FOREST RESEARCH INSTITUTE

DEEMED TO BE UNIVERSITY

DEHRADUN- 248006

REVISED SYLLABUS
(Credit based)

FOR

M.Sc. Programme

In

Environment Management

Programme Objectives: The programme aims to provide opportunities to the students to make themselves aware about the problems related to environmental concerns and its management. The programme is designed to provide a holistic and integrated approach of learning comprising of classroom lectures, classroom assignments, practical sessions, interactive seminars, field visits, industrial visits, term papers, divisional attachments and master's thesis writing. The course builds and facilitates understanding of the dynamics of environment especially in the context of ecology, forestry, and climate change. Different types of processes, models, plans and techniques related to environmental processes are described and discussed through class room interaction as well as exposures visits to different ecosystems and institutional/industrial arrangements. The students are expected to get enough exposure for practical solutions to various ecological and environmental problems in the context of today's world.

Programme Structure: The programme consists of courses and other requirements worth a total of 89 credits. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week. Each semester will consist of 18 to 20 weeks of academic work equivalent to 90 actual teaching days. The programme structure and respective credits are given below as:

Programme Structure		Credits
Core courses	:	53
Foundation courses	:	5
Elective courses	:	5
Synopsis	:	1
Master's thesis	:	17
Master thesis seminar	:	2
Term paper I	:	2
Term paper II	:	2
Study tour	:	2
Total	:	89

Allotment of credits to different courses

FIRST SEMESTER

Course Code	Course	Credit	
		Theory	**Practical**
Foundation Course			
ERG 101	Remote Sensing and Geographical Information System	1	1
Core Course			
EFE 111	Fundamentals of Ecology	3	1
EEA 112	Ecosystem Analysis	3	1
EPB 113	Environmental Physics and Biogeochemistry	3	1
ECE 114	Conservation Ecology	3	1
EIA 115	Environmental Impact Assessment	3	1
ETP 116	Term Paper I	2	-
Total credits in first semester $16^a + 6^b + 2^c = 24$			

SECOND SEMESTER

Course Code	Course	Credit	
		Theory	**Practical**
Foundation Course			
ESC 201	Environmental Statistics and Computer Application	2	1
Core Course			
EFM 211	Forestry for Sustainable Management	3	1
ERE 212	Restoration Ecology	3	1
EGF 213	Global Climate Change and Forest	3	1
EFE 214	Forest Economics	2	1
EPM 215	Environmental Pollution Management	3	1
ETP 216	Term Paper II	2	-
Total credits in second semester $16^a + 6^b + 2^c = 24$			

THIRD SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Core Course			
EPS 311	Environmental Policy, Law and Sociology	3	1
EEM 312	Environmental Microbiology	3	1
EFC 313	Forest Certification	2	-
EDM 314	Disaster Management	3	1
EST 315	Study Tour	2	-
Elective course 5 Credits			
ENM 321	Natural Resource Conservation and Management	4	1
EBM 322	Bio Diversity Monitoring and Management	4	1
EBC 323	Bio Statistics and Computer Application	4	1
ESM 324	Solid Waste Management	4	1
EPC 325	Forest, Society and Climate Change	4	1
ERG 326	Remote sensing and Geographic Information System- Advance and Application in Environmental Management	4	1
EIA 327	Environmental Impact Assessment	4	1
EWH 328	Wildlife and Habitat Management	3	2
PTN 330	Plant Taxonomy	2	3
UFT 331	Urban Forestry	3	2
Total credits in third semester		$11^a+3^b+5^c+2^d=21$	

FOURTH – SEMESTER

Code	Particulars	Credit
ESY 441	Synopsis	1
EMT 442	Master's Thesis	17
ETS 443	Master Thesis Seminar	2
Total		20

a- Theory, b- Practical, c- Term paper, d- Study tour, e- Elective paper. One lecture credit comprises of one hour teaching of the course in a week, while one practical credit comprises of two hours of practical/assignment work in a week

Descriptions of Course Code

The courses of M. Sc. programme are divided into four series:

- ❖ 100-series courses pertain to first semester
- ❖ 200-series courses pertain to second semester
- ❖ 300-series courses pertain to third semester
- ❖ 400-series courses pertain to fourth semester
- ❖ Credit for Synopsis, Master's thesis and Master thesis seminar is designated by code no. 441, 442 and 443 respectively

Course code is formulated as:

- ➢ First alphabet shows programme
- ➢ Second and third alphabet shows course name
- ➢ First digit shows semester number
- ➢ Second digit shows course type (0= foundation, 1= core, 2= elective)
- ➢ Last digit shows course number

1st SEMESTER

FOUNDATION COURSE

ERG 101 **REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS**

LEARNING OBJECTIVES: To develop understanding about the scope and application of remote sensing and Geographic Information Systems in Environmental science

MODULE I INTRODUCTION

- Remote Sensing: History of Remote Sensing, Aerial Remote Sensing, Satellite Remote Sensing, Space programme development in different countries
- Limitations of Remote Sensing; Resolution- Definition and types; Remote sensing data types, cost and sources

MODULE II AERIAL REMOTE SENSING

- Aerial Remote Sensing/ (Air Borne RS):Aerial Photography; Principle of Remote Sensing; Characteristic of Electromagnetic spectrum and spectral range; Sensors; Agency involved for aerial photography; Cameras used ; Types of Aerial Photography depending on: i) Orientation of optical axis, ii) Angle of coverage; Sources of energy; Measurement on Aerial photographs: Scale determination and Height measurement. Limitations

MODULE III BASIC OF MAPS

- Introduction, Classification, Concept of scale, Fundamentals of Cartography, Numbering of topographical maps, Map Projection, Datum and Spheroid. Preparation of Thematic maps using aerial photographs: Elements of Photo Interpretation; Stereoscopes- Types & Functions; Area Calculation by: i) Dot grid, ii) Square grid, iii) Planimeter

MODULE IV SATELLITE REMOTE SENSING (SPACE BORNE)

- Types of Remote Sensing based on: Source of Energy; Platform. Types of Satellite: LANDSAT, IRS, SPOT, IKNOS, QUICKBIRD,RADAR, LIDAR, SRTM, NOAA. Types of Sensors and their - MSS, TM, LISS-I, II, III, IV, PAN, Characteristics AVHRR, WIFS, A WiFs. Multispectral Scanners: Whiskbroom and Pushbroom scanners

MODULE V **PREPARATION OF VEGETATION/FOREST COVER MAP USING SATELLITE DATA**

- Visual Interpretation; Basic principle of Image interpretation; Elements of Image interpretation; Digital Interpretation; Supervised, Unsupervised and Hybrid approach if interpretation

- Types, Platform and Utility; Radar Microwave Remote Sensing; Lidar Sensing and applications

- Geographic Information System (GIS):Definitions and objectives, Principle of GIS, Basic requirements of GIS, Components of GIS, Data Structure, Data Types, Data models, Topology, Applications in Forestry and Environment

- Global Positioning System (GPS): Definitions, Types of GPS, Principle of GPS, Functions, GPS Segments, Applications in Forestry, Limitations

PRACTICALS

- Digital Image Processing of satellite data

- Geo-referencing of Toposheet

- Geometric rectification of satellite data

- Sub-setting of satellite data

- Classification and Area computation

- Digitisation of Polygon and line in vector format

- Computation of Area, length and perimeter

- Use of GPS in forest survey

CORE COURSES

EFE 111   FUNDAMENTALS OF ECOLOGY

LEARNING OBJECTIVES: To provide knowledge about population and community ecology, dynamics and sampling procedure for vegetation analysis

MODULE I INTRODUCTION

- Definition of Ecology, Evolutionary/ Historical background
- Natural ecosystems, Concept of species (niche, species interaction- mutualism, commensalism, competition, ammensalism, character displacement) and individual, Concept of carrying capacity

MODULE II AUTECOLOGY

- Introduction to Autecology; Population definition & characteristics (population size, density dispersion, age structure, natality, mortality etc)
- Population parameters- growth, fluctuation, regulation and dynamics, r and k selection, species interaction and intra and inter specific competition, evolutionary consequences of competition, allelopathy, biotic potential

MODULE III SYNECOLOGY

- Introduction to Synecology; Community dynamics, concept, structure and composition.
- Community characteristics (analytical characters-quantitative and qualitative, synthetic characters), dominance and diversity (alpha, beta, gamma), community coefficients, cluster analysis, association analysis, gradient analysis (ecotone, habitat and niche).
- Vegetation mapping, Community classification concept (individualistic and vegetational continuum concept).

MODULE IV ECOSYSTEM

- Ecosystem components and structure; Abiotic and biotic factors, trophic relation, functional aspect of ecosystem.
- Ecological succession (definition and causes), types of succession, process of succession, succession models, concept of climax

MODULE V VEGETATION SAMPLING

- Vegetation sampling; Purpose of studying plant communities, sampling units (point frame transect and quadrat), size and shape of sampling unit (species area curve, running mean method), methods of sampling (line transect, quadrat and point centered quarter method).

PRACTICALS

- Ecological sampling of an area (line transect, quadrat and point centered quarter method).
- Phyto-sociological analysis
- Species-Area Curve
- Measurement of tree height and diameter
- Determination of homogeneity and heterogeneity of the system using Raunkier's frequency class

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EEA 112   ECOSYSTEM ANALYSIS

LEARNING OBJECTIVES: To impart knowledge of ecosystem, biomes and functional aspects of ecosystem

MODULE I MAJOR ECOSYSTEM

- Ecosystem concepts, evaluation of ecosystem past and present, major ecosystems of India and world (terrestrial, aquatic, marine), influence of climatic factors on major ecosystems of the world
- Major biomes of India and world, biogeographic regions of India and world, agro-ecological and floristic zones, forest types of India

MODULE II RESOURCE DEPLETION

- Natural resources (definition and types), Natural resources degradation (types and causes), loss of biodiversity, land degradation, deforestation, ecological and social impact of resource depletion

MODULE III FUNCTIONAL ASPECTS OF ECOSYSTEM

- Functional aspect of ecosystem analysis; Energy flow (food chain, food web, ecological pyramid), energy resources and use efficiency, ecological energetic and energy models.
- Biomass production (gross and net), biomass estimation methods.
- Litter production and decomposition in different ecosystem.
- Biogeochemical cycles (nutrient cycle: carbon, nitrogen, sulphur, phosphorus, hydrological cycle); Cybernetics and homeostasis

PRACTICALS

- Collection of litter, soil and plant samples
- Nutrient analysis
- Vegetation analysis
- Calculation of the species diversity, similarity index, concentration of dominance, richness Index and evenness
- Measurement of biomass and productivity

EPB 113   ENVIRONMENTAL PHYSICS AND BIOGEOCHEMISTRY

LEARNING OBJECTIVES: To develop understanding of students about structure and chemical composition of the atmosphere, hydrosphere and lithosphere and physico-chemical properties and nutrient dynamics of soil

MODULE I ATMOSPHERE

- Structure of the atmosphere, radiation budgets, general circulation in the atmosphere, prevailing and adiabatic lapse rates, air masses and fronts, vertical profiles of major and trace gases
- Cloud formation and precipitation, cloud classification, condensation nuclei, global patterns of pressures and winds, monsoon systems.
- Chemical composition and processes in the atmosphere, atmospheric photochemistry, reactions of nitrogen, oxygen, ozone, chlorides. Transport and deposition processes of dust and aerosols in the atmosphere.

MODULE II HYDROSPHERE

- Chemistry of hydrosphere: properties of water(surface and ground water), physical chemistry of sea water, characteristics of natural water, complexation in natural water and waste water, aquatic chemical reactions. Ground water recharge, aquifers

MODULE III LITHOSPHERE

- Landform and their development; structure and tectonics, weathering, erosion, classification
- Structural classification of minerals and their properties; major rock forming and ore minerals
- Geochemical classification and distribution of elements in the earth, properties of soil parent materials and their relation to soil and vegetation.

MODULE IV SOIL SCIENCE

- Definition of soil, soil types, factors of soil formation, weathering of rocks and minerals and processes of soil formation
- Soil profile. Soil colloids, Soil physico-chemical properties, soil water, types of soil water, its retention, movement, availability and measurement of soil water, soil organic matter and its role in soil fertility.
- Causes, kinds, extents of soil degradation & pollution and measures for their prevention and amelioration.
- Plant nutrition; essential nutrients and their forms in the soil and their role in plant growth, factors and forms of erosion.

PRACTICALS

- Monitoring of micro-meteorological parameters, maximum and minimum temperature, relative humidity, wind speed and wind direction, solar radiation, preparation of wind rose diagram
- Determination of soil moisture, bulk density, porosity, colour, pH, N, P, K and organic carbon
- Physical and chemical properties of minerals and different diagnostic characters of rocks

ECE 114   CONSERVATION ECOLOGY

LEARNING OBJECTIVES: To acquaint students about conservation of biological resources, natural selection, ecosystem fragmentation, energy sources and environmental laws

MODULE I INTRODUCTION

- Definition of conservation, postulates of conservation biology. The origin and evolution of living organisms, the invasion of unoccupied ecological niches, Adaptive radiation, genetic plasticity a factor in evolution
- Natural selection; self-replicating molecular assemblages, limiting factors and tolerance curves, rules of inheritance for life on earth, Mendelian genetics, nature versus nurture, selfish genes, population genetics, maintenance of variability, genetics and ecology of extinction

MODULE II ECOSYSTEM INSTABILTY

- Species of biological importance: Native, Non-native, indicator, endemic, threatened, umbrella, flagship, keystone, and charismatic species.
- Ecosystem fragmentation and edge effects, concept of keystone species, effects of species deletions and additions and invasive species on the maintenance of biological diversity, stability and complexity in relation to development
- Red and green data books, genetic resources, world conservation strategy.

MODULE III INVENTORIZATION AND MONITORING

- Survey, monitoring and sampling populations for biological conservation, collection and analysis of inventory data, criteria on choice of species for conservation

MODULE IV CONSERVATION OF RESOURCES

- Energy sources: Conservation and management of non-renewable fossil fuel resources, strategies for management of non renewable reusable mineral and metal resources. Forest and water resources and their conservation and management
- Conservation of biological resources: *in-situ* and *ex-situ* conservation strategies, captive breeding, botanical and zoological gardens; design and management of protected area for wildlife conservation. Cultural significance of natural protection

PRACTICALS

- Measurement of leaf area and leaf area index (LAI)
- Estimation of moisture contents of leaves and soil
- Estimation of chlorophyll content (from grass and tree leaves)
- Measurement of root-shoot ratio

EIA 115   ENVIRONMENTAL IMPACT ASSESSMENT

LEARNING OBJECTIVES: Students will be able to explore the features, auditing and monitoring of EIA reports, public participation in Environmental decision making and quality checks in EIA

MODULE I INTRODUCTION AND BACKGROUND

- Origin of EIA and historical perspective, scope and purpose of EIA; Key merits of environmental assessment in regulating the state of environment
- Global experience in EIA; Comparative review of EIA systems in different countries and regions

MODULE II ENVIRONMENTAL LEGISLATIONS AND REGULATIONS

- Salient features of EIA legislation and other statutory obligations
- Environmental decision making in India: Environmental clearance procedures and national requirements.

MODULE III ASSESSMENT FRAMEWORK

- Flow charts showing key steps; Methodological approaches and tools for key stages in the process: Screening (classification of developments and stage to determine the level of EIA, exclusion and inclusion lists of projects, different approaches to screening) Scoping (scoping steps, guidance and tools, and stakeholder involvement), Impact prediction and evaluation (approach for baseline development and methods of impact identification-checklists, Matrices, Networks)

MODULE IV METHODS AND TOOLS FOR EIA

- Introduction to various impact assessment methods: checklist, matrices, networks, indices and weight scaling techniques and their scope and limitations
- Prediction and assessment of impact on the land, air, water, noise, biological and socioeconomic environments
- Mitigation: definitions and hierarchy of measures including avoidance, reduction, rectification and compensation enhancement approaches, principles and concepts of offsets, type of offsets

MODULE V PUBLIC PARTICIPATION IN ENVIRONMENTAL DECISION MAKING

- Regulatory requirements, procedures, advantages and disadvantages of public participation
- Environmental Impact Assessment Reporting: Guidelines for developing formats for

preparing and reviewing EIA reports and Environmental Management Plans, Case studies

MODULE VI ENVIRONMENTAL AUDITING AND MONITORING

- Concepts, objectives and usefulness of monitoring relevant to impact mitigation, Types (Impact/effect monitoring, Baseline monitoring, Compliance monitoring; Mitigation monitoring), Ex ante and Post ante EIAs
- Accreditation of EIA consultants: Obligatory requirement in India, introduction to national accreditation scheme

MODULE VII ISO STANDARDS

- ISO 9001, historical background, benefits and clause analysis.
- EMS and its benefits, formulating environment policy exercise, preparation ground for development EMS-Initial environmental review and exercise of identification of environmental aspects,
- Clause analysis of ISO 14001, explanation of PDCA cycle
- Training need identification, communication, audit process, preparation audit investigation-interview techniques and nonconformities, closing meeting and follow up. Attributes of an auditor and psychology of auditing audit reporting, certification process and certification bodies, legislation pertaining to ISO 14001 documentation-preparation of L/R, emergency preparedness and response
- Comparison of ISO 9001 and ISO 14001, comparison of ISO 14001 and OHSAS-18001.

PRACTICALS

Case studies on:

- EIA of development projects
- EIA of restored mine lands
- EIA of hydroelectric plant

ETP 116   Term paper I

Learning objective

The objective of the term paper is to develop the skill of research writing. In this course generally students have to review literature in their field of interest related to environment. They have to prepare a project report on a particular topic under the supervision of faculty and submit it to the university.

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2nd SEMESTER

FOUNDATION COURSE

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ESC 201   ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATIONS

LEARNING OBJECTIVES: To develop the understanding of application of basic statistics and computer software in Environment Sciences and Management

MODULE I BASIC STATISTICS

- Variable and Data: Variables, Types of variables, Data and data types, Data collection, Classification and tabulation, Primary and secondary data, Scales of data (Nominal, Ordinal, Interval and Ratio)

- Exploring Data: Frequency distribution, Graphs (Bar diagrams, Histograms, Pie-Charts, Stem and Leaf Plots), Skewness and Kurtosis

- Measures of central tendency and dispersion: Measures of central tendency and their characteristics, Measures of dispersion and their characteristics

- Correlation: Measure of relationship- Scatter Plot, Covariance, Correlation, Rank correlation, Properties of correlation coefficients

- Regression: Simple and multiple regression, Characteristics of regression coefficient

- Estimation: Estimation of mean and variance, point and interval estimation

MODULE II PROBABILITY

- Probability and Probability distributions: Basic concepts of probability. Binomial distribution, Poisson distribution, Normal distributions

MODULE III TESTING HYPOTHESIS

- Null and alternative hypotheses, types of errors in testing hypotheses, tests of significance: one sample t- test; two sample independent t- test, paired t-test, F-test, z-test

MODULE IV SAMPLING

- Basics of sampling, Random and Non-random sampling, advantages and disadvantages of sampling, concepts of simple random sampling, concepts of stratified random sampling, concepts systematic sampling.

MODULE V COMPUTER APPLICATIONS

- Windows OS, MS Word, MS Excel, MS Power point

PRACTICALS

- Data collection from field or forests
- Secondary data collection from existing literature
- Classification and Tabulation of collected data
- Frequency distribution and graphs from the collected data
- Estimation of central tendency and dispersion from the collected data
- Testing exercise for t-test
- Making the above reports through MS Word
- Analysing the above data through MS Excel
- Making presentation of the results of above exercises through MS Power Point

EFM 211   FORESTRY FOR SUSTAINABLE MANAGEMENT

LEARNING OBJECTIVES: Students will be introduced to basic forestry including botany, silviculture, mensuration, non wood forest products and sustainable forest management.

MODULE I INTRODUCTION

- Overview of Forestry in India: Historical development of forest management in India, benefits from forests and forest resources.
- Evolution of forest policy: Overview of forest policies and agroforestry policy in India

MODULE II FOREST BOTANY

- Importance of systematic botany in forestry: concept of genus, species, herbarium, arboretum, Bambusetum.
- Plant nomenclature, Bentham and Hooker system of classification, identification of Family, Genus and Species using Flora.

MODULE III SILVICULTURE

- Definition of silvics and silviculture, study of locality factors (climatic, topographic, edaphic and biotic)
- Succession, classification of forests, Champion and Seth classification of Indian forests
- Forest regeneration, natural regeneration through seed and vegetative parts, regeneration of forests and mixed regeneration
- Seed collection, processing, storage, nursery establishment, nursery operations, plantation establishment and aftercare
- Afforestation of different types of sites (saline alkali soils, laterite soil, water logged area, shifting sand, strips, farmland)
- Silviculture systems: Definition, classification and brief study of the following systems: clear felling system, uniform system, group system, coppice & coppice with standard and reserve system
- Thinning
- Rotation and its types

MODULE IV FOREST MENSURATION

- Measurement of tree –methods of measuring – diameter, girth height, form, basal area, volume and age of standing trees, biomass estimation

MODULE V FOREST PROTECTION

- Agencies causing forest damage viz. man, fire, cattle wildlife, insects and pathogens, nature of their damages, cause, prevention, remedial measures.
- General forest protection against fire, equipment and methods, controlled use of fire.

MODULE VI NON WOOD FOREST PRODUCTS

- Definition, Importance, diversity/Types, their distribution, role in rural livelihood and industry, present and future scope of utilization

MODULE VII SUSTAINABLE FOREST MANAGEMENT

- Concept of sustained yield

PRACTICALS

- Seed viability and Quality Testing
- Seed collection and storage techniques
- Nursery: Site selection, layout, infrastructure and tools, containers
- Nursery operations for growing plants through seeds, cuttings, budding and grafting; grading, transport of plants
- Preparation of plantation area, planting and maintenance
- Measurement of tree diameter, height, volume and age
- Visit to forest areas with different site conditions and silvicultural systems
- Visit to timber depot, NWFP industry
- Identification of plants using flora upto genus level

ERE 212   RESTORATION ECOLOGY

LEARNING OBJECTIVES: To impart knowledge about restoration of degraded land, public participation in conservation and restoration and concept of sustainable development

MODULE I INTRODUCTION

- Definition, aims and objectives of restoration, principles, concepts and strategies (long term vs. short term), physical, chemical and biological restoration, role of ecological principles in restoration, holistic approach in restoration

MODULE II RESTORATION OF NATURAL AND DEGRADED RESOURCES

- Restoration of degraded lands/waste lands, range land, forest, river corridor, water resources, mine spoils and wet lands
- Methods of soil and water conservation for reclamation of degraded land. The concept of sustainable development, Environmental degradation and conservation issues, Global change and sustainable issues

MODULE III MICROBIAL MANAGEMENT

- Microbial management and biofertilizers for restoring soil fertility. Biotechnology for restoration of degraded land.

MODULE IV PUBLIC PARTICIPATION IN RESTORATION

- Role of public participation, government agencies and NGOs in conservation and restoration, environmental education and its role in conservation and restoration

PRACTICALS

- Cover, Basal area
- Soil binding capacity
- Charting and Mapping of Vegetation,
- Root Density
- Fertility Rejuvenation Index,
- Infiltration rate
- Field visit to restoration sites

EGF 213   GLOBAL CLIMATE CHANGE AND FOREST

Learning objectives: To develop the understanding of Earth's Climate System, climate change Mitigation and International Cooperation: Agreements and Instruments such as Kyoto protocol, UNFCCC, IPCC, CDM projects

MODULE I INTRODUCTION

- The Climate System: Processes, Variability and Change including an overview of the climate system and greenhouse effect. The major components of the climate system(atmosphere, ocean, land and cryosphere) and interactions among the components (e.g. Earth's energy balance, surface energy balance, hydrologic cycle, atmospheric circulation, ocean circulation) that determine the state of the climate will be examined. Processes of natural climate variability and climate change will be explored, with emphasis on India. Human-caused climate change.

- Evidence of climate changes of the distant and recent past and their causes. Reconstructions of the Earth's climate in the distant past from palaeoclimate proxies and causes of climate changes in the palaeo-record

- Methods for projecting future climate change, projections of climate change at global and regional scales, and uncertainties in climate change projections. Observed and projected climate changes for Indian biogeographic regions

MODULE II NATURAL AND MANAGED RESOURCES

- Land as a resource. Land use classification (Theory+Practical), Landuse planning, Landuse resource management and major issues.

- Water resources: Spatial and temporal distribution of water resources. Use and abuse of surface and ground water. Water as an energy debate and crisis (Pros and cons of dams-especially in Himalayan region)

- Mineral resources: Major mineral resources of India, distribution across country, impact of mineral harvesting on environment including biodiversity.

- Forest resources: Forest vegetation, status and distribution, contribution as resource. Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people, non-timber forest products. Developing and developed world strategies for forestry.

- Interrelationships among different types of natural resources.

- Role of different stakeholders in natural resource management-government, non-governmental organization, corporate sectors and communities (sacred groves)

MODULE III IMPACTS AND VULNERABILITY

- Understand the concepts of vulnerability, exposure, sensitivity, adaptive capacity, resilience and thresholds

- Understand at a basic level the causes of vulnerability

- Learn the key vulnerabilities for India

- Understand the response strategies of adaptation and mitigation and the factors that enable and impede these responses

- Impacts on species at physiological levels (evapo-transpiration, phenology, migration, reproduction) and at population level bringing changes in species distribution

- Impacts of climate change on biotic interactions including symbiotic (pollination, seed dispersal), predatory (pest control) and diseases spread.

- Impacts of climate change on biological invasions. Species distribution of invasive plants, changes in physiology and reproduction and impacts of biodiversity.

- Impacts of climate change on food security. Definition of food security. Causes of food insecurity (local, regional, international, social, gender). Sensitive countries and biogeographic zones and methods to deal with food insecurity (biotechnological and policy level, including regional and international, changes for dealing with food insecurity).

MODULE IV CLIMATE CHANGE MITIGATION AND ADAPTATION

- Adaptation and mitigation strategies for forest, agriculture, aquatic and urban ecosystem (Visit to Urja Bhawan, Dehradun to understand the recent technological interventions by the department)

- Synergies in adoption and mitigation

- Linking adaptation and mitigation within climate policy mechanisms

- Policy, technology and finance requirements for adaptation and mitigation

MODULE V INTERNATIONAL CONVENTIONS

- International Multilateral Environmental Agreements and Climate Change; the Rio Conventions and their Synergy; UNFCCC, its various, bodies and their functions

- Kyoto Protocol, its operationalization and implication for developed and developing Countries.

- The Clean Development Mechanism (CDM) and its operationalization; modalities and procedures; National Communication to the UNFCCC (NATCOM); Carbon Markets; Role of IPCC in global Climate Change policy perspective

PRACTICALS

- Assignments

EFE214   **FOREST ECONOMICS**

LEARNING OBJECTIVES: The course is designed to explain the role and application of economics in management of forest, wildlife and environment.

MODULE I FUNDAMENTALS OF ECONOMICS

- Definition, Basic concepts
- Micro and Macro Economics, utility and marginal analysis, demand–supply of forest products, Law of diminishing marginal utility, Law of equimarginal utility, Law of Demand, Elasticity of demand, Law of Supply, Market equilibrium, Production Possibility curve, Production theory as applied to forestry, Production function, Factors of production.
- Role of markets, open market economy, different forms and types of market competitions, regulation, cases studies of forest products, Market efficiency, Market intelligence, Marketing of tree products, Marketing strategies for NTFPS, Cooperative Societies.
- Costs and revenues, Opportunity Cost, Interest, Rent, Wages
- Investment criteria, Benefit cost analysis, Internal rate of return (IRR), Sensitivity analysis and their applications

MODULE II FOREST RESOURCE ECONOMICS

- Goods and services from forests, measuring forest ecosystem values and benefits, Monetization of intangible services from forest
- Soil expectation value
- Total Economic Valuation, Models for direct and indirect benefit estimation market price method, productivity method, Travel Cost Method (TCM), Hedonic Pricing Method (HPM) and Contingent Valuation Method (CVM) and other cost based methods of economic valuation and their application
- Contribution of goods and services from forests to national GDP, Natural Resource Accounting, National Income.
- Economics of air, water and energy resources
- Economics of carbon sequestration

MODULE III PROJECT FORMULATION, IMPLEMENTATION, MONITORING AND EVALUATION

- Basic guidelines for preparation of project reports
- Assignments and case studies to demonstrate the economic valuation of different components of environment

- Collection and analysis of price and quantity data for various forest products
- Study of Marketing channels and price spread for important timber and non timber forestry products

PRACTICALS

- Assignments

EPM 215   ENVIRONMENTAL POLLUTION MANAGEMENT

LEARNING OBJECTIVES: To acquaint the students with different types of pollution, their sources, causes and control measures

MODULE I INTRODUCTION

- Definition of pollution, pollution of the biosphere causes and significance, classification of pollutants, National and International Environmental Standards

MODULE II AIR POLLUTION

- Types and major sources of air pollutants, dispersal and deposition, response of biotic and abiotic ecosystem components to pollutants, impact of air pollutants on human beings
- Ionizing radiation, acid rain- causes and consequences. Monitoring of gaseous pollutants and particulate matter
- Air pollution mitigation and control. Atmospheric composition, reactions in the lower and higher atmosphere, radioactivity in the atmosphere, air quality standards and criteria. Air pollution control equipment viz. settling chambers, inertial separators, cyclones, multiple cyclones, bughouse filters, scrubbers or wet collectors, electrostatic precipitators, advantages and disadvantages of control equipment
- Air pollution abatement technologies including vehicular emissions

MODULE III WATER POLLUTION

- Definition, types, sources and classification of water pollution, ground, surface and marine water pollution
- Sewage and wastewater treatment and recycling, water quality and standards
- Concept of DO, BOD, COD and thaeir effects on flora and fauna.
- Characterstics of domestic, industrial and agricultural wastes, their effects on water bodies; thermal pollution. Marine pollution-a general account
- Minimata episode, Itai Itai episode, water pollution due to nutrients.

MODULE IV SOIL POLLUTION

- Definition, sources & types- classification of soil pollutants, effects on soil, to health and productivity.
- Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, industrial effluents and surfactants. Detrimental effects of soil pollutants, Remedial measures for soil pollution.
- Integrated solid waste management

MODULE V NOISE POLLUTION

- Basic properties of sound waves-plane and spherical wave, sound pressure and intensity levels, decibel, effect of meteorological parameters on sound propagation
- Measurement and analysis of sound. A weighted sound level; equivalent sound pressure level (Leq) Noise pollution level (NPL), sound exposure level (SEL), traffic noise index (TNI), day-night level, noise criteria curves; noise sources; machinery noise, pumps; compressors, building and construction equipment, domestic appliances, traffic- vehicular, train, aircraft, diesel generator sets
- Prediction of traffic noise-nomograph method. Noise control sound absorption coefficient (ast), sound absorbing materials, reverberation time, acoustic silencers, mufflers, barriers, vibration and impact isolation

PRACTICALS

- Monitoring of dust fall, SPM, CO_2, CO, O_2, NOx, Sox in ambient air
- Sampling of water samples, determination of acidity and alkalinity, total dissolved solids and total suspended solids, dissolved oxygen, COD, BOD, turbidity, pH, conductivity of water, hardness, chloride, sulphates.
- Noise monitoring at residential localities/ forest areas

ETP 216   Term paper II

Learning objectives

The objective of term paper is to make students to aware about, how to write a scientific research paper/technical report. It helps the student to develop ability to do logical arguments, and thought process and also helps students to learn to relate their thoughts in a concise manner. It will also develop the communication and report writing skills.

EPS 311 ENVIRONMENTAL POLICY LAW AND SOCIOLOGY

LEARNING OBJECTIVES: To impart the knowledge of environmental legislation and policies (national and international) and develop the understanding of environmental sociology and human rights in relation to environment

MODULE I ENVIRONMENTAL POLICY AND LAW

- Environmental Legislation for protection of species and natural resources
- Government policies for environmental conservation. Government Agencies responsible for environmental protection. Environment Protection Act, Air Act and Water Act
- International environmental legislations, protocols, treaties, conventions pertaining to environment
- Public Interest litigations and their role in control of environmental pollution in India

MODULE II ENVIRONMENTAL SOCIOLOGY

- Interrelationship among Ecology, Environment and Society. Role of population growth, technology and urbanization on society. Sustainable development and resource conservation
- Importance of bio-diversity and peoples value for ecosystem. Environmental needs and social justice, participatory management of biological resources
- Environmental Movements in India with special reference to Chipko and NBA
- Human Rights in relation to environment. Role of NGOs in Environmental Protection

PRACTICALS

- A detailed study of any one of the national or international NGO working in the field of environmental conservation and protection
- A detailed study of any one PIL case in India
- A detailed study of any one Environmental Movement in India
- A small report on any contemporary environmental problem having a bearing on interrelationships between environment and society
- Visit to Industries

EEM 312 <u>ENVIRONMENTAL MICROBIOLOGY</u>

<u>**LEARNING OBJECTIVES**</u>: To acquaint with fundamental aspects of microbial diversity and their function in environment.

<u>MODULE I</u> FUNDAMENTALS OF MICROBIAL DIVERSITY

- Microbes and environment, classification and occurrences, distribution, diversity and ecological importance, characteristics of protists, prokaryotes and viruses.
- Photoautotrophs, chaemolithotrophs, organotrophs, parasites and symbionts
- Techniques of microbial culture
- Scope of environmental microbiology.

<u>MODULE II</u> SOIL MICROBIOLOGY AND BIOREMEDIATION

- Soil microorganisms and their interaction, soil borne diseases
- Microbial treatment of soil pollution, pesticides and surfactants
- Biological management of hazardous wastes and wasteland
- Biocontrol agents, Biofertilizers
- Microbial mining and metal recovery

<u>MODULE III</u> IMPACT OF MICROBES ON ENVIRONMENT

- Microbial toxins, bio magnification, bioaugmentation, biomineralization
- Release of genetically engineered microbes and environmental risks
- Air borne pathogens and air borne diseases
- Water borne pathogens and water borne diseases
- Bioremediation of oil spills

<u>MODULE IV</u> AIR AND WATER MICROBIOLOGY

- Microbial dispersal through air and water,
- Microbiota of fresh water and marine water
- Estimation of microbial mass
- Waste water treatment (sewage and industrial effluents), properties and step involved in aerobic and anaerobic treatments, specific biotechnological approaches (conventional and advanced treatment technology)
- Bacteriology of water, milk and air
- Microbial standards of water quality
- Methanogenic and fermentative bacteria, down stream processing

PRACTICALS

- Isolation of Rhizobium bacteria and their culture from root nodules
- Gram staining of Rhizobium bacteria
- Isolation, purification and maintenance of fungal culture: sub culturing, mineral oil preservation, lysolization
- Effluent treatment using microbes

EFC 313   **FOREST CERTIFCATION**

LEARNING OBJECTIVES: The objective of the course is to introduce concept and importance of forest certification and its programme in India.

MODULE I INTRODUCTION

- Forest certification: concept, definition, origin, evolution, relevance and benefits, Emerging issues, trends and schemes, certification and labeling, essentials of forest certification

MODULE II FOREST CERTIFICATION PROGRAMMES

- Standards, certification process, accreditation, auditing, organizational process, national and international schemes, certificate processes at global level, Forest certification Initiative in India, Extent of forest certification and certified timber market.

MODULE III CERTIFICATION OF FOREST PRODUCTS

- NTFPs and their role in forest management, certification of NTFPs, issues, merits and demerits of NTFPs certification, certification of wood based products

MODULE IV SUSTAINABILITY, CHALLENGES AND POTENTIAL OF FOREST CERTIFICATION

- Framework for forest certification in India, Government policies and their objectives, Indian forest certification agencies, Standards of certification for sustainable utilization, and management of forest resources, progress of certification in India, stakeholder expectation and economics of forest certification

EDM 314   DISASTER MANAGEMENT

LEARNING OBJECTIVES: To familiarize the students with cause and effects of natural disaster, it's forecasting and warning systems and programme planning for better management

MODULE I NATURAL DISASTERS

- Natural disasters, nature, causes and effects, cyclone, tornadoes, floods, earthquakes, avalanches, landslides, drought, diseases, and fire
- Forecasting and warning systems of disasters, measurements of responses of disasters, community reaction to disaster, coping mechanism, classes of victims

MODULE II DISASTER MANAGEMENT

- Disaster management, pre-disaster phase, actual disaster phase, post-disaster phase, disaster assistance, technological assistance, relief camps, organization, camp layout, fire fighting camping and tent pitching, rope, knots and their use, rescue, emergency rescue.

MODULE III DISASTER EDUCATION

- Disaster education. Alternatives and new directions, conceptualizing disaster recovery, mitigation and preparedness, programme planning and management
- Case studies of disasters

PRACTICALS

- Assignments and field visits

EST 315   STUDY TOUR

Learning objectives

A study tour is organised every year for the students of M.Sc. Environment Management to acquaint themselves with the knowledge in the relevant fields. The study tours are intended for giving actual field exposures to students. It helps in providing a real opportunity to students to visualize the professional efforts and measures taken by different industries, institution in tackling the problems of environment

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ENM 321   NATURAL RESOURCE CONSERVATION AND MANAGEMENT

LEARNING OBJECTIVES: To introduce the challenges for society in conserving natural resources such as forest, mineral, wildlife, soil, water and their sustainable management

MODULE I INTRODUCTION

* Current issues, Public policy. Law and public involvement: Endangered Species Act, Clean Water Act, Renewable and Nonrenewable resources

MODULE II FOREST RESOURCES

* Distribution of forests, wood production, carbon sequestration, non-wood forest produce
* Cost associated with forest exploitation, cost of felling/removal and transportation of forest produce
* Energy cost for forest exploitation, environmental cost, loss of habitat, deforestation impact reforestation and processing cost, sustainable management

MODULE III MINERAL RESOURCES

* Distribution and management, economics of mineral resources, cost associated with mineral exploitation, economic cost, energy cost, environmental cost, steps in mineral exploitation, recycling as an alternative

MODULE IV SOIL AND WATER RESOURCES

* Soil structure and use, decomposition of parent rock, formation of humus and organic matter, soil properties, soil texture, soil erosion, water holding capacity, biological activity in soil, soil conservation practice, land capability classes, contour forming strip forming, terracing, Salt affected soils and their management, Acid soils and their management, Water resources, water management, wind erosion, use of wind breaks

MODULE V WILDLIFE RESOURCES

* Wildlife resources, restoration of wildlife, habitat management

PRACTICALS

* Characterization and categorization of threatened species and habitat for biodiversity conservation in peri-urban forest ecosystem

EBM 322   BIODIVERSITY MONITORING AND MANAGEMENT

LEARNING OBJECTIVES: To impart the thorough knowledge of biodiversity, their conservation status, assessment and management strategies including preservation plots and action plans

MODULE I INTRODUCTION

- Biodiversity Inventorization, monitoring and characterization, Documenting and mapping biological diversity, Conservation sites characterization, NDVI (Normalized Difference Vegetation Index), floristic diversity of India and adjacent region, endemicity value, recent trends in allied subject: Bamboo, Rattans medicinal plants diversity)

MODULE II CONSERVATION STATUS ASSESSMENT

- Loss of biodiversity, Threat and conservation value: categorization of threat-international norms and national perspective; prioritization of key areas of conservation

- Techniques and tools of Biodiversity Impact Assessment, Economic evaluation of benefits of biodiversity and genetic resources; Integrated aspects of using indigenous knowledge and grassroots innovations and management

MODULE III MANAGEMENT STRATEGIES

- Development of conservatories and repositories, Protected areas, Regionaland Global biodiversity Hotspots

- Base line study on Preservation plots, Corridors and migratory routes of flora and fauna

- Role of community in biodiversity management, man and animals conflict management

- National Biodivesity Strategy and Action Plan, National Biodiversity Authority, Wildlife Protection Act, International Conventions and initiatives-CBD, UNFCCC, CITES, WCS, GBIF, IUCN and important institutions

- Network on biodiversity information and management; Database development and information sharing through interdisciplinary cooperation and support

PRACTICALS

- To make a single species inventory with enumeration with <u>locational habitats</u>
- Study of the area of occupancy and extent of occurrence of species in naturalized colonized area with emphasis on habitat viability indices
- Biodiversity impact assessment studies. Threat and conservation value assessment on the biodiversity of different ecosystem

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EBC 323   BIOSTATISTICS AND COMPUTER APPLICATION

LEARNING OBJECTIVES: To train the students about the fundamentals and application of statistical methods for addressing issues of Environment Sciences and Environment Management

MODULE I INTRODUCTION

- Basic overview of Statistical Methods; Central Tendency and Dispersion, Probability and probability distributions, Correlation and Regression, Tests of significance

MODULE II SAMPLING TECHNIQUES

- Advanced Sampling plans; Multistage Sampling, Double sampling, Cluster sampling; Treatment of non-response in sampling

MODULE III TIME SERIES ANALYSIS

- Time series analysis and its applications in understanding environment: Introduction to Time Series, Component of Time Series (Random, Trend, Seasonal and Cyclic Fluctuations), Moving averages, Autocorrelations, ARIMA, Smoothing a time series Co-integration, forecasting using time series models

MODULE IV MULTIVARIATE ANALYSIS

- Multivariate Analysis of variance
- Multiple Regression Analysis
- Principal Component Analysis
- Factor analysis
- Basics of Cluster Analysis
- Basics of Discriminant Analysis
- Basics of Correspondence Analysis

MODULE V COMPUTER APPLICATION

- MS Excel, MS Access, Statistical software- SPSS, Statistica etc

PRACTICALS

- Practical in the field or forests and measurement of three parameters

- Exercise on multiple regression analysis on collected data

- Time series data analysis on any environmental issues

- Data analysis through statistical software

- Data analysis through statistical software for multivariate data

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ESM 324   <u>**SOLID WASTE MANAGEMENT**</u>

<u>**LEARNING OBJECTIVES:**</u> To impart knowledge of issues, approaches, characteristics, control measures of solid wastes and technologies for management

<u>MODULE I</u> SOLID WASTE MANAGEMENT

- Introduction, Municipal Solid Waste Management in India: Issues and approaches, Engineering principles; Sources, nature and characteristics; quantitative and qualitative; Solid waste problems: Industrial, Mining, Agricultural and Domestic (urban) wastes, waste processing techniques, Hydrological aspects of solid waste. Regulatory aspects of Solid Waste Management

<u>MODULE II</u> SOLID WASTE DISPOSAL

- Sanitary landfill planning, site selection, design and operation, equipment, costs, Aerobic landfill stabilization. Biological oxidation. Composting, optimum conditions for composting, Biogas; Pyrolysis; Incineration: waste characterization, combustion calculation, unit operations, supply of air, products of combustion, furnace temperature, furnace calculation, storage of refuse, waste reduction and environmental control

- Industry specific solid waste management, Agriculture, Process Industry, Mineral and Metallurgical industry, Disposal of industrial and mill tailings, Resource and energy recovery: Recycling of solid waste, Integrated waste management

- Energy from the waste: important in national and international context

<u>PRACTICALS</u>

- Assignments

LEARNING OBJECTIVES: To impart knowledge of Climate Change issues at global and national level and connecting people on social and environmental concerns

MODULE I SOCIAL DIMENSIONS ON CLIMATE CHANGE

- Community social structure, status and role, norms and values, Concepts of equality, inequality, exclusion, poverty and deprivation, Social Stratification (class, status groups, gender, ethnicity and state, citizenship, democracy, civil society, ideology)
- Social-scientific concepts relevant to understanding the interactions between climate and society.
- Sociological issues related to climate change- Social causes, consequences, conflicts over resources etc
- People and forest interface in managing natural resource and Common property resources, gender perspective and priorities in relation to resource use and management, Gender impact analysis, Social drivers of Climate Change
- People and forest interface in managing natural resource and common property resources
- Gender perspective and priorities in relation to resource use and management
- Social drivers of Climate change
- Social theory and Climate change.

MODULE II CLIMATE CHANGE ISSUES AT GLOBAL AND NATIONAL LEVEL

- Policies and initiatives related to global climate change. UNFCCC process, UNFCCC Subsidiary Bodies, Their role and responsibilities, role of various players/negotiating groups/regional organizations and non state actors in global climate regime, political and economic perspective of global climate policy.
- Conceptual understanding of Kyoto Protocol and Paris Agreement
- Market mechanisms under Global climate regimes, Kyoto Protocol, New Market Mechanism under Paris Agreements, Voluntary Carbon Markets
- National communication (NATCOM) to UNFCCC principles and processes. Developing GHG inventories for various sectors of economy, Domestics policies and actions for climate change mitigation and adaptation, National Action Plan on Climate Change, National Adaptation Fund.
- India's NDCs to UNFCCC international responses to domestic action.

MODULE III ASSESSING VULNERABILITY & ADAPTATION POTENTIAL

- Socio-ecological System
- Approaches and Frameworks for assessing Socia-ecological systems

- Concept of sustainability
- Vulnerability-Definition and Explanations; Identification and Quantification; Effects and Functions of Vulnerability.
- Vulnerability and climate change-Understanding of risk, vulnerability, precarity, fragility, adaptation, resilience, exposure, sensitivity, hazard
- Basic elements of the Entitlements and Capability approach to the analysis of vulnerability
- Vulnerability, Scale, Framing, Measures and Indicators
- Vulnerability assessment framework
- Environmental Livelihoods-Bringing in the Environment
- Adaptation- ASolution
- Resilience
- Global Policy on Climate Adaptation
- Case studies (Sustainable Livelihood Approach and Vulnerability Approach)

MODULE IV Data Analysis

- Data and Information: Measuremental scale, population and sample, sample survey
- Development of field survey questionnaire
- Data collection tools- Participatory Rural Appraisal (PRA), Rapid Rural appraisal (RRA) and Questionnaire Survey
- Data processing
- Spatial and non- spatial data handling using Geographic Information Systems (GIS)
- Participatory process, Stakeholders and SWOT Analysis
- Communicating and connecting to people on social and environmental concerns
- Data base creation tools for handling large data sets
- Analysis of trends and scenarios
- Scientific writing of result

MODULE V FIELD WORK

- Selection of a problem for vulnerability assessment
- Literature search
- Developing protocol for vulnerability assessment
- Data collection from field for a selected problem
- Data analysis
- Report writing
- Presentation and communication of finding

PRACTICALS

- Vulnerability Assessment of Climate Change Impacts on a Social ecological system
- Development of adaptation protocol for Climate Change Impacts on a Social ecological system

**ERG 326 REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM-
ADVANCES AND APPLICATION IN ENVIRONMENTAL
MANAGEMENT**

LEARNING OBJECTIVES: To impart advance knowledge of application of remote sensing and Geographic Information Systems in Environmental management

MODULE I ADVANCED DIGITAL IMAGE PROCESSING

- Conversion of digital numbers to spectral radiances and top of atmosphere (TOP) reflectance; Concepts of atmosphere correction and radiometric normalization of multi-date satellite images; Spectral indices and their use in vegetation characterization; Multi-resolution and multi-sensor images fusions; Change detection techniques using temporal (multi-date) satellite images; Sub-pixel classification techniques; Principles of high resolution, microwave, thermal, hyper spectral and LIDAR data processing.

MODULE II TERRAIN ANALYSIS

- Digital elevation model (DEM) and other terminologies like digital surface model (DSM) and digital terrain model (DTM); Sources of DEMs (e.g. topographic maps, aerial and satellite stereo photos/images, radar interferometer. LIDAR systems);
  Global and Indian DEMs available in public domain; Derivatives and applications of DEMs such as slope aspect and elevation, generation of shaded relief images and perspective views, topographic indices, watershed analysis, etc

MODULE III GEOSPATIAL ANALYSIS

- Vector and raster-based analysis techniques; Multi-criteria analysis; Network analysis and its applications; Interpolation methods; Overview of internet GIS (or WebGIS) and geo-web services; Concepts of Mobile GIS, crowed sourcing and location-based services; Existing geo-web portals (e.g. BIS, Bhuvan, India WRIS, etc)

MODULE IV ENVIRONMENTAL APPLICATION AND CASE STUDIES

- Utility of high data, microwave and hyper spectral remote sensing and LIDAR in forest cover type density mapping, monitoring and biodiversity characterization and

conservation planning, estimation of forest growing stock, biomass and carbon pool, up scaling carbon and energy fluxes, forest infestation disease detection, etc., Species niche modeling; Assessment and modeling of forest hazards. INFFRAS; Inputs for solving forest litigation issues; Wildlife habitat suitability modeling and Protected Area management; Assessing LULC change and modeling future scenarios of LULC for EIA and EMP; National Forest Information System (NAFIS). Wildlife Information System (WILIS)

PRACTICALS

- Advanced image processing-- Calculating spectral indices and using them for vegetation characterization, change detection using multi-date satellite images

- Terrain analysis-- Downloading different DEM products and their visual analysis, generation of slope (amount and aspect) map, shaded relief images and perspective views and watershed analysis including stream delineation, ordering and watershed delineation

- Geospatial analysis-- Vector and raster-based analysis techniques based on single and multiple layer operations, Interpolation of point data. Exploring geo-web portals (e.g. BIS, IBIN, Bhuvan, India WRIS, etc.). Data collection using Mobile GIS

- Application and Case Studies- Case studies demonstrating the potential of remote sensing and GIS techniques

- Short Group Project – To be carried out by groups of students on different topics of their choice of two to three week duration

EIA 327   ENVIRONMENTAL IMPACT ASSESSMENT

LEARNING OBJECTIVE: To acquaint students about the importance of Strategic Environmental Assessment in cumulative, regional and landscape level impact assessment

MODULE I METHODS FOR EIA

- Elaboration of steps in traditional EIA process

MODULE II STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

- The importance of SEA as a tool for assessing impacts of policy, plan and programmes. Relevance of SEA as a global tool for addressing cumulative, regional and landscape level impacts

- Examples of SEA and SEA like approaches from India; Key example of good SEAs from around the world. Introduction to tools and techniques

MODULE III ENVIRONMENTAL ECONOMICS

- Introduction to some recent approaches of economic valuation of impacts and their application in impact assessment and presentation of case studies

MODULE IV ADVANCED LEARNING ON MITIGATION STEPS

- Principles and concepts of offsets, type o1 offsets, examples of bio-banking and wetland banking and market based mitigation strategies
- Comparison of EIA approaches in other countries in South Asia
- Life Cycle Assessment Approach in Impact assessment
- Impact Assessment for addressing climate change

PRACTICALS

Students will be exposed to practical aspects of the Environmental Impact Assessment through Self Learning Modules-

- Scoping for Hypothetical or real EIA study
- Scoping based on scenario projection through visuals (Some select films can be used)
- Review of EIA Reports and preparing comments for appraisal of project
- Development of Alternatives based on details available for project planning to ensure least impact option
- EIA Report writing with case studies
- Seminar on select topics (eg: Merits of EIA using case study, shortfalls of EIA; What best practices would improve benefits of EIA for decision making)
- Review and observations on Public Participation and Public Hearing
- Conduct of environmental review for evaluating mitigation compliance
- Essay on Road map for making EIA a tool for good governance
- Review of decision support software for EIA

EWH 328 WILDLIFE AND HABITAT MANAGEMENT

LEARNING OBJECTIVES: This course aims to provide a comprehensive understanding of wildlife and their conservation strategies with ecosystem development.

MODULE I NTRODUCTION

- Objective of wildlife conservation and wildlife biology, biological basis for conservation of wildlife. Review of biology of major groups of vertebrates, fish, amphibians, reptiles, birds and mammals with emphasis on importance in wildlife management
- The IUCN categories of conservation status of species. Importance of invertebrate conservation

MODULE II WILD LIFE BEHAVIOUR

- Animal habitat interactions, pattern of habitat utilization, feeding ecology of herbivores, carnivores, insectivores and omnivores, temporal and spatial variation in food resources, animal body conditions, reproductive ecology, dispersion, pattern of growth, study of signs and symptoms of wildlife presence, role of minerals in animal health, adaptation with respect to temperature and water
- Wildlife behavior – Instinct and learning Behavioral ecology, study method and significance for conservation, Group living in animals, Territory in animals, Social organization
- Management of Wildlife Animals in Distress - Causes of distress; trapping, snaring, accidents, injuries, affected by disease and physical disability. Orphaned young, Approach to the handling of animals in distress in consideration to safety of humans and animals concerned, crowd control, techniques for animal capture, restraint and immobilization

MODULE III ECO DEVELOPMENT AND HABITAT MANAGEMENT

- Habitat Ecology – Major Wildlife Habitats, forests, grasslands, wetlands, deserts, Wildlife cover requirement, Edge effect and interspersion, physical and biological features of habitats. Grassland habitats, Habitat Dynamics, Habitat Evaluation Procedures, Forage quality and quantity

- Definition and classification. Wetland values and functions, wetland degradation and loss. Wetland management principles. Identifying major problems and setting 36 | P a g e objectives and priorities. Management of wetland habitats for ecological processes and wildlife

- Rationale for undertaking eco-development, Basic concepts, significance of commodities participation in eco-development, significance of Local Traditional Knowledge in conservation, dependencies of local communities on PA's/ Natural resources, Stakeholders in conservation and their conflicts, SWOT Analysis, Linkage between conservation and development, Livelihood strategies in context of ecodevelopment, Protected areas , mutual impact zone analysis, participatory tools and methods for gathering data for planning eco-development, Micro-planning

- Significance of research in wildlife, wildlife habitat management -- creation of water sources, wallows and saltlicks. Vulnerability of resources and protection, fire as a management tool, livestock grazing, weeds eradication

MODULE IV WILDLIFE TOURISM

- Translocation and reintroduction. Tourism in protected areas. Development of Interpretative facilities, visitor characteristics, expectations and motivations, sustainability in Wildlife Tourism

MODULE V POPULATION DYANAMICS

- Population dynamics, Population estimation, Meta-population, Census techniques, Wildlife health management, Need for wildlife health management, History of wildlife diseases in India, Importance of wildlife health monitoring, problems and solutions, Determinants of disease, Infectious and non-infectious diseases

PTN 330   PLANT TAXONOMY

LEARNING OBJECTIVES: The objective of the course is to impart knowledge about nomenclature and classification of genus, species and variety and to develop skills and abilities to identify plants in the field.

PRACTICALS

- Description of different types of stems; different types of leaves; flowers; inflorescences and different types of fruits.

- Floral parts, dissection and characteristics of one specimen each of ten families with identification, drawing of floral parts with floral formula and floral diagram of species with the help of local flora

- Field botanization, collection and making herbarium for identification of plant or tree species during various tours with the help of flora/

- Virtual Herbariums (Use of Digitalization Flora)

THEORY

MODULE I INTRODUCTON

- Importance of plant taxonomy

- History of Plant Taxonomy in India

- Taxonomy in relation to: Anatomy, Chemotaxonomy, Numerical taxonomy, Cytotaxonomy, Molecular Taxonomy/ Phylogeny, Palynology, Ecology

- Phytogeography, GIS Tools use in Taxonomic explorations

- Plant conservatories (Herbarium, Botanical Garden etc)

- Taxonomic Keys (Dichotomous & polyclave keys)

- History of the classification of Angiosperms, Classifications propose by Bentham and Hooker, Engler and Prantl, De candolle, Hutchinson, Takhtajan, Cronquist. Their merits and demerits. APG classification (Angiosperm Phylogeny Group system of plantclassification*)*

MODULE II BOTANICAL NOMENCLATURE

- International code of Botanic Nomenclature (ICBN and ICN); principles; Rules and recommendations; priority; typification; Rules of effective and valid publications; retention and choice of names.

MODULE III DESCRIPTION OF IMPORTANT FAMILIES

- Dendrology
- Description   of families viz. Magnoliaceae, Dipterocarpaceae, Meliaceae, Sterculiaceae, Leguminosae, Rosaceae, Lythraceae, Myrtaceae, Rhizophoraceae, Rubiaceae, Lauraceae, Fagaceae, Verbenaceae, Euphorbiaceae, Coniferae, Poaceae (Bamboo)

MODULE IV ETHNOBOTANY

- Ethnobotany and its importance.
- Ethnobotany of important forest species

UFT 331   URBAN FORESTRY

MODULE I: CONCEPTS AND PRINCIPLES OF URBAN FORESTRY
- Introduction and concept of Urban Forestry, Indian and global perspectives of urban forestry
- Importance and scope of urban forestry
- Urban forestry at municipal level-benefits of urban forestry
- Environmental problems in urbanizing world
- Benefits of linking forest and vegetation with urban planning
- Contribution of urban forests in generating livelihoods for urban poor in India

MODULE-II URBAN BIODIVERSITY
- Threats including damaging agents; control/management measures and other mitigation techniques
- Significance of urban biodiversity in India
- Climate change affect and urban vegetation
- Preparation of urban biodiversity register (UBR)
- Monitoring the loss of urban biodiversity
- Strategy for Urban biodiversity planning, conservation and development
- Whole tree transplantation and its techniques
- Trees felling in cities and procedure

MODULE- III MANAGEMENT OF URBAN FOREST LANDSCAPE
- Species choice for urban forestry, site, tree selection and planting
- Characteristic features of tree species suitable for urban forestry
- Tree growth and development
- Technical aspects of tree maintenance-pruning, cleaning, post plantation care, cleaning, nursery, water management
- Types of plantation, design & tree architecture, monitoring, urban, landscape forestry management issues, stake holder's analysis.
- Production of tall plants
- Setbacks of trees and infrastructure, trees vs. buildings

MODULE IV URBAN FORESTRY PLANNING POLICY AND APPLICATION
- Integration of urban forestry in city planning, institution policy and social issues, incentives and partnerships
- Role of government, NGOs, corporate houses and civil society organizations in urban green space development, Public Private Partner (PPP) model
- Case study of Urban Green Space Management in Metro Cities (New Delhi, Chandigarh, Bangalore etc.)

PRACTICAL:
- Field trip for tree species identification in urban setup/ Botanical garden/ Arboretum
- Field trip deal with tree selection, tree pruning, tree reaction to wounding and an introduction to hazard tree assessment.
- Disease survey and risk assessment of "Avenue Trees" in urban setup
- Visit to Fungarium, Insectary/Museum, and diagnosis of fungal and insect attack
- Nursery visit for assessment of urban forestry species, their disease and management.
- Group/class project on urban forest designing

4th Semester

ESY 441	**Synopsis**	**1 Credit**
EMT 442	**Master's Thesis**	**17 Credits**
EMT 443	**Master's Thesis Seminar**	**2 Credits**

LEARNING OBJECTIVES: In final semester students have full six month to conduct their own experiment and conclude the findings as thesis reports. . Students work on research problem and hypothesis under the supervision of a concerned faculty. It equips the students to pursue the goal in academic area or R and D section. They learn methodology and techniques of research writing. This provides an opportunity to students about identifying problems such as challenges and opportunities and solving problems through research and experimentation