness in disaster management. Post Disaster Relief and Logistic Management; Community Participation at various stages of disaster management. Case studies on industrial disasters (Chernobyl, Bhopal, etc.).

References:

1. RadiationBiophysics, E.L. Aplen,AcademicPress,LondonU.K.
2. Occupational Health and Safety Management: A Practical Approach, Third Edition - Charles D. Reese.
3. Fundamentals of Occupational Safety and Health - Mark A. Friend and James P. Kohn.
4. Natural Disasters 10th Edition - Patrick Leon Abbott.
5. Hazardous Wastes, Industrial Disasters, and Environmental Health Risks: Local and Global Environmental Struggles 2011th Edition - Francis O. Adeola.

Course : DSE 405 (P) – 5b

RADIATION HAZARD, OCCUPATIONAL SAFETY AND DISASTER MANAGEMENT PRACTICAL

Totalno.oflectures:15 **FullMarks –(5+20)**

1. Demonstration of GM counter.
2. Preparation of occupational health safety report of any industry.
3. Preparation of pre and post disaster management plan of any natural hazard.
4. Preparation of industry specific safety manual.
5. Preparation of Safety Audit report of any industry.

References

1. RadiationBiophysics, E.L. Aplen,AcademicPress,LondonU.K.
2. Cahill, L. B., & Kane, R. W. (2010). *Environmental health and safety audits*. Government Institutes. Cahill, L. B. (2002).
3. Conducting third-party evaluations of environmental, health, and safety audit programs. Environmental Quality Management.
4. Collins, L. R. (2000). Disaster management and preparedness. CRC Press.