

**SCHEME OF EXAMINATION
AND SYLLABUS
OF
MASTER OF SCIENCE
(NATURAL RESOURCE MANAGEMENT)

(ACADEMIC SESSION AUGUST 2015 -2016)
Programme Code-047**

**UNIVERSITY SCHOOL OF ENVIRONMENT MANAGEMENT
NEW DELHI-110078**

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- **Programme Code: 247**
- **Title of the Programme: Master of Science (Natural Resource Management)**
(Restructured Curriculum from implemented August 2015 batch)
- BOS meeting on 28.07.2015
- **Academic Council's Approval:** _____
- **University School of Studies of the Programme:**
University School of Environment Management (USEM)
- Contact for any further query:
Dean's Secretariat USEM
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New Delhi 110078 (India)

w.e.f. Academic Session 2015

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M. Sc. (Natural Resource Management)

PREFACE

Natural Resource Management (NRM) Degree

Natural Resource Management (NRM) is an integrated and multidisciplinary approach combining Earth-Science, Life-Science, Environmental Science, Social Science and Management Science to manage and restore natural resources and ecosystems. Natural Resource Management sustains and restores abiotic and biotic resources within wilderness, forestry, recreational, agricultural and urban areas and the skills to address management problems. Natural Resource Management helps to balance the needs of people and the economy with protecting the ability of ecosystems to support soil, water, forests, wildlife, fish, recreation, and other resources. Natural Resource Management professionals are trained to look for ways to make responsible natural resource management decisions which consider all stakeholders. The degree requires two years of study (Four Semesters). As per the choice based credit system of UGC, circular 2014 the syllabus is restructured and updated with the concept of Core Courses (CC), Foundation Courses (FC), Elective Courses (EC) viz. Generic Elective (GC)/ Core Elective (CE) and Open Electives (OE) courses.

Relevance:

The Natural Resource Management program will increase the University School of Environment Management School Educational Programme for higher studies. The Natural Resource Management (NRM) curriculum requires an in-depth understanding of the subjects of Environmental Degradation and Unsustainable Consumption of Resources. There are only a few Universities in India that offer courses about NRM. There are huge infrastructures and extensive economic development is being planned in India, to maintain and promote economic growth. Natural resources are key components for the growth and prosperity of the nation. Such courses will develop contemporary expertise with domain knowledge which will help students through their advanced curriculum. The University may have professional linkages with U.S. Universities in the field of Environment Management to strengthen research and teaching programme. Such contemporary courses will supply the manpower required for industries, sectoral business and for future knowledge development.

Examination

The University has adopted the semester system for this programme. In addition to the End Term Examination, there is a continuous evaluation of student's performance throughout the academic programme. The Odd Semester Examinations are conducted in the months of December-January and the Even Semester Examinations are conducted in the months of May-June.

Field Excursions , Summer Training and Dissertations

The syllabus covers enough field exposure to students for the interactions with outside world through field excursions, summer training and dissertations. All these components are evaluative and supervised by experienced faculty members; students can get firsthand practical knowledge through such activities, credit weightage are given in the scheme.

Evaluation and Award of Degree

The overall weight of a course in the syllabi and Scheme of Examination is determined in terms of credits assigned to the course. Obtaining a minimum of 50% marks in aggregate in each course, including the End Term Examination and the teacher's continuous evaluation, is essential to earn the assigned credits. A student who secures less than 50% of marks in a course is, therefore, deemed to have failed in that course. A student is eligible for the award of University degree, if he/she has registered himself/herself, has undergone the regular course of studies, completed the project report/dissertation specified in the curriculum of his/her programme within the stipulated time, and has secured the minimum number of credits as prescribed for the award of concerned degree.

Broad Guidelines for Question Paper

The question papers are key tools for assessing student learning. Question papers are very meticulously planned to cover the entire course and include all components of assessment:

- 1) Knowledge
- 2) Comprehension
- 3) Application
- 4) Analysis and Evaluation
- 5) Synthesis
- 6) Creativity and Innovation

Instructions to Paper Setter

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.

2. Apart from question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, the student may be asked to attempt only 1 question from each unit. Each question should be worth 12 possible marks.

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Code No.	Subject	L	T	P	Credits
First Semester					
EMNRM 601 (Foundation Course)	Fundamentals of Natural Resource Management	4			4
EMNRM 603	Ecology and Ecosystems	4			4
EMNRM 605	Earth, Water Resources and Natural Disasters	4			4
EMNRM 607	Energy Resources and Environment	4			4
EMNRM 609	Elements of Geoinformatics	4			4
Practicals					
EMNRM 651	Ecology and Ecosystems Lab			4	2
EMNRM 653	Geoinformatics Lab			4	2
EMNRM 655	Soil, Rock and Mineral Lab			4	2
EMNRM 657	Seminar/Term Paper *				1
	Total				27
Second Semester					
EMNRM 602	Biodiversity and Biosystematics	4			4
EMNRM 604	Forest Resources, Planning and Management	4			4
EMNRM 606	Environmental Economics and Ecosystem Services	3			3
EMNRM 608	Environmental Statistics	4			4
EMNRM 610	Aquatic Ecosystem and Wetland Management	4			4
	Generic/ Core Elective (Any one)				
EMNRMGE 616	Environmental Modelling	4			4
EMNRMGE 618	Ecotechnology for Natural Resource Management	4			4
EMNRMGE 620	Climate Change and Carbon Management	4			4
EMNRMGE 622	Watershed Management	4			4
* (NUES- Non University Examination System)					

EMNRMGE 624	UrbanForestry, Biodiversity&Landscape	4			4
Practicals					
EMNRM 652	Biodiversity Assessment and Taxonomy Lab			4	2
EMNRM 654	Forest Inventory & Mensuration Lab			2	1
EMNRM 656	Environmental Statistics and Computer Applications Lab			4	2
	Summer Training/ Field Visit				
	Total				28

Third Semester					
EMNRM 701	Environnemental Impact Assessment and Auditing	4			4
EMNRM 703	Agro-ecosystems and Agroforestry	3			3
EMNRM 705	Natural Resource Policy, Governance and Livelihood	4			4
EMNRM 707	Wild Life Management	3			3
EMNRM 709	Project Management and Financial Analysis	3			3

Open-Electives (Any one) **					
EMOE731	Climate change mitigation & adaptation	4			4
EMOE733	Disaster Risk Reduction and Management	4			4
EMOE735	Urban Biodiversity Strategies for Conservation	4			4
EMOE 737	Human aspects of Biodiversity and Environment	4			4
EMOE739	Corporate Social Responsibility	4			4
EMOE741	Sustainable Ecotourism	4			4

Practicals					
EMNRM 751	Water quality Analysis Lab			2+2	2
EMNRM 753	Industry and Field visits – Reports and Presentation				1
EMNRM 755	Summer Training Report & Presentation				3
	Total				27
Fourth Semester					
EMNRM 702	Seminar and Progress Report				4
EMNRM 704	Dissertation				22
	Total				26
	Total Credits				108

Total No. of credit offered in all four semesters 108

- Summer Training (6-8 Weeks) outside University in any Industry/Organization.
- ** Students will opt for one relevant open elective paper offered by USEM or by any other University School of GGSIPU

The student will require to earn 100 credits for the award of the degree. The students will not have the option to drop any course covered in scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination of the programme.

Course Code: EMNRM 601

L:4 T:0 C:4

Course Title: **FUNDAMENTALS OF NATURAL RESOURCE MANAGEMENT**

UNIT-I

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Ecological, social and economic dimension of resource management. Natural resources and development.

UNIT-II

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, Forest products. Developing and developed world strategies for forestry.

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case-studies.

Fish and other marine resources: Production, status, dependence on fish resource, unsustainable harvesting, issues and challenges for resource supply, new prospects.

UNIT-III

Land resources: Land as a resource. Dry land, land use classification, land use planning and desertification. Land resource management and major issues.

Water resources: Use and over-utilization of surface and ground water, drought, conflicts over water, dams-benefits and problems. Water ecology and management.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

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UNIT-IV

Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies.

Poverty and implications in resource management in developing countries – poverty in developing countries, causes and link with resources scarcity and poverty.

Resource Management Paradigms: Resource management the evolution and history of resource management paradigms. **Resource conflicts:** Resource extraction, access and control system.

Management of Common International Resources: Ocean, climate, International fisheries and management commissions; **Antarctica:** the evolution of an international resource management regime.

Text Books:

1. **Francois Ramade 1984.** Ecology of Natural Resources. John Wiley & Sons Ltd.
2. **Odum, E.P. 1971.** Fundamentals of Ecology. W.B. Saunders Co. USA, 574p

Reference Books:

1. **Coastal Ecology & Management, Mann, K.H. 2000.** Ecology of Coastal Waters with Implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303.
2. **Harikesh N Mishra 2014 Managing Natural Resources-** Focus on Land and Water. PHI Learning Publication.
3. **Global Change and Natural Resource Management, Vitousek, P.M. 1994.** Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
4. **Agarwal, K.C., 2001.** Environmental Biology, Nidhi Publication Ltd. Bikaner.
5. **Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001,** Environmental Encyclopedia, Jaico Publishing House.
6. **Heywood, V.H. & Watson, R.T. 1995.** Global Biodiversity Assessment.Cambridge Univ. Press.
7. **Miller T.G. Jr.** Environmental Science, Wadsworth Publishing Co. (TB)
8. **Townsend C., Harper J, and Michael Begon.** Essentials of Ecology, Blackwell Science.

Course Code: **EMNRM603**

Course Title: **ECOLOGY AND ECOSYSTEMS**

(L – 4, C- 4)

UNIT-I

Introduction: Definitions, history and relevance, levels of ecology, types of ecosystem, abiotic and biotic environments, biotic – abiotic interactions, soil types, UNESCO scheme of soil classification.

Population ecology: Population attributes, population changes, survivorship curves, growth models, demographic models, dispersion

Community ecology: Community structure, two-species interactions, food webs, succession

UNIT-II

Ecosystems ecology: Climate and weather, energy flows, productivity, nutrient cycling, hydrological cycling, cycling index, biogeochemical cycles (C, N, P, S).

Ecosystem Services: Scope, application, model and examples from India and outside.

Global ecology/ Threats to Ecosystems: Greenhouse effect and climate change, ozone depletion, terrestrial and aquatic biomes; ecosystems responses to long-term climate patterns.

UNIT-III

Ecosystem management: Ecosystem degradation, ecosystems rehabilitation and restoration, pollution abatement in lentic and lotic environments, UN protected area categories: national parks, sanctuaries, Community and biosphere reserves. Principles of ecosystem based management and applications.

UNIT-IV

Sustainability and Sustainable Development: Sustainability theory, the underlying ecological imperative, carrying capacity, sustainability and society (social justice, development, economy), Sustainable Forest Management (SFM), Agenda-21 and UNEP programmes towards sustainable development.

Text Books:

1. **Michael L. Cain**, William D. Bowman, and Saily D. Hacker (2014). Ecology, 3rd Edition. Sinauer Associates Inc. US, 648p.
2. **Odum, Eugene P., and Gary W. Barrett. 2007.** Fundamentals of Ecology, 5th edition. Thomson Brooks / Cole.

Reference Books:

1. **Gotelli, Nicholas J. 2008.** A Primer of Ecology, 4th edition. Sinauer.
2. **Stiling, Peter. 2001.** Ecology: Theories and Applicatios, 4th edition. Prentice Hall.
3. **Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. 2007.** An Introduction to Sustainable Development. Earthscan.
4. **Edwards, Andres R. 2005.** The Sustainability Revolution: Portrait of a Paradigm Shift. New Society.
5. **Primack, Richard B. 2010.**Essentials of Conservation Biology, 5th edition. Sinauer.

Course Code: **EMNRM 605**

Course Title: **EARTH, WATER RESOURCES AND NATURAL DISASTERS** (L – 4, C- 4)

UNIT-I

Earth Resources: Atmosphere, lithosphere, hydrosphere, interior of Earth, geological work of wind and water, underground water, rock cycle, rock types - igneous, sedimentary and metamorphic rocks, mineral types, mineral resources of India, types of erosion and weathering, soil formation, soil profiles, land use and land use planning, earth resource mapping and the use of remote sensing and GIS.

UNIT-II

Water Resources: Hydrology, hydrological cycle and its components, drainage systems, classification of water resources, characteristics of water resources. Surface run-off, stream flow estimation, problems of water and ground water resource depletion, watershed types and Functions.

UNIT-III

Natural Hazards: Flood types and causes, drainage basins, nature and frequency of floods, effects. Flood hydrographs., types and causes of landslides, coastal hazards including cyclones, tsunamis, the effects of tides and tidal effect prediction, earthquake seismology, causes, intensity and magnitude of earthquakes, geographic distribution of earthquakes zones, nature of destruction, causes and consequences of forest fires.

UNIT-IV

Applications for management: Soil and water conservation measures, erosion control, case studies in water resource conservation and management, flood management and control, landslide control and mitigation measures, coastal zone management, earthquake mitigation for buildings and dams, forest fire mitigation and management.

Text Books:

1. **Roy, A.B. 2010.** Fundamentals of Geology. Narosa.
2. **Singh, Rajvir. 2000.** Watershed Planning and Management. Yash.

Reference Books:

1. **Wallace, John M., and Peter V. Hobbs. 1997.** Atmospheric Science: An Introductory Survey, Academic Press.
2. **Bocker, Egbort, and Rienk Van Grondille, 1999.** Environmental Physics. John Wiley & Sons.
3. **Murthy, V.V.N. 2009.** Land and Water Management, 5th edition. Kalyani Publishers.
4. **Heathcote, I.W. 1988.** Integrated Watershed Management: Principles and Practice. John Wiley.
5. **Raganuth, H.M. 2007.** Hydrology: Principles, Analysis and Design, 3rd edition. New Age International.
6. **Dennen, William H., and Bruce R. Moore.** Geology and Engineering. Wm C Brown Publisher.

Course Code: **EMNRM 607**

(L: 4 T: 0 C: 4)

Course Title: **ENERGY RESOURCES AND ENVIRONMENT**

UNIT-I

Fundamentals of energy: Definition of energy and power, various units of energy, various forms of energy, laws of thermodynamics, solar radiation and spectrum, estimation of solar radiation.

Energy, Environment and Development: Energy use pattern in different parts of the world, Indian energy scenario for different sectors, urban and rural energy use systems and patterns, Need for new and alternate energy resources.

UNIT-II

Energy Resources: Non-conventional forms of energy - Coal , petroleum , natural gas and lignite, resources and reserves available in India, Nuclear energy : Fission energy, fusion energy, Nuclear power generation, nuclear reactors, Geothermal energy.

Renewable energy resources-Solar energy , Flat plate collectors, photovoltaic cells , Solar power; Wind energy , wind farms ; Geo-thermal energy ; Hydropower and micro-hydel power ; Tidal energy; Ocean Thermal Energy Conversion(OTEC) Technology; Hydrogen as an alternate fuel.

UNIT-III

Bioenergy and Rural energy systems :

Biomass energy, Bioconversion technologies, bioethanol and biohydrogen, biomass gasification, biomass gasifier systems, improved biomass cooking stoves.

Fuel wood production and consumption, agro residues as source of energy, pollution free improved biomass cooking stoves, Energy plantations, biodiesel crops and production in India, biogas digesters and technology for rural India.

UNIT-IV

Environmental Pollution: Environmental pollution from energy production and use, air pollution, primary and secondary air pollutants –sources and effects, greenhouse gases and global climate change, ozone depletion, acid rains water pollution, Sources and effects, thermal pollution and its impacts on aquatic life, Pollution from thermal power plants and control measures, Environmental issues associated with nuclear power generation, safe disposal techniques of nuclear power waste.

Environmental impacts of hydropower generation.

Text Books:

1. Tiwari, G.N. and M. K. Ghosal. 2005. Renewable Energy Resources: Basic Principles and Application, Narosa Publishing.
2. Edward H. Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addition-wesley Publishing Company, Reading.

References:

1. Ralf E. H. Sims (2004) Bio-energy Options for a cleaner Environment
2. David Merrick and Richard Marshall (1981). Energy-Present and Future options, John Wiley & Sons, New York.
3. D. D. Mishra (2012) Energy, Environment, Ecology and Society, S. Chand & Company Ltd. New Delhi
4. P.P. Bhojvaid (2008). Bio-fuels towards a greener and secure energy future.
5. Rakos Das Begamudre (2000), Energy Conversion Systems, New Age International Publishers, New Delhi.
6. C. S. Solanki (2009), Renewable Energy Technologies-A Practical Guide for Beginners, PHI Learning Pvt. Ltd., New Delhi.

Course Code: **EMNRM 609**

Course Title: **ELEMENTS OF GEOINFORMATICS**

(L: 4 T: 0 C: 4)

Unit I Remote Sensing - Introduction

Introduction to remote sensing, definition, physical basis of remote sensing, electromagnetic spectrum, radiation laws, atmospheric effects, basics of optical, thermal and microwave remote sensing, history of remote sensing, geometric and radiometric aspects of RS data. EMR interaction with earth surface materials, Spectral signatures of vegetation, water, soil, snow etc. in different regions of EMR, ground truth data collection; concepts in photogrammetry.

Unit II Platforms and Sensors

Remote sensing Platforms

Aerial and spaceborne platforms, orbits, sensors types – optical (multispectral, hyperspectral), thermal and microwave, resolutions, Landsat, SPOT, IRS, ERS, Radarsat, RISAT, and other operational remote sensing satellites.

Visual interpretation – Scale, maps and map projections, interpretation keys; image characteristics, media and formats of digital images, image enhancement, image transformations, classification – unsupervised and supervised classification, classifiers, statistical separability, accuracy estimation, change detection; 3-D visualisation.

Unit III Geographical Information System, and Satellite based Navigation systems

Introduction, GIS definition and terminology, data types, raster and vector data, GIS database design, spatial database creation – digitization, scanning; processing of data, GIS implementation and project management. Commercially available remote sensing and GIS softwares.

Satellite based navigation systems: concepts and applications; map projections and datums, coordinate systems; Survey of India topographical maps types and numbering system.

Unit IV Geoinformatics in natural resources management

Application of remote sensing techniques in natural resource management; ecosystem inventory and monitoring - forests, wetlands; land use planning; urban planning, snow and glaciers, potential ground water mapping; coastal zone management, protected area management, remote sensing and GIS in international conventions and protocols (Ramsar, CBD, Kyoto etc.).

Text Books:

1. **Joseph, George. 2005.** Fundamentals of Remote Sensing, 2nd Edition. University Press India.
2. **Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007.** Remote Sensing and Image Interpretation. Wiley India.

Reference Books:

1. **Sabins, Floyd F. 2007.** Remote Sensing: Principle and Interpretation. Waveland Press.
2. **Jensen, John R. 2009.** Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.

3. **Jensen, John R. 2004.** Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall.
4. **Lo, C.P., and Albert K.W. Yeung. 2009.** Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
5. **Joseph L.Awange and KyaloKiema (2013).** Environmental Geoinformatics – Monitoring, Springer, 541p.
6. **Mario A.Gomasca (2009).** Basics of Geomatics, Springer, 656p.

Course Code: **EMNRM 651**

Course Title: **ECOLOGY AND ECOSYSTEMS LAB**

(P – 2+2, C- 2)

1. Monitoring site characteristics
2. Using a GPS receiver
3. Raunkiaer's Lifeforms
4. Population and density estimation
5. Quadrat Sampling – Size and Numbers
6. Community Structure and vegetation indices
7. Transects – Kite diagram
8. Soil Analysis: composition (particle size), density
9. Soil: Nutrients (P, N, C)
10. Wetlands: delineation of wetland boundaries based on Remote sensing data, hydrophytic vegetation, soil moisture
11. Determination of habitat types and qualitative turbidity on satellite imagery
12. Wetland hydrology: area, depth, volume
13. Pools of soil organic matter
14. Hydrophytic plants and functional groups
15. Productivity assessment in aquatic ecosystems (phytoplanktons, submerged macrophytes, emergent macrophytes)

Course Code: **EMNRM 653**

Course Title: **GEOINFORMATICS LAB**

(P- 2+2, C- 4)

1. Introduction to the software (ArcGIS and Erdas Imagine)
2. Digital Image Classification
3. Georeferencing (Scanned topographical map and image to image)
4. Mosaicking
5. Fusion (Merging of high and low spatial and spectral resolution imagery)
6. Subset of imagery
7. Creation of geodatabase
8. Query and retrieval, overlay and map composition
9. Field data collections using GPS and importing to the computer
10. Case Study

Course Code: **EMNRM655**

Course Title: **SOIL, ROCK AND MINERAL LAB**

(P: C:2)

1. Rock properties
2. Mineral properties
3. Identification of rocks
4. Identifications of minerals
5. Soil pH and texture
6. Determination of density of soil
7. Porosity of soil
8. Test for presence/absence of some nutrients
9. Determination of water holding capacity and field capacity of soil
10. Capillary action of water in soils
11. Percolation of water in soils

SECOND SEMESTER

Paper Code: **EMNRM 602**

Paper Title: **BIODIVERSITY AND BIOSYSTEMATICS**

(L – 4, C-4)

UNIT I

Introduction to biodiversity:

Definition, components of biodiversity (genetic diversity, Species diversity, ecosystem diversity , agro-biodiversity, urban – Peri-urban biodiversity), forest biodiversity, community diversity and biocultural diversity; biodiversity indices (alpha, beta and gamma biodiversity); value of biodiversity ;threats to biodiversity.

UNIT II

Plant and animal taxonomy and systematics:

Brief history and definition (history of developments in taxonomy: Linnaean to post-Linnaean era), the importance of taxonomy in natural resource management, Parataxonomy, national and international organizations associated with taxonomic studies. (CBD, GSPC, GTI)

UNIT III

Theory and Practice of Biological Classifications and Reference collections:

Definition and problems of the species concept, intraspecific categories, population structure and taxonomic challenges, phenetic, cladistic and evolutionary concepts involved in nomenclature, taxonomic hierarchy. Importance of all biological studies, collection methods, methods of specimen preservation and storage, identification and annotation histories, The International Code of the Nomenclature (ICN) and International Code of Zoological Nomenclature (ICZN), the biosystematics and its future directions.

UNIT IV

Biodiversity Conservation Approaches:

Landscape approach to biodiversity conservation, corridor approach, individual species approach, habitat conservation approaches, National Biodiversity Strategy and Action Plan.

Text Books:

1. Krishnamurthy, K.V. 2003. Textbook of Biodiversity.Science Publications.
2. Gurcharan Singh. 2004. Plant Systematics: an Integrate Approach. Science Publisher, USA

Reference Books:

1. Judd, W.S., C.S. Campbell, E.A. Kellogg, P.A. Stevens and M.C. Donoghue. 2008. Plant Systematics: A Phylogenetic Approach, 3rd edition. Sinauer.
2. Simpson, G.G. 1962. Principles of Animal Taxonomy. Oxford.
3. Mayr, E and P.D. Ashlock. 1991. Principles of Systematic Zoology. MacGraw-Hill.
4. Narendran, T.C. 2006.An Introduction to Taxonomy.Zoological Survey of India, Kolkata.
5. Primack, R.2006. Essentials of Conservation Biology. Sinauer associates, Inc., USA

Course Code: **EMNRM 604**

L:4 T:0 C:4

Course Title: **FOREST RESOURCES, PLANNING AND MANAGEMENT**

UNIT-I

Introduction to Forest Resources: Importance of forest. Extent of forest in India, in relation to other countries. Forest vegetation, status and distribution. Major forest types of India and their characteristics. Factors influencing resource availability. Locality factors of forest-climate, physiography, geology and soil condition, biotic factors, influence of plant competition, parasites, epiphytes, climber, weeds on forests.

UNIT-II

Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Treats in forest resources- cattle grazing, different methods of control against grazing and browsing animals- rotational and controlled grazing. Effect of wild animals on forest regeneration; Human impacts- Encroachment, poaching, theft of forest produce, shifting cultivation and control – meeting the legitimate demands. Forest fires- harmful and beneficial effects, control measure against fires. Pests and diseases of forests- The management and control of such diseases. Weed problems in natural forests and plantations and their control.

UNIT-III

Forest Management: Forest resource inventory.

Tending operation in forestry- weeding, cleaning, thinning, improvement felling, pruning and climber cutting. Forest regeneration- natural and artificial, their significance. Forest Management System- silviculture and sylvicultural system -Clear felling system, shelter wood system, selection system, coppice system. Production forestry – concept of forest growth, growing stock-increment, rate of growth, rotation and yield and its regulation. Concept of Forest Working Plan its purpose and salient features and Microplan.

UNIT-IV

Approaches and Planning Forest Resource Management:

Afforestation and reforestation, Plantation in various types of ecosystems. Sustainable Forest Management (SFM), criteria and indicators of forest management. Ecological, social and economic dimension of resource management. Approaches to forest conservation. Forestry organisation - role and functions of various forestry wings. Participatory Forestry: Joint Forest Management-approaches, methods and present status.

Text Books:

- West, P.W. Trees and Forest Management. 2004, Springer Publication
- Montagnini, Florencia, Jordan, Carl F. 2007 Tropical Forest Ecology: The Basis for Conservation and Management. Springer Publication

Reference Books:

- James P. Kimmins 2006 Forest Ecology, Pearson Publication.
- Larr, Anthonie Van, AkcaAlparslan 2007 Forest Mensuration, Springer Publication

- Mehta T., Khanna L.S. 1981. Handbook of Forest Utilization, Periodical book Agency, Dehra Dun.
- Dwivedi, A.P. 1993. *Forests - the non-wood resources*. International Book Distributor, Dehradun.352
- Bhattacharya P., Kandya A.K. and Krishna Kumar 2008. Joint Forest Management in India, Aavishkar Publisher, Jaipur.Vol. I & II
- Adrian Newton 2007 Forest Ecology and Conservation: A Handbook Techniques. Oxford University Press
- J.B. Lal 2007 Forest Ecology. Nataraj Publication

Course Code: **EMNRM 606**

Course Title: **ENVIRONMENTAL ECONOMICS AND ECOSYSTEM SERVICES** (L: 3 T:0 C: 3)

UNIT-I

Concept: Definition and scope of environmental economics. Concept of economic value, relevance of environmental economics, relationship with natural resources, environment and economic growth. The Evolution and growth of environmental economics.

Basic concept and theories, Collective Choices and applications: Social benefits, costs and welfare function. Concept of CPR, open access. Hardin's Thesis of 'The Tragedy of Common'. Environmental valuation, valuation of non-market benefits, ecological economics- methodology

UNIT-II

Environmental Accounting: Genesis of environmental accounting. Market, demand, supply and prices. Cost / benefit analysis, methods of costing, cost criteria, evaluating alternative projects, operational vs. total costs, determining benefiting vs. comprehensive stakeholders. Application of resource accounting, Externalities- method of abatements.

Methods of pricing resources- example forest and mineral resources. Population resources and the environment, command and control vs. emission trading, emission trading vs. exposure trading, hotelling principle, future strategies for mineral resources.

UNIT-III

Ecosystems services -Direct and indirect economic benefit from – forest ecosystems, mountain ecosystems, mineral and water resources, ecotourism. Concept of payments for Ecosystem Services (PES), examples from natural resources.

Natural Resource Market: Initial concept of market and marketing, NRM sectors product marketing and their roles, promoting NRM products- NTFPs, livestock, watershed, fisheries, agriculture and medicinal plants and ecotourism.

UNIT-IV

Role of national and international organizations in the promotion of sustainable natural resource use and management.

Case studies related to resource economics-

1. Payment for ecosystem services
2. Mineral Mining
3. Sustainable fisheries
4. Forest certification

Text Books:

1. **Barber, E. 1989.** Economics: Natural Resources Scarcity and Development. Earthscan.
2. **Harris, J.M. 2006.** Environmental and Natural Resource Economics: A Contemporary Approach, 2nd edition. Houghton Mifflin.

Reference Books:

1. **Biergefard, L.E. 1993.** Natural Resource Tenure: A Review of Issues and Experiences With Emphasis on Sub-Saharan Africa. International Rural Development Centre.
2. **Katar Singh and Anil Sishodia 2007.** Environmental Economics- Theory and Application. Sage Publication
3. **Field, Barry C. 2008.** Natural Resource Economics An Introduction. Waveland Press.
4. **Houand, Daniel S, Au.** Economic analysis for ecosystem-based management: application to marine and coastal environments: Washington, RFF Press, USA.
5. **Heal, Geoffrey. 2000.** Nature and the Marketplace: Capturing The Value Of Ecosystem Services. Island Press.

Course Code: **EMNRM 608**

Course Title: **ENVIRONMENTAL STATISTICS**

(L – 4, C-4)

Unit-I

An overview of environmental systems, Basic definitions and applications, Generation of environmental data; Types and objectives of environmental studies; Random processes, Stochastic processes in the environment; Significance / relevance of data analysis in environmental management.

Unit-II

Sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data; Methods of data collection; Methods for selecting sampling locations and times; Simple random sampling, Stratified random sampling, Systematic sampling; Graphical representation by histogram, polygon and pie diagram.

Unit-III

Measures of central tendency; Mean, median, mode; Sampling distributions of - Means, Difference of means, Proportion, Variances , Covariance; Estimation of parameters: Point and Interval estimates; Confidence interval estimation of - Means, Difference of means; Correlation and regression: positive and negative correlation and calculation of karlpearsons co-efficient of correlation; Linear regression and regression equation, calculation of an unknown variable using regression equation ; ANOVA, one and two way classification

Unit-IV

Tests of Hypotheses: Null and Alternative Hypothesis; Type I and Type II Errors; Level of significance; Parametric tests (Concerning Means, Difference of means, Proportion, Variances): Tests of significance for large samples: Z test , Types of Z test (one sample and two sample) , Standard error for Z test ; Tests of significance for small samples: T-test (One sample, Two Sample: Independent and Dependent), Standard error for T-test ; F-test for comparison of variance ; Goodness-of-fit test – Chi-Square test; Test for quality of data: Qtest ; Nonparametric tests – Sign test, Wilcoxon Signed Rank test , Kruskal-Wallis test.

Text Books:

1. Joseph, A.J. (1997). *Health, Safety and Environmental Data Analysis*, Lewis Publishers : New York.
2. Pentecost, A. (1999). *Analysing Environmental Data*. Longman : London.

Reference Books:

1. Gilbert, R.O. (1987). *Statistical Methods for Environmental Pollution Monitoring*, New York, Van Nostrand Reinhold.
2. McBeen, E.A. (1999). *Statistical Procedures for Analysis of Environmental Monitoring Data*.

3. Keith, L.H. (Ed.) (1988). *Principles of Environmental Sampling* ACS Professional References, American Chemical Society.
4. Berthouex, P.M. and Brown, L.C. (1994). *Statistical for Environmental Engineers*. Lewis Publishers, CRC Press.
5. Johnson, R.A. (1999). *Miller & Freund's Probability and Statistical for Engineers (5th edn)*. Prentice-Hall of India Pvt. Ltd.: New Delhi.
6. Walpole, R.E. and Myers, R.H. (1985). *Probability and Statistics for Engineers and Scientists (3rd edn)*. Macmillan Publishing Company: New York.

Course Code: **EMNRM 610**

Course Title: **AQUATIC ECOSYSTEM AND WETLAND MANAGEMENT**

(L4 P0 T0 C4)

Unit-I

Introduction

Aquatic ecosystems: Definitions, Fresh water (lentic, and lotic), marine and wetland ecosystems, classification of aquatic ecosystems and wetlands; chemical composition of fresh and marine waters; ecosystem services and degradation.

Ecology of aquatic ecosystems: Elements of structure, functions and processes in fresh water (lakes and rivers), marine and estuarine ecosystems with respect to hydrology, and biodiversity; wetland soils types and redox potential; energy flow in aquatic ecosystems; stratification and zonation in rivers, lakes and oceans with respect to light, temperature, and pressure. Biological adaptations in plant and animals.

Unit-II

Fresh water ecosystems

Lakes and reservoirs: Community organization, productivity, trophic levels and food webs; Bioassessment and biocriteria in lakes and reservoirs, index of biological integrity, eutrophication and trophic state index; nutrient dynamics, methanogenesis, climate change and impact on lakes and reservoirs; ecology of constructed wetlands.

Rivers: Types of rivers, longitudinal profile and classification of drainage network, rivers and ecological continuum, riparian and flood plain wetlands; community organization; trophic structure and food webs; energy flow; negative and positive feedbacks and resilience.

Unit-III

Marine & Estuarine ecosystems

Case I & II waters, estuary types and genesis; organisms (plants, animals, microbes) in various ecological zones, community organization, nutrient cycling and dynamics, upwelling and downwelling of nutrients; mangroves, coral reefs; Biodiversity in arctic and antarctic oceanic environment.

Unit-IV

Aquatic biodiversity, ecosystem services and restoration

Landscape ecological concepts; ecological restoration of fresh water and coastal ecosystems. Coastal regulation zone, International conventions & protocols: Ramsar Convention, Convention on Biological Diversity, Ramsar sites in India. Remote sensing and GIS in aquatic ecosystem management, biodiversity conservation, climate change and aquatic ecosystem response.

Text Books:

1. M. Dobson (2000). Ecology of Aquatic Management, Pearson Education
2. G.K. Singh, K.C. Nautial (2009) Biodiversity and Ecology of Aquatic Environment. Narendra Publishing House

Reference Books:

1. Mitsch, W.J. and J.G. Gosselink (2015). Wetlands, 4th edition, John Wiley & Sons.
2. Van Der Valk, Arnold G., and Arnoud Van Der Valk (2012). The Biology of Freshwater Wetlands. Oxford University.
3. Raymundo E. Russo (2008). Wetlands: Ecology, Conservation and Restoration. Nova Science Publishers Inc.
4. Paul A. Keddy (2010). Wetland Ecology: Principles and Conservation. Cambridge University Press.
5. Walter K. Dodds (2002). Fresh Water Ecology-Concepts and Environmental Applications, Academic Press.
6. Peter Castro and Michael E. Huber (2003). Marine Biology. 4th Edition. Mc-Graw Hill.
<http://www.ramsar.org>

Course Code: **EMNRMGE 616**

Course Title: **ENVIRONMENTAL MODELLING**

(L – 4, C-4)

Unit-I

Introduction: Environmental systems - an introduction; An overview of mathematical models applied to various environmental issues; Concept, need, scope and objectives of environmental modelling; Model classification – Brief review of different types of models: Mathematical (Deterministic), Numerical, Stochastic & Physical Models

Unit-II

Air Quality Modelling: Air Quality Modelling – Historical perspective; Air quality models – objectives and aim of Modelling; Approaches to model building, elements of air quality models, classification of models; Gaussian Plume model – Point source models

Unit -III and IV

Water Quality Modelling:

General: Water Quality Modelling – Historical Perspective; Water Quality Models and Water Resource Management systems.

Fundamentals of Water Quality Modelling: Mass Balance, Steady-State Solution, and Response Time; Control-Volume Approach ; Particular solutions; Completely mixed system - concept of continuously stirred tank reactors (CSTR) ; Different types of loading, Feedforward and feedback systems of reactors

Incompletely mixed system :Diffusion.; Distributed Systems (Steady-State); . Distributed Systems (Time-Variable).

Surface Water Quality Modelling: River and streams; Estuaries and Lakes; Dissolved Oxygen Models : DO sag model; BOD and Oxygen Saturation; Gas Transfer and Oxygen Reaeration; Streeter Phelps equation for point sources;

Elements of Ground Water Modelling: Brief overview.

Text Books:

1. Thomann, R.V. and Mueller, J.A. (1987). *Principles of Surface Water Quality Modelling and Control*, Harper & Row, New York.
2. Chapra, S.C. (1997). *Surface Water-Quality Modelling*. McGraw-Hill International Edition.

Reference Books:

1. Benarie, M.M. (1980). *Urban Air Pollution Modelling* (Cambridge, MA: The MIT Press)
2. Hipel, K.W. and Mcleod, A.I. (1994). *Time series Modelling of Water Resources and Environmental Systems*. Elsevier Science B.V. Amsterdam, Netherlands.
3. Zannetti, P. (1990). *Air Pollution Modelling, Theories, Computational Methods and available Software*.
4. Buonicore, A.J. and Davis, W.T. (1994). *Air Pollution Engineering Manual*. Air and Waste Management Association, New York, Van Nostrand Reinhold.

Course Code: **EMNRMGE 618**

Course Title: **ECOTECHNOLOGY FOR NATURAL RESOURCE MANAGEMENT** (L – 4, C- 4)

UNIT-I

Systems approach and Ecosystem Modelling : Systems Theory-application to ecosystems, ecosystem stability- resistance and resilience, cogenerichomotaxis and redundancy, resource apportionment models; ecosystem cybernetics and regulation.

Ecological modelling - Matrix Model, Compartment model, System transfer functions, mathematical and statistical models ecosystem management

UNIT-II

Ecotechnological principles for Sustainable growth: Emergent ecosystem properties governing sustainability, Application of Ecotechnology for sustainable development and societal welfare; Ecosystem dynamics, Building resilience of ecosystems; soil stabilisation and soil fertility management, Ecological footprints.

UNIT-III

Ecotechnological applications to polluted and degraded sites: Eco restoration principles and approaches, Bioamelioration and rehabilitation of salt-affected and water-logged lands, cryptobiotic crusts for rehabilitation, Riparian zone restoration; Phytoremediation technology for decontamination of polluted sites by rhizofiltration, phytoextraction, phytostabilisation and phytotransformation; Eco restoration of mined areas.

UNIT-IV

Ecotechnological applications for Industrial waste management:

Balancing inputs and outputs of materials and energy in industries, life cycle planning and eco-efficiency; Ecosystem based demineralization and decarbonation; Constructed Wetland technology: Important macrophytes, rhizoflora and microfauna, applications in wastewater treatment; Cradle to cradle approach for waste management, Development of green belts for moderation of toxic emissions.

Text Books:

1. Jørgensen, S.E 2012. Introduction to Systems Ecology. CRC Press/ Taylor & Francis
2. Mitsch, W.J. and. Jørgensen, S.E. 1989. Ecological Engineering: An Introduction to Ecotechnology, John Wiley and Sons, Inc. New York

Reference Books:

1. Kangas, P.C. 2004. Ecological Engineering: Principles and Practice. Lewis Publishers, CRC Press, Boca Raton, Florida
2. Mitsch, W.J. and. Jørgensen, S.E. 2004. Ecological Engineering and Ecosystem Restoration" John Wiley and Sons, Inc., New York
3. George Kvesitadze, GiaKhatisashvili, TinatinSadunishvili & Jeremy Ramsden. 2006. Biochemical Mechanisms of Detoxification in Higher Plants : Basis of phytoremediation, Springer
4. Robert H. Kadlec and Scott Wallace. 2005. Treatment Wetlands, 2nd Ed. CRC Press

5. Cairns Jr., J. (Ed.), 1994. Rehabilitating Damaged Ecosystems, Vol I. CRC Press
6. R. Socolow 1994. Industrial Ecology and Global Change. Cambridge University Press
7. Wackernagel, M. and W. Rees. 1996. Our Ecological Footprint: Reducing Human Impact on the Earth. Gabriola Island, BC: New Society Publishers.

Course Code: **EMNRMGE 620**

Course Title: **CLIMATE CHANGE AND CARBON MANAGEMENT**

(L: 4 T: 0 C:4)

UNIT-I

Energy issues and climate change: Climate change, global warming and greenhouse effect, greenhouse gases (GHGs) and their sources, quantifying CO₂ and methane emissions, global warming potential (GWP), the radiative balance, earth's carbon reservoirs and carbon cycle. Impacts of climate change in different ecosystem: Models of global and Indian changes including temperature rise, sea level rise, coastal erosion and flooding, positive feedbacks, Climate change refugees

UNIT-II

Controlling carbon dioxide: Efforts to restrict carbon dioxide levels: Kyoto Protocol, recent protocols, methods to increase carbon dioxide absorption in power production, agricultural production, forestry, and industry, the Copenhagen Summit and its implications, future predictions.

Carbon Trading: The concept of carbon credits, standard and branded credits and mechanisms, alternative trading models (European, Indian), global and Indian scenarios

UNIT-III

Carbon sequestration: Carbon management through abiotic sequestration, geologic injection, conventional and non-conventional techniques, carbon sequestration in vegetation, deep saline aquifers deposit, ocean carbon absorption, alternatives and risks, carbon farming and carbon trading, carbon auditing, methane source and sinks, methane emissions from rice paddy and wetlands.

UNIT-IV

Strategic management of carbon emissions: Future predictions, best Management Practices, types of certification, and case studies related to global warming and its control in different ecosystem, REDD and REDD+ mechanism.

Text Books:

1. Gilbert M. Masters. (2005). Introduction to environmental engineering and science Prentice-Hall of India, New Delhi
2. Brohe, Arnaud, Nick Eyre, and Nicholas Howarth. 2009. Carbon Markets: An International Business Guide (Environmental Market Insights), Routledge.

Reference Books:

1. A.P. Mitra et. al. (2004). Climate Change and India: Uncertainty Reduction in Greenhouse Gas Inventory Estimates, Universities Press(India) Pvt. Ltd.
2. Labatt, Sonia, and Robert R. White. 2007. Carbon Finance: The Financial Implications of Climate Change (Wiley Finance). Wiley Finance
3. Esty, Daniel C., and Andrew Winston. 2009. Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage. Wiley.
4. Egbert Boeker and Rienk van Grondelle (2013). Environmental science Physical Principles and Applications.

Course Code: **EMNRMGE 622**

Course Title: **WATERSHED MANAGEMENT**

(L – 4 C-4)

UNIT-I

Definition and scope: Concept, delineation from topographical maps, remote sensing and GIS mapping, watershed problems and characteristics, types, watershed function, important objectives in management and development, field data collection.

UNIT-II

Characteristics: Landuse, vegetation, drainage, morphometry, climate, soils, geology, slope and aspect, soil erosion and estimating the soil loss erosivity index, Universal Soil Loss Equation (USLE).

UNIT-III

Hydrology: Hydrological cycle, drainage system, classifications characteristics of water resources, surface runoff, rainfall-runoff relationship, stream flow estimation, erosion control, water conservation.

UNIT-IV

Planning and management: Watershed management, multi-objective planning, watershed restoration and prioritization, resource use patterns, landuse practices, people participation, integrated watershed development, monitoring, economics of watershed protection, risks, climate change adaptation in watershed, ecosystem services of watershed.

Case studies – Success stories of Watershed Management in India.

Text Books:

1. **Singh, Rajvir. 2000.** Watershed Planning and Management. Yash Publications.
2. **Murthy, V.V.N. and M.K. Jha. 2009.** Land and Water Management, 5th edition. Kalyani Publishers.

Reference Books:

1. **Heathcote, I.W. 1988.** Integrated Watershed Management: Principles and Practices. John Wiley and Sons.
 2. **Ragunath, H.M. 2007.** Hydrology: Principles, Analysis and Design, 3rd edition. New Age International.
 3. **Das, Ghanshyam.** Hydrology: Soil Conservation and Watershed Management. PHI.
- Suresh, R. 2009.** Soil and Water Conservation Engineering, 2nd revised edition. Standard Publishers.

Course Code: EMNRMGE 624

Course Title: **URBAN FORESTRY, BIODIVERSITY AND LANDSCAPE** (L: 4 T:0 C:4)

UNIT-I

Concepts: Urban greens, landscape, urban forestry and biodiversity, Indian and global perspectives of urban forestry. Human dimensions of urban forests - migration, urban poverty and livelihood. Environmental problems in urbanizing world. Ecological, social, economic, health, cultural, recreation values of urban green space. Benefits of linking forest and vegetation with urban planning. Contribution of urban forests in generating livelihoods for urban poor in India. Concept of sustainable cities, Smart cities and green space.

UNIT-II

Urban biodiversity: Floral and faunal diversity in urban landscape. Urban trees and shrubs. Threats and significance of Urban biodiversity in India. Characteristics of selected urban forestry species. Significance of biodiversity parks. Design wildlife habitat. 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.

UNIT-III

Management of urban forest landscape: Urban landscape elements. Species choice for Urban forestry. Technical aspects of tree maintenance-pruning, cleaning, post plantation care, cleaning, nursery, water management. Types of plantation, design & tree architecture, monitoring, urban forestry management issues, stake holder's analysis. Case study of Urban area restoration- waterbody and wasteland.

UNIT-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 following Cities-

- New Delhi
- Hyderabad
- Bangalore

Synthesis and directions for future research, planning and implementation in urban forestry and biodiversity.

Text Books:

1. **Grey, G.W., and F.J. Denke. 1986.**Urban Forestry. Wiley Publication.
2. **Miller, R.W. 1997.**Urban Forestry: Planning and Managing Urban Green Spaces, 2nd edition. Prentice Hall.

Reference Books:

1. **Konjendijk, et al. 2005.**Urban Forests and Trees.Springer.

2. **Kuchelmeister, G. 1998.**Urban Forestry in the Asia – Pacific Region: Status and Prospects. APFSOS Working Paper #44, Food and Agriculture Organization.
3. **Bradley, Gordon A., (editor)** Urban Forest Landscapes: Integrating Multidisciplinary Perspectives.

Course Code: **EMNRM 652**

Course Title: **BIODIVERSITY ASSESSMENT AND TAXONOMY LAB** (P: 4 C: 2)

1. Study of local angiosperm plants – morphological & floral characteristics of common families.
2. Techniques of herbarium collection and preparation
3. Technique of classification and identification of animals
4. Assessment of herbaceous vegetation of the campus area by quadrat method
5. Assessment of tree species of the campus area by quadrat method
6. Study and comparison of Raunkier's life form with that of campus area

Course Code: **EMNRM 654**

Course Title: **FOREST INVENTORY AND MENSURATION LAB**

(P: 2 C: 1)

1. Vegetational Inventory of grasslands
 - a. Species Diversity
 - b. Grass biomass production assessment
2. Rapid assessment method for forest vegetation
 - a. Vegetational profile
 - b. Canopy measurement: Structure, Canopy cover
 - c. Tree Biomass estimates
 - d. Leaf Biomass harvesting level.
 - e. Different kinds of Transect methods Belt and Line and Point Centre Quadrat for forest Vegetational analysis.
3. Assessment of leaf photosynthetic area.
4. Forest/ Trees; Timber volume measurement
5. Yield calculation for tree biomass
6. Forest Carbon Assessment- below ground and above ground

References:

1. Kangas, Annika and MaltomoMattis 2006 Forest Inventory :Methods& Application, Springer.
2. R.Mishra. Forest Ecology Field Manual.
3. Field Method Manual by M. Poffenberger, Betsy McGean, N.H. Ravindranath and Madhavgadgil. (Eds. Society for Promotion of Wasteland Development. 1992.
4. N.H. Ravindranath: Carbon Inventory Method. Springer Verlag.
5. Bachmann, Peter; Köhl, Michael; Päivinen, Risto,2012 Assessment Of Biodiversity For Improved Forest Planning, Springer.

Course Code: **EMNRM 656**

Course Title: **ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATIONS LAB** (P:4 C:2)

1. To determine the descriptive statistics for the data set.
2. To construct Box plot, Individual value plot and histograms for the given data set and interpret the same.
3. To develop null and alternate hypothesis.
4. To understand the concept of standard error and confidence interval.
5. To understand sampling distributions and find central tendency.
6. To conduct one sample and two sample Z-test.
7. To conduct a t-test and interpret using standard values.
8. To conduct one sample T-test
9. To conduct two sample T test
10. To conduct a paired T-test to evaluate two test procedures and dependent data sets
11. To check for bias and significance of results for t-test
12. To carry out non parametric Mann Whitney Test for a sample.
13. To evaluate correlation between two parameters at various significance level.
14. To find a regressive coefficient and fit a linear model for a problem

THIRD SEMESTER

Course Code: EMNRM-701

(L: 4 T:0 C:4)

Course Title: **ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND AUDITING**

UNIT-I

Introduction to EIA: origin and development of EIA, objectives and purpose, hierarchy in EIA

Legal framework: Legislative requirements and administrative procedures for EIA in India, EIA Gazette Notification, 1994 and 2006, National Environmental Policy Act

General EIA methodology; Environmental baseline data -collection and significance

UNIT-II

Impact analysis methodologies: Screening- criteria, siting guidelines, prohibited zones; Scoping: Identification of Valued Environmental Components (VEC), Impact Identification - Checklists, matrices, qualitative methods, networks and overlay maps; Impact prediction- prediction models for impacts on air, water, soil and biological environment , Impact evaluation -multi attribute utility theory, environmental evaluation system- Cost benefit analysis, Economic valuation of intangible environmental impacts, Social impact assessment

UNIT-III

Mitigation, Public participation and decision making: Mitigation methods and approaches, Appraisal, review, Decision making, Public participation in environmental decision making- advantages and disadvantages role of NGOs in public participation

Environment Management Plan: Planning, selection of appropriate procedures, Environmental Impact Statement (EIS),

Case studies: EIA of thermal power plant, pulp and paper mills, fertilizer industry, distilleries, river valley projects, mining projects, urbanization and linear development.

UNIT-IV

Environmental Audit: Guidelines for environmental auditing, importance of environmental auditing, types of audits, general audit methodology and basic auditing structure, elements of ISO 14000, Environmental Audit rules under environmental Protection Act of 1986, first and third party audits, definitions of consumption audits, pollution audits, hazardous issues audits.

Text Books:

1. Canter, Larry W. Environment Impact Assessment. McGraw-Hill.
2. Rau, G.J. and C.D. Weeten. 1980. Environmental Impact Analysis Handbook. McGraw Hill.

Reference Book:

- 1.Y. Anjane July 2002 *Environmental Impact Assessment Methodologies*, B.S.Publications,
2. Glasson, John, Rikki Therievel and Andrew Chadwic. 1999. Introduction to Environmental Impact Assessment, 2nd edition UCL Press.
- 3.Kulkarni, Vijay and T.V. Ramchandra. Date Environmental Management. Capital Publishing.

4. Mhaskar, A.K. Environmental Audits. Enviro Media Publications.
5. Eccleston, Charles H. 2011. Environmental Impact Assessment: A Guide to Best Professional Practices. CRC Press.
6. *D. P. Lawrence Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons, 2003.*

Course Code: **EMNRM 703**

(L: 3 T:0 C: 3)

Course Title: **AGRO-ECOSYSTEMS AND AGRO-FORESTRY**

UNIT-I

Concept & Scope in Agroecosystem and Agroforestry- Concept agro-ecosystem, characteristics of agro-ecosystem and sustainability. Agro climatic zones. Land management - land use pattern of Indian farmers.

Dynamics of soil fertility and farming. Field survey methods for soil health and moisture conservation measures: Factors associated to crop selection and cropping pattern. Concept of zero tillage and organic agriculture.

Agroforestry scope, definition and applications. Classification of agroforestry systems. Types of Agroforestry Systems – Agrisilviculture, Agrosilvopasture, Alley Cropping, Hortisilviculture, Plantation Models for AF.

Traditional agroforestry systems in India- home gardens, Taungya system, Shifting cultivation and boundary plantation. Agroforestry practices existing in different states of India.

UNIT-II

Technical Applications in Agroforestry– Multipurpose Trees and Shrubs (MPTS) in Agro – forestry. Bamboo, fuelwood & fodder trees. Choice of species for agroforestry. Few commercial species for agro-forestry plantation. Techniques handling of agroforestry seeds for nursery and plantation

Agroforestry management. Role of nitrogen fixing trees and shrubs in agro-forestry, bio-fencing models. Role of bio-fertilizer (Mycorrhiza) in agroforestry. Allelopathy & its role in agroforestry.

UNIT-III

Integrated Agroforestry System – Scope of energy plantations, horticulture, livestock, apiculture and sericulture along with agroforestry. Agroforestry practices from developing countries – Bangladesh, China, Indonesia Sri Lanka, Nepal, Thailand, Philippines. Farmers extension-outreach programme. Designing agroforestry model – experimental agro-forestry: Diagnosis & design Exercise: Agroforestry model designing. Risk associated with monoculture. Integration of agroforestry with other systems. Agroforestry issues, research needs.

UNIT-IV

Agroforestry based case discussion:

Topic focus:-

- Private Sector Participation in Agroforestry: Case studies for Indian Industries- *Poplar Subabul, Casurina and Eucalyptus* based agroforestry
- Carbon sequestration: An underexploited environmental benefit of agroforestry systems.
- Biofuel plantation in wasteland areas – Problems and Prospects. Importance in land management
- Wet Rice Cultivation- A Traditional Sustainable land use practice amongst Apatani Tribes of Arunachal Pradesh

Text Books:

1. **L. K. Jha 1995.** Advances in Agroforestry. Ashish Publisher House, New Delhi.
2. **P. Dwivedi 1992.** Agroforestry Principles and Practices. Oxford and IBH Publishers, New Delhi.

Reference Books:

1. **Nair, P. K. Ramachandran 2007. An Introduction to Agroforestry.** Springer Publication.
2. **K. Bandyopadhyay 1997.** A textbook of Agroforestry with Applications. Vikas Publications, New Delhi.
3. **Anil Kumar 1989.** Wasteland Management in India. Ashish Publishing House, New Delhi.
4. **L.K. Jha and P.K. Sen Sharma.** Agroforestry in Indian perspective
5. **Panjab Singh, P.S. Pathak, M.M. Roy 1996.** Agroforestry Systems for Degraded Lands.
6. **Chuhdawat, Gautam 1993.** Textbook of Agroforestry. Oxford and IBH Publishers, New Delhi

Course Code: **EMNRM 705**

(L: 4 T:0 C: 4)

Course Title: **NATURAL RESOURCES POLICY, GOVERNANCE AND LIVELIHOOD**

UNIT-I

Introduction: Legal and political environments in resource management. Global and local governance of natural resources. Challenges of good governance. Ostrom design principles and basic frameworks, organizational structure and stakeholders in NRM and livelihood. Role of local institutions: Joint Forest Management Committees (JFMCs), watershed committees, irrigation committees, Forest Rights Act (FRA) committees, Biodiversity Management Committees (BMCs), etc. Natural Resources Conflicts and their resolutions.

UNIT-II

Overview of legal policy instruments in Natural Resource Management: National Forest Policy, 1988; National Environment Policy, 2006; National Conservation strategy, National Action Plan on Climate Change, 2008; ICZM-Indian Coastal zone management; Coastal Regulation Zone notification, 1991; Wildlife Protection Act, 1972, Forest Conservation Act, 1980; Environment Protection Act, 1986; Water Act, 1974. Biological Diversity Act, 2002 and Rule, 2004; Forest Rights Act, 2006; Green Tribunal Act, 2009; National Food Security Act, 2013. The precautionary principle and common responsibilities.

UNIT-III

Livelihoods and relation with Natural Resource Management (NRM): Concepts and scope of livelihood, livelihood framework analysis, various capitals involved, indigenous communities and traditional livelihoods, forms of natural resources and dependencies of local people. Natural resource crisis and impacts on the livelihood of people, ecological, sociocultural and economic dimensions, threats of traditional livelihood from globalization, urbanization, privatization, and migration, climate change impacts, mitigation and adaptation

Non-Timber Forest Products (NTFP) as a source of rural livelihood: NTFP types, and distributions; social, ecological and economic role of NTFP. First step survival strategy, policies and acts to support NTFP activities. Importance of sustainable resource management- A case study. NTFP Deregulation.

Unit-IV

International and National efforts: CITES and other international treaties and conventions, roles of international organizations and NGOs. Rural Development Programme and Schemes for livelihood development in India. Green business and green ethics, stakeholder analysis, understanding and managing governance issue, governance tactics and tools, CSR (Corporate Social Responsibility) as a tool for sustainable NRM based business.

Case studies :-

- Corporate social responsibility (CSR) for
- E-governance
- Livestock based livelihood strategies in Semi-arid and Dry Lands
- Ecotourism Initiative for Community Development and income generation

Text Books:

1. **Knight, Richard L. 1995.** A New Century for Natural Resources Management. Island Press.
2. **Arjya B.Majundar, DeosmitaNandy and Swayambhu Mukherjee 2013** Environment and Wildlife Laws in India. LexisNexis Publisher.

Reference Books:

1. **Bhattacharya Prodyut, Kandya A.K. and Krishna Kumar 2008.** Joint Forest Management in India, VOL.I& II. Aavishkar Publisher, Jaipur.
2. **Daily, Gretchen, editor, et al. 1997.** Nature's Services: Societal Dependence On Natural Ecosystems. Island Press.
3. **Malhotra, KC and ProdyutBhattachrya. 2010.** Forest and Livelihood. Pub. Centre for Economic and Social Studies. Hyderabad.
4. **Shackleton, Sheona, Charlie Shackleton, and Patricia Shanley, (editors) 2011.** Non-Timber Forest Products in the Global Context (Tropical Forestry).Springer.
5. **Kareiva, Peter, et al. 2011.** Natural Capital: Theory and Practice of Mapping Ecosystem Services. Oxford.

Course Code: **EMNRM 707**

(L: 3 T:0 C: 3)

Course Title: **WILDLIFE MANAGEMENT**

UNIT-I

Introduction and History of Wildlife Conservation

Global as well as Indian Prospective: Historical perspectives and its importance-direction and approach for conservation in present context. Concept of Protected Area Network (PAN), IUCN, CITES

Values and Ethics in Wildlife Conservation: Definitions and (Instrumental; Intrinsic; Ecocentrism; Religious traditions and conservation) Ethics in conservation.

UNIT-II

Field ecology and methodology for wildlife monitoring:

Habitat Ecology: Concept of habitat-microhabitat to biosphere, Range, Area of occupancy, Niche and Resource Partitioning, Diversity indices.

Field techniques: For invertebrates (planktons; insects/arachnids) and vertebrates (amphibian, reptile, aves and mammals), Line/belt transects, Quadrat sampling, Point count, Scan sampling, Focal sampling, Time constraints sampling, Population indices.

UNIT-III

Wildlife Behaviour: Group living, selfishness and altruism; evolutionarily stable strategies; concept of optimality in decision making in animals; optimal foraging theory.

Current issues in wildlife conservation with case studies: Community based conservation approach, Impact of climate change on species diversity, Compensate payment for environmental services

Human-wildlife conflict, Poaching, Illegal trading, conflict management, approach, Impact of climate change on species diversity, Compensate payment for environmental services
Human-wildlife conflict, Poaching, Illegal trading, conflict management.

UNIT-IV

Wildlife Management

Population Viability and Habitat Analysis (PVHA), Captive breeding and propagation, rehabilitation and reintroduction, gene banks, *ex-situ* and *in-situ* conservation.

Regulations and Conservation Policies

Wildlife (Protection) Act, 1972 and Wildlife (Protection) Amendment Act, 2002, 2006;
Environment (Protection) Act, 1986; Forest (Conservation) Act, 1980; Biodiversity Act 2002 and Forest Rights Act 2006.

Text Books:

1. Bookhout, T. A. (1996). *Research and management techniques for wildlife and habitats* (5th Ed.). The Wildlife Society, Allen Press, Kansas, USA.
2. Buckland, S. T., Anderson, D. R., Burnham, K. P. and Laake, J. L. (1993). *Distance sampling-estimating abundance of biological populations*. Chapman & Hall, London, reprinted (1999) by Research Unit for Wildlife Population Assessment, St. Andrews.

Reference Books:

1. Woodroffe R., Thirgood S. and Rabinowitz A. (2005). *People and Wildlife, Conflict or Co-existence?* (Conservation Biology) Cambridge University.
2. Caughley, G. (1977). *Analysis of vertebrate populations*. John Wiley and Sons, New York.
3. Caughley G. and Sinclair A.R.E. (Eds.) (1994) *Wildlife Ecology and Management*, Blackwell Science, Cambridge.
4. Hunter M.L., Gibbs J.B. and E.J. Sterling (2008) *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
5. Rangarajan M. (2001) *India's Wildlife History*. Permanent Black, New Delhi, India.
6. Krebs, C. J. (1999). *Ecological Methodology* (2nd Ed.) Addison-Welsey Educational Publishers, Inc.
7. Sutherland, W. J. (2000). *The conservation handbook; research, management and policy*. Blackwell Sciences Ltd. London.
8. Sutherland, W. J., Newton, I. and Green, R. E. ((2004). *Bird Ecology and Conservation: A Handbook of Techniques*. Blackwell Sciences Ltd. London

Course Code: **EMNRM 709**

(L: 3 T:0 C: 3)

Course Title: **PROJECT MANAGEMENT AND FINANCIAL ANALYSIS**

UNIT-I

Financial analysis: Introduction to financial management: planning and forecasting, cost to volume profit analysis, working capital management, problems. Management of receivables, assets and liabilities, cost of capital, operating and financial leverages, capital structure, and international financial management. Financial and Economic Appraisal: Instrument and Choices.

UNIT-II

Project Management: Formulation, financing, implementation and control, project management including product cycles and logical framework analysis, exploration and screening, techno-economics, feasibility reports (marketing, technical, financial, and risk analysis). Microfinance and micro credit concept and their application in rural development and livelihood generation.

UNIT-III

Project identification and presentation: Socio-economic consideration in project formulation, social infrastructure projects for sustainable development, investment opportunities, project screening and presentation for decision making, capacity expansion, diversification.

Project costs and Finances: Calculating project costs, production costs, break-even analysis, financing methods, tax aspects, role of the financial institution in project finance. Strategic Management.

UNIT-IV

Marketing Management : Basic concept of Marketing. Marketing Environmental Analysis. Customer Behaviour and competitor analysis. Market analysis and market segmentation. Value chain analysis. Brand development. Developing competitive Marketing strategy by selecting Natural resource Product as example.

Text Books:

1. **Bhavesh, M. Patel. 2000.** Project Management: Strategic Financial Planning Evaluation and Control. Vikas Publishing.
2. Prasana Chandra, (2007). Financial Management: Theory and Practice. McGraw Hill.

Reference Books:

1. **Rashkonen, E., editor. 1997.** Managing Risk in Projects. E&FN Spon.
2. **Wysochi, Robert K., Bick Robert and David B. Crane. 2000.** Effective Project Management. John Wiley.
3. **Ezra, Solomon and John J. Pringle.** An Introduction to Financial Management. Prentice Hall of India.
4. **Goodman, Louis J. 1988.** Project Planning and Management: An Integrated System for Improving Productivity. Von Nostran Reinhold.

5. **Robinson S. Marguerite 2001.**The Microfinance revolution: Sustainable Finance for the Poor. The World Bank, Washington, DC.
6. Wysocki, R. K. (2011). Effective Project Management: Traditional, Agile, Extreme. Wiley International. 816 pp.
7. Kotler Philip, Koshy Abraham, &MithileswerJha(2005) Marketing Management. Person Education.

Course Code: **EMNRM 751**

Course Title: **WATER QUALITY ANALYSIS LAB**

(P: 4 T:0 C: 2)

S. No.	Name of Experiments
1.	To determine the pH value of a given water sample
2.	Determine the Acidity of given water sample
3.	Determine Alkalinity of given water sample
4.	Determine the Hardness of given water sample
5.	Determine the Chloride content in given water sample
6.	Determine the TSS, TDS, and TS in given water sample
7.	Determine Turbidity of given water sample
8.	Determine the Sulphate concentration in given water sample
9.	Determine Phosphate content in given water sample
10.	Determine the Fluoride content in given water sample
11.	Determine Dissolved Oxygen of given water sample
12.	Determine the BOD level in given water sample

Reference:

1. Standard Methods for Analysis of Water & Wastewater (APHA)
2. Guide Manual for Water and Wastewater Analysis, CPCB

Course Code: **EMOE 731**

Course Title: **Climate change mitigation & adaptation**

(L:4)

UNIT-I

Basic concepts and mechanisms: Science of climate change, global warming and greenhouse effect, radiative balance, earth's carbon reservoirs and carbon cycle, El-Nino and La Nino, greenhouse gases in the atmosphere – sources, levels and mechanisms of action.

Effects: Rise in earth's temperature; effects on forests; effects on agro ecosystems; desertification; effects on freshwater ecosystems; effects on oceans; sea level rise; melting of polar ice and glaciers; effects on rainfall patterns; extreme events, socio-economic and public health consequences.

UNIT-II

Climate Change Policy-Mitigation: Carbon storage and sequestration, carbon management through a biotic sequestration; oceanic and geologic injection, scrubbing and mineral carbonation; carbon management through biotic sequestration; forest ecosystems, wetlands; soil carbon sequestration; bio fuels, carbon farming and carbon trading

UNIT-III

Climate Change Policy – Adaptation: Climate change impact assessment – applications for agriculture, sea level rise and health; vulnerability assessment; economics of adaptation, measurement of adaptation cost; issues in financing adaptation; case studies

The Indian scenario: Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change; India's position and actions vis-a-vis international programmes (UNFCCC, CDM and Kyoto Protocol, REDD+, Copenhagen Accord, etc.).

UNIT-IV

International response: Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol; the bali road map; The Copenhagen Accord; future actions; ethics of climate change.

Text Books:

1. *J. T. Hardy, 2003, Climate Change: Causes, effects and solutions, John Wiley and Sons*
2. Egbert Boeker and Rienk van Grondelle (2013). *Environmental Science Physical Principles and Applications, John Wiley & Sons, Ltd., New York*

References:

1. Akimasa Suni, Kensuke, F., and Ai, Hiramatsu. (2010). *Adaptation and mitigation strategies for climate change. Springer.*

2. Gautam, P.L. Singh, V. and Melkania, U. (Eds.). (2009). Ecosystem diversity and carbon sequestration: climate change challenge and a way out for ushering in a sustainable future. Daya Publishing House, Delhi.
3. Ravindranath, N.H., Ravindranath, N. and Sathaye, J.A. (2002). Climate change and developing countries. Kluwer Academic Publishers.
4. Sarkar, A.N. (2010). Emissions trading and carbon management. Pentagon earth.
5. Burroughs, W.J. (2007). Climate change: A multidisciplinary approach (2nd edition.). Cambridge University Press. Dash,
6. Sushil Kumar. (2007). Climate change: An Indian perspective. Cambridge University Press India pvt.ltd. New Delhi.
7. IPCC, (2007): Summary for policymakers. In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7- 22.
8. S. Singh, *Trace Gas Emission and Plants*, Kluwer Academic Publishers, 2000
9. Stern, N., *The economics of climate change – The Stern Review*, Cambridge University Press, 2006.
10. Nordhaus, W.D., *Managing the Global Commons: The Economics of Climate Change*, MIT Press, 1994.
11. Toman, M.A., U. Chakravorty, and S. Gupta, *India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country*, RFF Press, 2003.

Course Code: **EMOE-733**

Course Title: **DISASTER RISK REDUCTION AND MANAGEMENT**

(L:4)

UNIT-I

Introduction: Concepts and definitions of Hazard, disaster, vulnerability, resilience, and risks; classification of disasters; brief introduction of Geological Disasters (earthquakes, landslides, tsunami, mining), Hydro-Meteorological Disasters (floods, cyclones, lightning, thunderstorms, hail storms, avalanches, droughts, cold and heat waves); Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents); Global Disaster Trends – Emerging Risks of Disasters; Climate Change and Urban Disasters

UNIT-II

Disaster Management Cycle, Risk Reduction and managing risks

Disaster Management Cycle; Principles of risk management, hazard and vulnerability mapping and analysis (physical, social, organizational, economical, technological). Developmental projects (dams, power plants etc.) and risk management; Evacuation, Communication, Search and Rescue; Emergency Operation Centre – Incident Command System; Relief and Rehabilitation; Post-disaster Damage and Needs Assessment; Restoration of Critical Infrastructure; Early Recovery – Reconstruction and Redevelopment;

UNIT-III

Disaster Risk Reduction tools and capacity building

Prevention and Mitigation of Disasters, Early Warning System; Preparedness, adaptive ecosystems management for disaster risk reduction; awareness during Disasters; Geoinformatics in Disaster Management (RS, GIS, GPS); Disaster Communication Systems (Early Warning and Its Dissemination); Land Use Planning and Development; Disaster safe designs and constructions; Structural and Non Structural Mitigation of Disasters; Disaster Risk Transfer and Financing; role of print and electronic media during disasters. Community based disaster risk reduction. Health issues and hospital preparedness and response; System approach in disaster management;

Disasters and Ecosystems: Climate change and ecosystems based management for disaster risk reduction and resilience;

UNIT-IV

Disaster Management in India

Disaster Management in India; Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies; National Disaster Management Authority (NDMA); NIDM (National Institute of Disaster Management), State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; International Agencies (International Space Charter, UNISDR); International Strategy for Disaster Reduction; Hyogo Framework (2005-2015); Sendai Framework (2015-2030); S&T Institutions for Disaster Management in India;

Text Books:

1. BimalKanti Paul (2011). Environmental Hazards and Disasters-Contexts, Perspectives and Management, John Wiley & Sons, 332p.
2. Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella (Ed)(2013). The role of ecosystems in disaster risk reduction, *United Nations University Press, 2013,*

Reference Books:

1. Jack Pinkowski (Ed.) (2008). Disaster Management Handbook, CRC Press -Taylor & Francis Group, 595p.
2. Joseph F. Gustin (2010). Disaster & Recovery Planning: A Guide for Facility Managers, 5th Edition, Taylor & Francis., 436p.
3. Thomas D. Schneid and Larry Collins (2001). Disaster Management and Preparedness, Lewis Publishers, 247p.
4. Vlasta Molak (Edited) (1997). Fundamentals of Risk Analysis and Risk Management, Lewis Publishers, 451p.
5. Yacov Y. Haimes (2009). Risk Modeling, Assessment and Management, Third Edition, A John Wiley & Sons, Inc. Publication, 1033p.
6. Gupta, Anil. K. and Sreeja S. Nair (2011). Environmental Knowledge for Disaster Risk Management, National Institute of Disaster Management, New Delhi
7. Govt, of India (2005). Disaster Management Act 2005.
8. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).

Course Code: **EMOE 735**

Course Title: **Urban Biodiversity Strategies and Environment**

(L:4)

UNIT-I

The Urban Ecosystem: An Introduction to Novel ecosystems in the Anthropocene

What is Urban?

What is Urban Ecology? Cities as Human and Ecological Systems,

Global and Local Patterns of Urbanization: Exo-urbanization, Suburbanization, New town, Disurbanization (or counterurbanization), Reurbanization, Slums, Shanty Towns

Urban climate and climate change- Urban Soil and Water, Heat Island Effect

Social and ecological urban systems

UNIT-II

Urbanization and Biodiversity

Biogeography and biodiversity of anthromes and novel ecosystems

Biodiversity within urbanized areas,

Urban Ecosystem Services

Impacts of Urbanization on Biodiversity

Positive Impact on Biodiversity

Extinction and urbanization

Urban Species and Communities: Native Species, Non-native species Urbanophilic, Urbanophobic, Synanthropic, Archaetypes, Neotypes, Impacts of Non-native/invasive/exotic species, Biotic Homogenization and Differentiation

UNIT-III

Conservation in Urban Areas

Urban Planning and Restoration

Reconciliation ecology

Urban planning and green infrastructure:

- Green roofs
- Green spaces
- Gardening/ Landscaping
- Living walls
- Vertical Gardening

Singapore/City Biodiversity Index

Biophilic Cities

Resilient Cities

Sustainable Cities

Green Delhi Movement in NCT of Delhi

UNIT-IV

Urbanization and Human Well Being

Convention On Biodiversity and Conservation

National Biodiversity Strategy and Action Plan

Local Biodiversity Strategy and Action Plan Guidelines

Diseases in urban Environment

Shaping cities for health: complexity and the planning of urban environments in the 21st century

Cities and Biodiversity Outlook Assessment Report

Conservation Education

Conservation and Society

Future Strategies for Urban Biodiversity

Text Books:

1. Hobbs, R. J., E. S. Higgs, and C. M. Hall, (eds. 2013). **Novel ecosystems: intervening in the new ecological world order.** John Wiley & Sons, Chichester, UK.
2. Adams LW. 1994. **Urban Wildlife Habitats.** Minneapolis: University of Minnesota Press.

Reference Books:

1. Kowarik, I. 2011. Novel urban ecosystems, biodiversity, and conservation. *Environmental Pollution* 159:1974-1983.
2. Pickett et. al. 2008. Beyond Urban Legends: An Emerging Framework of Urban Ecology, as Illustrated by the Baltimore Ecosystem Study. *Bioscience* 58(2): 139-150.
3. Pickett, S.T.A. and J.M. Grove. 2009. Urban Ecosystems: What would Tansley Do? *Urban Ecosystems* 12: 1-8.
4. Alberti et al. 2003. Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. *Bioscience* 53(12): 1169-1179..
5. Gilbert OL. 1989. **The Ecology of Urban Habitats.** London: Chapman and Hall.
6. Ellis, E.C. 2013. Sustaining biodiversity and people in the world's anthropogenic biomes *Current Opinion in Environmental Sustainability*, 5:368-372
7. Dallimer M., Irvine K.N., Skinner A.M.J., Davies Z.G., Armsworth P.R., Rouquette J.R., Maltby L.L., Warren P.H., Gaston K.J. (2012). Biodiversity and the feel-good factor: understanding associations between self-reported human well-being and species richness. *BioScience* 62: 47-55
8. Hughes J., Pretty J., Macdonald D.W. (2013). Nature as a source of health and well-being: is this an ecosystem service that could pay for conserving biodiversity? In: **Key Topics in Conservation Biology** (eds. D.W. Macdonald, K.J. Willis). John Wiley & Sons Ltd, Chichester.
9. Wiley & Sons, Chichester, UK. Hobbs, R. J., E. Higgs, and J. A. Harris. 2009. Novel ecosystems :implications for conservation and restoration. *Trends in Ecology & Evolution* 24:599-605.

Course Code: **EMOE 737**

Course Title: **Human Aspects of Biodiversity and Environment**

(L:4)

Unit-I

Linking biodiversity, environment and human being

Basic concept of biodiversity and environment: Biotic and abiotic factors, biodiversity and its components; How biodiversity and environment affects human well-being: case studies from historical perspectives and current scenario; Factors that affect human perceptions about biodiversity and environment

Unit-II

Understanding human aspects of biodiversity and environment

Socio-cultural diversity, ethnic diversity, linguistic diversity; Sacred groves and sacred landscapes; Understanding ecological services; Understanding how local biodiversity and environment affects human life (wrt local plants and animals, pesticide use vs agricultural pests, handling native vs. exotic sp, urban biodiversity and urban planning).

Understanding different missions related to human aspects of biodiversity and environment: 'Swachh Bharat Abhiyan', 'Clean Ganga' and 'Clean-Yamuna' campaign, 'Save Tiger', 'Save Vulture', 'Save Forest', 'Protect Wetlands' 'Decade on Biodiversity'.

Unit-III

Concepts and applications related to human aspects of biodiversity and environment

Concept of Indigenous Knowledge Management and benefit sharing with case studies; Biomimicry; Ecotourism and Eco-taxation; Eco-designing, Conservation education, Environmental journalism

Unit-IV

Addressing issues related to human aspects of biodiversity and environment

Ethical issues related to biodiversity and environment; Pro and cons of ban on animal dissection; Issues related to GM crops and Vertebrate pest management; Practising sustainability for a better future

Text Books:

1. Miller, G.T. and Spoolman, S. 2011. Living in the environment. Cengage Learning.
2. Pearce, D.W. and Moran, D. 1994. The Economic Value of Biodiversity. Earthscan Publishers.

Reference Books:

1. Wood, P.M. 2000. Biodiversity and democracy: rethinking society and nature. University of British Columbia Press.
2. Groom, M.J., Meffe, G.R. and Carroll, C.R. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
3. Primack, R. 2006. Essentials of Conservation Biology. Sinauer Associates, Inc., USA.

Course Code: **EMOE 739**

Course Title: **Corporate Social Responsibility**

(L:4)

UNIT-I

Concept of CSR: What do you mean by CSR? New Company Law in India: Doing Business with the Compulsory CSR. Business ethics and society in India, role of public policy in promoting CSR and sustainability, benefits of CSR programme; global principles and guidelines; The Companies Act, 2013 critical analysis, disclosure of CSR activities made compulsory, Mutual Co-existence: CSR and ensuring environmental sustainability.

UNIT-II

Scope of CSR across key sectors

Rural development and CSR, CSR initiatives being taken by selected public and private Indian companies for rural development; The Impact of CSR Programs on socio-economic development of Rural Poor. Greening environment. Role of NGOs and community. Health care development and CSR, CSR initiatives being taken by selected public and private Indian companies; The Impact of CSR Programs for clean India mission. Role of CSR in the area of Education, CSR initiatives being taken by selected public and private Indian companies;

UNIT-III

CSR Planning and Institutionalising : Institutionalizing CSR –various steps, corporate governance practices ,Indicators for measuring impacts, multi-stakeholder approach. Addressing Issues and challenges of CSR in India- sustainability, corporate disclosure, motivation for companies, investors' pressure, visibility factor, transparency, operating cost, duplication of work, alliance of industries for CSR, Corporate social reporting.

UNIT-IV

CSR based case discussion: Topic focus: concept, theory, approach, application and impact

- Green Business : Addressing Sustainable development
- Serving the world's poor profitably
- National Practice CSR case example
- Global best practice case example

Text Book:

1. Blowfield M, and Murray A 2008 Corporate Social Responsibility: A critical Introduction . Oxford University Press. USA
2. Bhattacharya, CB; Sen, Sankar; Korschun, Daniel (2011). Leveraging Corporate Social Responsibility: The Stakeholder Route to Business and Social Value. Cambridge: UK: Cambridge University Press.

Reference Books:

Visser, W.; Matten, D.; Pohl, M.; Tolhurst, Nick (2008). The A to Z of Corporate Social Responsibility. Wiley. ISBN 978-0-470-72395-1.

Kerr, M.; Janda, R.; Pitts, C. (2009). Pitts, C., ed. Corporate Social Responsibility: A Legal Analysis. Toronto: LexisNexis. ISBN 978-0-433-45115-0.

Philip Kotler and Nancy Lee (2005) Corporate Social Responsibility: Doing the Most Good for Your Company and Your Cause by Sage Publication.

Sanjay K Agarwal (2008) Corporate Social Responsibility in India. Sage Publication.

Course Code: **EMOE 741**

Course Title: **Sustainable Ecotourism**

(L:4)

UNIT-I

Concept of Ecotourism: Definitions, ecotourism, difference between tourism, examples various forms, development of ecotourism in India and outside. Ecological, social and economic dimensions of ecotourism, eco-tourists, linkages with local culture, ethics and livelihoods, stakeholders' analysis, threats due to large scale ecotourism.

UNIT-II

The ecotourism perspectives: High value may also be high impact, bulk ecotourism and problems, stakeholder challenges. Ecotourism Policy and practices, national policy framework, example – Madhya Pradesh & Uttarakhand State case. Successful ecotourism initiative, Criteria and Indicators for sustainable Ecotourism. Ecotourism certification, Accreditation of eco-lodges and resorts .

UNIT-III

Ecotourism alternative services and Ecotourism Products: sustainable extraction, extraction impacts, community involvement and compensation, shift from consumption to sustainable management. Concept of carrying capacity and factors. Designing ecotourism products and their relevance to ecology and livelihood, benefit sharing, capacity building of locals.

UNIT-IV

Case studies and analysis: Ecotourism in protected areas of India and abroad,

- Mangrove area and biodiversity conservation through ecotourism,
- Ecotourism in coastal areas
- Mountain area ecotourism in Sikkim
- Herbal ecotourism in Kerala,
- Wildlife area ecotourism.

Text Books:

1. Honey, Martha. 2008. Ecotourism and Sustainable Development: Who Owns Paradise? 2nd edition. Island Press.
2. Jennifer Louise Hill, Tim Gale 2005 Ecotourism and Environmental Sustainability: Principles and Practice. Ashgate Publishing Company. USA

Reference Books:

1. Patterson, Carol, Delia Owens, and Mark Owens. 2007. The Business of Ecotourism. Trafford Publishing.
2. Collier, Paul and Anthony J.J. Venables. 2011. Plundered Nations? Successes and Failures in Natural Resource Extraction. Palgrave MacMillan.
3. Seema Bhat & Syed Liyakhat 2008. Ecotourism Development in India: Communities, Capital and Conservation published by CEE, Ahmedabad.