GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

Guru Gobind Singh Indraprastha University
Sector – 16C Dwarka, New Delhi – 110078

(Coordination Branch)
Ph:011-25302135-136, Email: coordination112@gmail.com, Website: www.ipu.ac.in

F.No.: GGSIPU/Co-ord./50th AC/2021/ 121 **Dated:** 2nd **July, 2021**

Circular

Please find enclosed herewith the final Minutes of the 50th meeting of the Academic Council of the Guru Gobind Singh Indraprastha University held on **11/06/2021 at 11:00 AM** on Cisco Webex platform.

Ravi Dadhich

(Ravi Dadhich)
Registrar

To,

1 Dean- USBAS/ USBT/ USCT/ USEM/ USICT/ USHSS/ USMC/ USLLS/ USM&PMHS/ USMS/ USAP/ USE, GGSIP University.
2 Director- Academic Affairs/ Coordination/ Students' Welfare/ CDMS/ Development/ International Affairs/ CEPS/ Research and Consultancy/ Legal Aid / IUIIC, GGSIP University
3 Librarian, GGSIP University
4 Prof. P.K. Jhulka, (Retired), Max Institute of Cancer Care, 26-A Ring Road, Nirmal Puri, Nirmal Colony, Block -2, Lajpat Nagar-IV, New Delhi-110024
5 Prof. M.C. Sharma, 109, Nav Shakti Sadan, Sector 13, Rohini, New Delhi-110085
6 Prof. Karmeshu, (Retired), 150, Deepali, Road No. 42, Pitampura, Delhi-110034
7 Sh. Arvind Misra, 5/101, Mathura Road, Agra-282002
8 Shri. Sandeep Gupta, 100 UB Jawahar Nagar, Delhi-110007
9 Prof. Rajiv Bhat, School of Biotechnology, Jawaharlal Nehru University, New Delhi
10 Prof. (Dr.) Pradeep Kulshrestha, Dean, School of Law, Sharda University, Plot No. 32 & 34, Knowledge Part-III, Greater Noida-201306 (UP)
11 Ar. Rupal S. Randhawa, 204-A, Pocket B, Mayur Vihar, P hase-2, New Delhi-110091
12 Dr. Jagdish Lal Gupta, CP-18, Maurya Enclave, Pitam Pura, Delhi-110034.
13 Prof. M. Afzal Wani, University School of Law and Legal Studies, GGSIP University
14 Prof. Prodyut Bhattacharya, University School of Environment Management, GGSIP University
15 Prof. Amit Prakash Singh, University School of Information Communication & Technology, GGSIP University
16 Prof. Shalini Garg, University School of Management Studies, GGSIP University.
17 Prof. Lisa P. Lukose, University School of Law and Legal Studies, GGSIP University.
18 Prof. M.N. Hoda, Director, Bharti Vidhyapeeth's Institute of Computer Application & Management, A-4, Paschim Vihar, Rohtak Road, New Delhi-63.
19 Prof. Sonia Jindal, Principal, Gitarattan Institute of Advanced Studies and Training, Rohini, Delhi-85.
20 Prof. Ravi K. Dhar, Director, Jagannath International Management School, OCF, Pocket-9, Sector-B, Vasant Kunj, New Delhi-110070.
21 Prof. Maharaj Krishen Bhat, Director, Maharaja Agrasen Institute of Management Studies, Maharaja Agrasen Camp, Plot No. 1, Sec-22, Rohini, Delhi.

Copy for information of the Competent Authority:

(i) AR to the Vice Chancellor Secretariat for kind information of Hon'ble Vice Chancellor, GGSIP University.
(ii) AR to the Registrar office for information of Registrar, GGSIP University

(Shikha Agarwal)
Dy. Registrar (Coordination)

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
SECTOR – 16 C, DWARKA, NEW DELHI - 110078

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

FIFTIETH (50th) MEETING OF THE ACADEMIC COUNCIL

DATE : 11.06.2021

TIME : 11:00 AM

MINUTES OF 50th MEETING OF THE ACADEMIC COUNCIL

Ravi

INDEX

S. No.	Agenda Item(s) No.	Particulars	Page No.
		Diploma in Fire & Life Safety Audit from the Academic Session 2021-22.	
20	AC 50.20	To ratify the recommendations of the subcommittee of Academic Council by Hon'ble Vice Chancellor to consider the case of 22 students of 1st Year of 2019 batch of Ch. Brahm Prakash Govt. Engineering College (CBPGEC)	10
21	AC 50.21	To ratify the recommendations of the subcommittee of Academic Council by Hon'ble Vice Chancellor to consider the case of detention of Two (02) students of 3rd year of batch 2017 of Ch. Brahm Prakash Govt. Engineering College (CBPGEC)	10
22	AC 50.22	To consider and approve the revised Scheme & Syllabus of M.Tech. (Nano Science and Technology) programme in accordance with AICTE and CBCS options.	10
23	AC 50.23	To consider and approve the revised Scheme & Syllabus of M.Tech. (Engineering Physics) programme in accordance with AICTE and CBCS options with change in the title of course code BAEPC:602 may be modified to "Photovoltaic Technologies" in place of "Solar Photo-voltaic Technologies".	11
24	AC 50.24	To ratify the Admission and Selection Criteria, Syllabus for Entrance Examination, Scheme & Syllabus of M.Sc. Packaging Technology programme in Indian Institute of Packaging, Delhi to be started from the Academic Session 2021-22 under the aegis of USBAS.	11
25	AC 50.25	To ratify the revision of Scheme & Syllabus of MCA degree from 3 years to 2 years- affiliated institutes w.e.f. Academic Session 2020-2021 onwards.	11
26	AC 50.26	To ratify the revision of Scheme & Syllabus of MCA- Software Engineering at USIC&T (1st to 4th Semester Scheme and Bridge courses) alongwith the change in the duration of the MCA programme from 3 years to 2 years.	11
27	AC 50.27	To ratify the Scheme & Syllabus of Ph.D. course work at USIC&T for the Academic Session 2020-2021 onwards.	12
28	AC 50.28	Change in nomenclature of PhD degree offered by USEM from Ph.D. in Environment Management to PhD in Environmental Science	12
29	AC 50.29	Revised Scheme of Examination and Syllabus of M.Sc. Environment Management as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF)	12
30	AC 50.30	Revised Scheme of Examination and Syllabus of M.Sc. Biodiversity and Conservation as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK(LOCF)	12
31	AC 50.31	Revised Scheme of Examination and Syllabus of M.Sc. Natural Resource Management as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF)	12
[illegible]	[illegible]	[illegible] Environmental Studies (as proposed by the UGC and AICTE) to be offered to all the Undergraduate Programmes in the University School of Studies as Ability Enhancement Compulsory Course (AECC)	[illegible]
33	AC 50.33	Syllabus, course code and credits of the course Environmental Studies as Ability Enhancement Elective Course (AEEC)to be offered in the Postgraduate Programme in the University School of Studies	13
34	AC 50.34	To ratify the Mode of Admission, Eligibility Criteria, Number of	13

change in the duration of the MCA programme from 3 years to 2 years w.e.f. Academic Session 2020-2021.

Agenda Item No. AC 50.27: **To ratify the Scheme & Syllabus of Ph.D. course work at USIC&T for the Academic Session 2020-2021 onwards.**

The Academic Council ratified the Scheme & Syllabus of Ph.D. course work at USIC&T w.e.f. Academic Session 2020-2021.

Agenda Item No. AC 50.28: **Change in nomenclature of PhD degree offered by USEM from Ph.D. in Environment Management to Ph.D. in Environmental Science**

The Academic Council considered and approved the change in nomenclature of Ph.D. degree offered by USEM from Ph.D. in Environment Management to Ph.D. in Environmental Science.

Agenda Item No. AC 50.29: **Revised Scheme of Examination and Syllabus of M.Sc. Environment Management as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF)**

The Academic Council considered and approved the Revised Scheme of Examination and Syllabus of M.Sc. Environment Management as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF) w.e.f. Academic Session 2021-22.

Agenda Item No. AC 50.30: **Revised Scheme of Examination and Syllabus of M.Sc. Biodiversity and Conservation as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF)**

The Academic Council considered and approved the Revised Scheme of Examination and Syllabus of M.Sc. Biodiversity and Conservation as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF) w.e.f. Academic Session 2021-22.

Agenda Item No. AC 50.31: **Revised Scheme of Examination and Syllabus of M.Sc. Natural Resource Management as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF)**

The Academic Council considered and approved the Revised Scheme of Examination and Syllabus of M.Sc. Natural Resource Management as per the LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF) w.e.f. Academic Session 2021-22.

Agenda Item No. AC 50.32: **Syllabus, Course code and credits of the course Environmental Studies (as proposed by the UGC and AICTE) to be offered to all the**

SCHEME OF EXAMINATION

and

SYLLABUS

of

MASTER OF SCIENCE
In
NATURAL RESOURCE MANAGEMENT
(Programme Code - 247)

W.e.f.
From

Academic Session 2021-2022
(Onwards)

Based on
LOCF (Learning Outcome Based Curriculum Framework)

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
Sector 16C, Dwarka, Delhi- 110078

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Approved in the 50th Academic Council meeting held on 11th June, 2021 w.e.f. AS 2021-22 vide Agenda item 50.31.

SCHEME AND SYLLABUS OF EXAMINATION

Programme Code: **247**

Title of the Programme: **Master of Science (Natural Resource Management)**
(Restructured Curriculum from implemented August 2021 batch)

University School of Studies of the Programme: University School of Environment Management (USEM)

Contact for any further query:
Dean's Secretariat USEM
Ph: 91-11-25302360/62

Issued from

The Office of the Director, Academic Affairs

Guru Gobind Singh Indraprastha University

New Delhi 110078 (India)

w.e.f. Academic Session 2021

(Programme Name): Master of Natural Resource Management
(M.Sc. Programme)

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.

Programme Outcomes (PO)

PO_1:To create natural resource professionals equipped with in-depth knowledge and understanding of natural resources and how to conserve natural resources in a sustainable manner.

PO_2: To provide in-depth theoretical and hands-on practical knowledge on subjects ranging from ecology, natural resources, energy, water, earth, GIS, remote sensing, watershed, natural disaster and wild life management

PO_2:To appreciate the role of a natural resource managers in effective conservation interventions

Program Specific Outcome: - (PSO)

PSO_1: -Critically engage with concepts and theory in natural resources science and management from interdisciplinary perspectives

PSO_2: -Critically assess the modes through which conservation builds and extends power and describe in detail the factors that explain the emergence and performance of different types of governance.

PSO_3: -Evaluate the implications of emergent technologies for the future of natural resource management.

Choice Based Credit System

University follows Credit System of syllabi and examination. UGC has recently given guidelines for choice based credit system with a defined nomenclature for designing scheme of examinations and syllabus of different courses. In view of this, Scheme of Examinations and Syllabus have been revised and framed in accordance with the new UGC Guidelines and the courses have been divided into the following categories:

a. Foundation Course
b. Value based foundation course
c. Generic/Core Elective (GE)
d. Open Electives (OE)

Students have been given wide choice in selection of Generic Elective and Open Elective. A student may choose open elective either from the open electives floated by the School or may opt from the open electives offered by other University School of Studies. However, Generic/Core Elective is to be chosen from the Generic Elective Courses offered by the University School of Environment Management.

Relevance:

The Natural Resource Management program will increase the Academic strength University School of Environment Management School Educational Program 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 there advanced curriculum. The University may have professional linkages with national and international institutes and 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.

The programme offers excellent employability at various Government, Industry, Non-Government and International Organizations, conservation projects, consultancy work and fully funded Ph. D positions at various national and international universities and institutions.

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.

Industrial and Field Vistis, Summer Training and Dissertations

The syllabus covers enough field exposure to students for the interactions with outside world through educational field excursions, summer training and dissertations. All this components are evaluative and supervised by experienced faculty members; students can get firsthand and 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 shall carry equal marks.

Summer Training

1. After 2nd semester students will undergo summer training for six weeks in different industries/institutes.
2. The summer training reports will be evaluated in two parts. The Corporate Executive/organization, under whose guidance the summer training project has been completed, shall award marks out of 50. An internal Committee of Examiners from faculty will evaluate the work for 50 marks recommended by the Dean.
3. Evaluation will be based on the report and their presentations in the presence of the faculty members of the School.

Dissertation

1. Each student shall carry out a study for dissertation in the 4th Semester either in a research institution and or Govt./Private Organization that specializes in area relevant to the broad area of Environment Management or in-house at USEM.
2. The student will submit a synopsis at the beginning of the semester for approval from the department committee in a specified format. The student will have to present the progress of the work through seminars and progress reports. Evaluation of dissertation will be based on thesis and viva/voce by the Board of Examiners comprising the External Expert & Internal Examiner.

Credit Requirement

1. The student will require to earn a minimum of 100 credits for the award of the degree (Ref. GGSIPU/SMS/2000/1850, minutes of the joint Meeting of the Curriculum Development Committee)
2. The student will not have the option to drop any course covered in the scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination.

Programme Name): Master of Natural Resource Management
(M.Sc. Programme)

TEACHING METHODOLOGY AND SYSTEM OF INTERNAL ASSESSMENT FOR THEORY

Pedagogy to be followed

1. Lectures
2. Individual Assignments/ Group Assignments
3. Field/ Industry/ Internet-Based Project
4. Case Studies
5. Role Plays
6. Quizzes
7. Video Lessons

System of Internal Assessments:

1.	Attendance and Assignments	-- 05 Marks
2.	Mid-Term Examination	– 20 Marks
	Total Marks	**– 25 Marks**

Note: Internal assessment will continue till the time System of Continuous Evaluation is not implemented in the program by the University.

Note:

In case the programme is of 02 years duration then 4 semesters.

MASTER OF NATURAL RESOURCE MANAGEMENT
M.Sc. (NRM)

Code No.	Subject	L	T	P	Credits
First Semester (Core Courses)					
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**
HVE 102 (NUES)	Human Values and Ethics				**2**
	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**
EMNRMGE 624	Urban Forestry, Biodiversity and Landscape	**4**			**4**

*** (NUES- Non University Examination System)**

Practicals					
EMNRM 652	Plant Ecology and Taxonomy Lab			**4**	**2**
EMNRM 654	Forest Vegetation Assessment Lab			**4**	**2**
EMNRM 656	Environmental Statistics and Computer Applications Lab			**4**	**2**
EMNRM 658	Industry and Field visits – Reports Presentation*			**2**	**2**
	Total				**33**

*** Summer Training**

- Summer Training (6-8 weeks) will be conducted in any Industry/Organization at the end of second semester during summer vacation. This will be evaluated in 3rd semester in NUES mode.
- Educational/ industrial field visit will be conducted in 2nd semester, which is compulsory and evaluated in NUES mode.

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**
USMS 112 (NUES)	Entrepreneurial Mindset				**2**

Open-Electives (Any one) **					
EMOE731	Climate Change Mitigation and 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	Sustainable Ecotourism	**4**			**4**

Practicals					
EMNRM 751	Water quality Analysis Lab			**4**	**2**
EMNRM 753	Summer Training Report & Presentation				**2**
	Total				**25**
Fourth Semester -Dissertation					
EMNRM 702	Dissertation **B**ased Seminar and Progress Report (Midterm Evaluation)				**4**
EMNRM 704	Dissertation and Viva				**22**
	Total				**28**
	Total Credits				**113**

Total No. of credit offered in all four semesters - 113

** 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 108 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.

FIRST SEMESTER

Master of Natural Resource Management
(M.Sc. Programme)

FUNDAMENTALS OF NATURAL RESOURCE MANAGEMENT

Course Code: EMNRM 601 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To understand the concept of natural resources and their utilization pattern.
CO_2	What are the types of resources, their status and issues of degradation?
CO_3	To understand role of various ecological, economic and social aspects dependent for managing natural resources.
CO4	To know various approaches of NR management in India

UNIT-I **12 Hrs**

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Inter relationships among different types of natural resources. Concept of common property. Ecological, social and economic dimension of resource management. Impact of natural resources depletion on environment and development.

UNIT-II **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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.

Suggested Readings and References

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
3. Harikesh N Mishra 2014 Managing Natural Resources- Focus on Land and Water. PHI Lerning Publication.
4. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
5. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press.
6. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)

Course Expected Outcomes:

CEO_1	Understanding overall resource management situation in the country with reference to natural resources.
CEO_2	Understanding various resources and their contribution to socio-economic condition of the country.
CEO_3	Student will be able to understand how resource management paradigm has changed globally.
CEO_4	Overall understanding about linkages between different resources on the Earth.

Master of Natural Resource Management

(M.Sc. Programme)

ECOLOGY AND ECOSYSTEMS

Course Code: EMNRM 603 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To imbibe clear understanding of ecosystem functioning and intricacies
CO_2	To inculcate the knowledge of global environment issues and threat and instill and investigate various options for solution
CO_3	To empower them to be effective managers of ecosystem
CO_4	To indoctrinate on the minds of the students the inclination towards social justice and sustainable development

UNIT-I **12 Hrs**

Introduction: Definitions, history and relevance, levels of ecology, types of ecosystem, Components of Ecosystem, biotic-abiotic interactions, soil types, USDA/FAO scheme of soil classification.

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

Community Ecology: Community Structure, two-species interactions, food webs, Vegetational succession; types and processes

UNIT-II **12 Hrs**

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

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

Global Environment/threats to ecosystem: Greenhouse effect and climate change, ozone depletion, terrestrial and aquatic biomes; ecosystem responses to long-term climate patterns.

UNIT III **12 Hrs**

Ecosystem Management: Ecosystem degradation, ecosystems rehabilitation and restoration of degraded ecosystem, UN protected area categories, national parks, sanctuaries, community and biosphere reserves. Mountain, desert, mangrove and urban ecosystem based management and applications.

UNIT IV **12 Hrs**

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.

Suggested Readings and References:

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

3. Gotelli, Nicholas J. 2008. A Primer of Ecology, 4th edition, Sinauer

4. Stilling, Peter, 2001. Ecology: Theories and Applications, 4th Edition, Prentice Hall.

5. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. 2007. An Introduction to Sustainable Development, Earthscan.

6. Primack, Richard B. 2010. Essentials of Conservation Biology, 5th Edition, Sinauer.

Course Expected Outcomes:

CEO_1	Graduated students will be have clear understanding of ecosystem function and integrity
CEO_2	At the end of this course, students will be empowered to take informed and judicious decision towards restoration and management of ecosystem.
CEO_3	Students will be have clear understanding of ecosystem function and integrity
CEO_4	Graduated students will be understand the sustainable development practices

Master of Natural Resource Management
(M.Sc. Programme)

EARTH, WATER RESOURCES AND NATURAL DISASTERS

Course Code: EMNRM 605 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To develop a broad understanding of earth and water resources and their distribution.
CO_2	To understand what are the various types and causative factors of natural hazards.
CO_3	To understand the consequences of depletion of earth and water resources and impact of natural disasters.
CO_4	To educate and aware the students about the mitigation measures of soil and water conservation and disaster management.

UNIT-I **12 Hrs**

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, landuse and landuse planning, earth resource mapping and the use of remote sensing and GIS.

UNIT-II **12 Hrs**

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, groundwater province of India.

UNIT-III **12 Hrs**

Natural Hazards: Concept of Natural Disasters, 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 **12 Hrs**

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.

Suggested Readings and References:

1. Roy, A.B. 2010.Fundamentals of Geology. Narosa.
2. Singh Prabin (2010). Engineering and general geology. Kataria & Sons Publication.
3. Murthy, V.V.N. 2009. Land and Water Management, 5th edition.Kalyani Publishers.
4. Raganuth, H.M. 2007. Hydrology: Principles, Analysis and Design, 3rd edition. New Age International.
5. Dennen, William H., and Bruce R. Moore. Geology and Engineering. Wm C Brown Publisher.
6. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).

Course Expected Outcomes:

CEO_1	Understanding of earth and water resources will be enhanced.
CEO_2	The learner would be able to utilize the scientific and technological skill for soil and water conservation.
CEO_3	The learner would also be able to know the causative factors of natural disasters.
CEO_4	Students would be able to understand the implementation of scientific methods to minimize the impact of natural disaster through suitable mitigation measures on natural resources and society.

Master of Natural Resource Management
(M.Sc. Programme)

ENERGY RESOURCES AND ENVIRONMENT

Course Code: EMNRM 607 **L-04,** **Credits – 04,**

Course Objectives:

CO1	To impart basic concepts of energy and to create an understanding about the energy use patterns in India and various parts of the world.
CO2	To introduce the various conventional and renewable energy technologies
CO3	To impart knowledge on recent development in bioenergy and rural energy systems
CO4	To instruct on environmental pollution associated with energy production and use

UNIT-I **12 Hrs**

Fundamentals of energy: Definition of energy and power; 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 **12 Hrs**

Energy Resources: Non-conventional forms of energy - Coal, petroleum, natural gas: resources and reserves, Nuclear energy: Fission energy, fusion energy, Nuclear power generation, nuclear reactors, Renewable energy resources : Solar energy, Flat plate collectors, photovoltaic cells, Solar power; Wind energy, wind farms; Geothermal energy; Hydropower and micro-hydel power; Tidal energy; Ocean Thermal Energy Conversion (OTEC) Technology; Hydrogen as an alternate fuel.

UNIT-III **12 Hrs**

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, biogas digesters and technology for rural India.

UNIT-IV **12 Hrs**

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 rain; water pollution; thermal pollution of water; 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.

Suggested Readings and References:

1. Edward H. Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addition-wesley Publishing Company, Reading.
2. D. D. Mishra (2012) Energy, Environment, Ecology and Society, S. Chand & Company Ltd. New Delhi
3. P.P. Bhojvaid (2008). Bio-fuels towards a greener and secure energy future.
4. Rakos Das Begamudre (2000), Energy Conversion Systems, New Age International Publishers, New Delhi.
5. C. S. Solanki (2009), Renewable Energy Technologies-A Practical Guide for Beginners, PHI Learning , N. Delhi.
6. John. Twidell and Tony Weir (2015). Renewable Energy Resources, Routledge, Taylor and Francis.

Course Outcome:

CEO1	Students shall learn to visualize energy use scenario and development issues
CEO2	Students will be able to enhance their skills on renewable and conventional energy technologies
CEO3	Students will acquire the knowledge on bioenergy technology and rural energy systems
CEO4	Students will learn the various aspects of environmental pollution associated with energy production and use.

Master of Natural Resource Management
(M.Sc. Programme)

ELEMENTS OF GEOINFORMATICS

Course Code: EMNRM 609 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To give inside details about the subjects Remote Sensing, Geographic Information System and Global Positioning System.
CO_2	To appraise the students how to do different digital image processing techniques and to interpret the remotely sense data in more efficient ways.
CO_3	To understand the types of data used in GIS and how different models are used to represent the real world and their functionalities.
CO_4	To understand the applications of Geospatial technology in the fields of environment viz., environment and natural resources management, urban planning, coastal landform studies, snow and glacier studies and in disaster management.

Unit-I **12 Hrs**

Basic Principles of Remote Sensing

Introduction to remote sensing, definition, physical basis of remote sensing, electromagnetic spectrum, remote sensing resolutions, radiation laws, atmospheric effects, basics of optical, thermal and microwave remote sensing. History of remote sensing. Spectral signatures of vegetation, water, soil and snow in different regions of EMS. Remote sensing platforms, orbits, sensor types. Characteristics of IRS, Landsat, SPOT and other operational remote sensing satellites.

Unit-II **12 Hrs**

Remote Sensing Data Analysis and Global Positioning System (GPS)

Digital Image Processing - image rectification & restoration, image enhancement, data merging, digital image classifications, hyperspectral image analysis, biophysical modelling, image transmission and compression. Visual interpretation – principles, strategies and elements. Satellite based navigation systems - concepts and applications with focus on conservation and management of natural resources. Survey of India topographical map types and numbering system.

Unit-III **12 Hrs**

Geographic Information System (GIS)

Basic principles and components of GIS, spatial information and spatial data types, geographic phenomena, geographic field, geographic objects and boundaries, raster-based GIS data processing with both regular and irregular tessellations, vector-based GIS data processing and topology, spatial relations and spatial analysis. Map projections, datum and coordinate systems. Remote sensing and GIS software.

Unit-IV **12 Hrs**

Geoinformatics in Natural Resources Management

Application of Geoinformatics in natural resource management – landforms, forests, wetlands, coastal zone, snow and glaciers, groundwater prospect zone mapping, land use mapping and disaster management.

Suggested Readings and References:

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.
3. Sabins, Floyd F. 2007. Remote Sensing: Principle and Interpretation. Waveland Press.
4. Jensen, John R. 2009. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.
5. Lo, C.P., and Albert K.W. Yeung. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
6. Rolf A de By. 2001. Principle of Geographic Information System. ITC Text Book Series. Enschede, The Netherlands.

Course Expected Outcomes:

CEO_1	After completing the course students will enable to understand the basic principles of Remote Sensing, Geographic Information System and Global Positioning System.
CEO_2	The course will immensely help students to understand the functionality and contributions of different satellite series worldwide.
CEO_3	This will help the students to analyse the spatial data and link them with other attribute data.
CEO_4	Once basic is clear students will have overall idea how this technology can be utilized in different fields of environment with emphasis on natural resource management.

Master of Natural Resource Management
(M.Sc. Programme)

ECOLOGY AND ECOSYSTEMS LAB

Course Code: EMNRM 651 **P-04,** **Credits – 02,**

Course Objectives:

CO_1	To empower students the concept of ecosystem components and its structure and function
CO_2	To transform ecological field researcher and inculcate students to take up cutting-edge researcher in future
CO_3	To enable students to predict environment change
CO_4	To enable students to give suggestion based on sound ecological knowledge

4 Hrs/week

1. Monitoring site Characteristics
2. Using GPS
3. Raunkier's Life forms
4. Population and density estimation
5. Quadrate sampling – Size and Numbers, Frequency, density, abundance, etc
6. Community structure and vegetation indices
7. Soil Analysis: composition (particle size/texture), density
8. Study of different groups of plants; hydrophytes, mesophytes and xerophytes

Course Expected Outcomes:

CEO_1	Graduated will be trained professional and independently carry out research activities in the field of ecology
CEO_2	They will be effective managers of ecosystem.

Master of Natural Resource Management
(M.Sc. Programme)

GEOINFORMATICS LAB

Course Code: EMNRM 653 **P-04,** **Credits – 02,**

Course Objectives:

CO_1	The main objectives of this subject are to give the hands-on experiences in the fields of Remote Sensing, GIS and GPS both at laboratory and field level.
CO_2	To discuss details about different image processing techniques including how a raw image can be registered and be utilized for development purposes.
CO_3	To give practical knowledge how to create geodata base and how different methods can be utilized to solve certain problems using case studies.
CO_4	To give practical exposure how to collect field data using GPS and to import those on map to prepare a final output map.

4 Hrs/Week

1. Introduction to the software - ArcGIS and Erdas Imagine
2. Digital Image Classification – Supervised and Unsupervised
3. Georeferencing - Scanned topographical map and image to image georeferencing
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 maps

Suggested Readings and References:

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.
3. Sabins, Floyd F. 2007. Remote Sensing: Principle and Interpretation. Waveland Press.
4. Burrough, P.A. 1976. Principles of Geographic Information System for Land Assessment. Oxford: Clarandon Press.
5. Lo, C.P., and Albert K.W. Yeung. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
6. Rolf A de By. 2001. Principle of Geographic Information System. ITC Text Book Series. Enschede, The Netherlands.

Course Expected Outcomes:

CEO_1	After completing the course students will enable to handle both the image processing and GIS software.
CEO_2	Students will be able to generate geodata base and how different queries could be applied on these databases to solve certain problem.
CEO_3	Students also be able to interpret the raw image using different digital image processing techniques.
CEO_4	Students will be confident how field data can be collected with the help of GPS and to bring them on the map.

Master of Natural Resource Management
(M.Sc. Programme)

SOIL, ROCK AND MINERAL LAB

Course Code: EMNRM 655 **P-04,** **Credits – 02,**

Course Objectives :

CO_1	To get knowledge by hands on experience for identification of rocks and minerals on the basis of their characteristics.
CO_2	To understand the laboratory methods for analyzing various characteristics and properties of soil.
CO_3	To introduce and understand porosity, bulk density and water holding capacity of soil.
CO_4	To introduce the laboratory analysis methods for status of soil nutrient.

4 Hrs/week

1. Rock properties
2. Mineral properties
3. Identification of rocks
4. Identifications of minerals
5. Mineral distribution map of India
6. Petrological microscope
7. Soil pH and Electric conductivity
8. Determination of Bulk density and particle density of soil
9. Porosity of soil
10. Test for presence/absence of some nutrients
11. Determination of water holding capacity and field capacity of soil
12. Estimation of organic carbon content of soil
13. To estimate chloride content in soil samples
14. Estimation of carbonate and bicarbonate in soil samples

Suggested Readings and References:

1. Deer, W.A., Howie, R.A. and Zussman, J. (1992): An Introduction to the rock forming minerals, Longman.

2. Verma, P. K. (2009): Optical minerology, CRC press.
3. Klein, C. and Huburt, Jr., C.S. (1993): Manual of Mineralogy. John Wiley.
4. Weil, R.R. and Brady, N.C. (2017): The Nature and Properties of Soils, 15th edition, Pearson Education.
5. Bandyopadhyay, K., Aggarwal, P., Chakraborty, D, Pradhan, S., Garg, R.N. and Singh, R. (2012): Practical Manual on Measurement of Soil Physical Properties, Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi.
6. Chaurasia, S. and Gupta, A D. (2014): Handbook of Water, Air and Soil Analysis, International E – Publication, Indore, India

Course Expected Outcomes:

CEO_1	Students will be able to learn how one can identify rocks and minerals in the field.
CEO_2	Students will be able to learn about the porosity, bulk density and water holding capacity of soil.
CEO_3	Students will be able to learn about the different methods to assess the availability of soil nutrients and status of soil fertility.

Master of Natural Resource Management
(M.Sc. Programme)

SEMINAR/TERM PAPER

Course Code: EMNRM 657 **Credits – 01,**

Course Objectives:

CO_1	The students will get an opportunity to identify a topic for an in-depth analysis
CO_2	Term paper will provide an understanding on how to write a research article
CO_3	Presentation, research and academic writing skills will be improved
CO_4	Provide an opportunity for some individual interaction between the student and faculty

Methodology of term paper **12 Hrs**

- Students are required to select a topic of their own choice from the current contemporary topics or select a topic after consultation course coordinator and other faculty.
- The word limit of the term paper is 5000 words (excluding references). Please do not exceed the word limit.
- The term paper shall have a proper structure- Abstract, Table of contents, Introduction, Objectives, Problem statement, Literature Review, Methodology, Results and Discussion, Conclusion and Reference.
- Plagiarism shall be checked, refrain from copying. The sources of articles to be reviewed should be peer-reviewed journal articles and books; and properly referenced throughout the contents of term paper. References should be in APA/Harvard format.
- The assessment shall be based on criteria – viz. contents and clarity in term paper, presentation, adherence to the deadline, plagiarism report.
- The term paper shall be submitted through a softcopy and a hard copy to the Course Coordinator.

Course Expected Outcomes:

CEO_1	Students will write a paper that locates and synthesizes relevant primary and secondary sources of data and has a clear, coherent and plausible argument, logical structure, correct grammar and proper references (footnotes and bibliography).
CEO_2	Students will learn new research methods and review existing literature, which will enable them to understand their topics in-depth and critically think regarding solutions
CEO_3	Use writing to learn and synthesize new concepts- the students receive feedback that helps them develop their research, writing and presentation skills, evidence and support an argument
CEO_4	Students will write a paper that locates and synthesizes relevant primary and secondary sources of data and has a clear, coherent and plausible argument, logical structure, correct grammar and proper references (footnotes and bibliography).

SECOND SEMESTER

Master of Natural Resource Management
(M.Sc. Programme)

BIODIVERSITY AND BIOSYSTEMATICS

Course Code: EMNRM 602 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To have clear understanding on scope and values of biodiversity
CO_2	To enlighten students with various types of classification systems
CO_3	To equip students with various methods so as to enable them to carry out research in areas of description, identification, nomenclature and development and history of classification.
CO_4	To inculcate the interest in the minds of student on any biodiversity conservation activities in future

UNIT I **12 Hrs**

Introduction to biodiversity:

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

UNIT II **12 Hrs**

Development, types and organizations in taxonomy:

Definition, history and development of taxonomy, the importance of taxonomy in natural resource management, Types of classification - artificial, natural and phylogenetic, Para-taxonomy, national and international organizations associated with taxonomic studies. (CBD, GSPC, GTI)

UNIT III **12 Hrs**

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. Methods in taxonomic studies: collection, preservation and storage of specimens, The International Code of the Nomenclature (ICN) and International Code of Zoological Nomenclature (ICZN), the biosystematics and its future directions.

UNIT IV **12 Hrs**

Biodiversity Conservation Approaches:

Conservation strategies- In situ and Ex situ conservation, Various approaches to conservation - Landscape approach to biodiversity conservation, corridor approach, individual species approach, habitat conservation approaches, IUCN Red data book, Man and animal conflicts, National Biodiversity Strategy and Action Plan,

Suggested Readings and References:

1. Krishnamurthy, K.V. 2003. Textbook of Biodiversity. Science Publications.
2. Gurcharan Singh. 2020. Plant Systematics: Theory and Practice. 4th edition, Oxford & IBH/CBS
3. 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.
4. Mayr, E and P.D. Ashlock. 1991. Principles of Systematic Zoology. MacGraw-Hill.
5. Narendran, T.C. 2006.An Introduction to Taxonomy. Zoological Survey of India, Kolkata.
6. Primack, R.2006. Essentials of Conservation Biology. Sinauer associates, Inc., USA

Course Expected Outcomes:

CEO_1	By the end of the course, students will be fully equipped in working independently in the field of conservation and management of biodiversity and natural resources.
CEO_2	They can also go for higher studies in the field of research and development with full confidence.
CEO_3	Graduated students will take a lead in any conservation activities in any capacity

Master of Natural Resource Management
(M.Sc. Programme)

FOREST RESOURCES, PLANNING AND MANAGEMENT

Course Code: EMNRM 604 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To understand the contribution and significance of forest resources in India.
CO_2	What are the factors responsible for de-forestation and over-exploitation?
CO_3	The concept of forest resource inventory and various silivicultural system of forest management.
CO_4	To understand the approaches of sustainable forest management.

UNIT-I **12 Hrs**

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 completion, parasites, epiphytes, climber, and weeds on forests.

UNIT-II **12 Hrs**

Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest, relationship forest with tribal people. Threats in forest resources- Effect of domestic and wild animals on forest regeneration, cattle grazing- methods of control against grazing and browsing animals- rotational and controlled grazing.; 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 **12 Hrs**

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- siliviculture and sivicultural 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 **12 Hrs**

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.

Suggested Readings and References:

1. Montagnini, Florencia, Jordan, Carl F. 2007 Tropical Forest Ecology: The Basis for Conservation and Management. Springer Publication
2. James P. Kimmins 2006 Forest Ecology, Pearson Publication.
3. Bhattacharya, P. 2018 Redefining Forestry for Effective Livelihoods. TERI Press. New Delhi.
4. Dwivedi, A.P. 1993. Forests - the non-wood resources. International Book Distributor, Dehradun.352
5. Bhattacharya P., Kandya A.K. and Krishna Kumar 2008. Joint Forest Management in India, Aavishkar Publisher, Jaipur.Vol. I & II
6. J.B. Lal 2007 Forest Ecology. Nataraj Publication

Course Expected Outcomes:

CEO_1	Understanding the overall contribution of forest resources in India.
CEO_2	Understanding the need for forest resource management and their various approaches.
CEO_3	How forest resource planning is done in the field?
CEO_4	Learning from field projects of participatory forest management.

Master of Natural Resource Management
(M.Sc. Programme)

ENVIRONMENTAL ECONOMICS AND ECOSYSTEM SERVICES

Course Code: EMNRM 606 **L-03,** **Credits – 03,**

Course Objectives:

CO_1	What is the concept of ecological economics and common property resources?
CO_2	How environmental accounting is done in the field of natural resource management?
CO_3	What do you mean by ecosystem services, what are the different types of ecosystem services?
CO_4	The concept of payment for ecosystem services and economics associated to natural resource conservation and marketing.

UNIT-I **9 Hrs**

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 **9 Hrs**

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 **9 Hrs**

Ecosystems services –Direct and indirect economic benefit from – forest ecosystems, mountain ecosystems, mineral and water resources, ecotourism. Total Economic Value- Use and Non-Use Values, Concept of payments for Ecosystem Services (PES), examples from natural resources. Green GDP.

UNIT-IV **9 Hrs**

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

Suggested Readings and References:

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

Course Expected Outcomes:

CEO_1	Student will understand the contribution of environmental economics and their services.
CEO_2	Understanding various methods of accounting the contribution of ecosystem services.
CEO_3	Approaches of augmentation of natural resource management through environmental accounting.
CEO_4	The contribution of international and national organization for promoting natural resource management in India.

Master of Natural Resource Management
(M.Sc. Programme)

ENVIRONMENTAL STATISTICS

Course Code: EMNRM 608 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	An advanced understanding of the statistical theory and probabilities
CO_2	To analyze various statistical methods for important problems in environmental sciences
CO_3	To elaborate the application of statistical techniques on environmental data.
CO_4	Shall help in interpreting the results so obtained

Unit-I **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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.

Suggested Readings and References:

1. Joseph, A.J. (1997). Health, Safety and Environmental Data Analysis, Lewis Publishers, New York.
2. Pentecost, A. (2003). Analysing Environmental Data. Longman, London.
3. Gilbert, R.O. (1987). Statistical Methods for Environmental Pollution Monitoring, New York, Van Nostrand Reinhold.
4. McBeen, E.A. (1999). Statistical Procedures for Analysis of Environmental Monitoring Data.
5. Keith, L.H. (Ed.) (1988). Principles of Environmental Sampling ACS Professional References, American Chemical Society.
6. Berthouex, P.M. and Brown, L.C. (1994). Statistical for Environmental Engineers. Lewis Publishers, CRC Press.

Course Expected Outcomes:

CEO_1	Collating and treating data through various statistical methods
CEO_2	Understanding the application of statistical techniques to specific problems
CEO_3	Learning which test shall be applied where
CEO_4	Interpreting the results obtained after application of statistical parameters

Master of Natural Resource Management
(M.Sc. Programme)

AQUATIC ECOSYSTEM AND WETLAND MANAGEMENT

Course Code: EMNRM 610 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	To understand the physical, chemical, and biological components of aquatic ecosystems including lakes, rivers, streams, wetlands, and marine
CO_2	Be familiar with the basic principles of hydrodynamics, biology and biogeochemistry as they relate to the science and management of aquatic ecosystem.
CO_3	To understand how diverse disciplines approach are required for the study of freshwater and marine ecosystems in the context of classical as well as contemporary research.
CO_4	To demonstrate how landscape concepts, GIS and remote sensing are being applied for conservation and restoration of aquatic ecosystems.

Unit I: **12 Hrs**

Ecology of Aquatic ecosystems

Definitions: Fresh water (lentic, and lotic), marine and wetland ecosystems, classification of aquatic ecosystems; chemical composition of fresh and marine waters. Major environmental (abiotic and biotic) factors and ecosystem processes; Energy flow in aquatic ecosystems; Water quality and pollution of lakes, reservoirs, rivers, and marine waters; Aquatic Invasive species. Nutrient dynamics, methanogenesis, carbon cycle, climate change and impact on aquatic ecosystems

Unit II: **12 Hrs**

Fresh water ecosystems

Lakes and reservoirs: Stratification and zonation in lakes; Community organization, productivity, trophic levels and food webs; Bioassessment and bio-criteria in lakes and reservoirs, index of biological integrity, eutrophication and trophic state index; biological adaptations, Wetlands: Soil types and redox potential; Ecology of constructed wetlands.

Rivers: Types of rivers, geomorphology, longitudinal profile and classification of drainage network, rivers and ecological continuum, riparian and flood plain wetlands; river biodiversity, community organization; trophic structure and food webs; energy flow

Unit III: **12 Hrs**

Marine & Estuarine ecosystems

Structure and function of marine ecosystems; Case I & II waters, estuary types and genesis; organisms (plants, animals, microbes) in various ecological zones, community organization, productivity, upwelling and downwelling of nutrients; mangroves, coral reefs; Biodiversity in Arctic and Antarctic oceanic environment.

Unit IV: **12 Hrs**

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.

Suggested Readings and References:

1. Singh, G. K. and Nautial, K. C. 2009. Biodiversity and Ecology of Aquatic Environment. Narendra Publishing House
2. Mitsch, W.J. and Gosselink,J.G. 2015. Wetlands, 4th edition, John Wiley & Sons. 744p.
3. Keddy, P. A. 2010. Wetland Ecology: Principles and Conservation. Cambridge University Press, 516p.
4. Dodds, W. K. 2002. Fresh Water Ecology-Concepts and Environmental Applications, Academic Press.
5. Castro, Pand Huber, M.E. 2003. Marine Biology. 4th Edition. Mc-Graw Hill.
6. Allan, J.D. and M.M. Castillo. 2007. Stream ecology: structure and function of running waters. 2nd Edition. Springer, NY.

Course Expected Outcomes:

CEO_1	Upon completion of this course students will be able to reliably demonstrate understanding of how aquatic ecosystems function, analyze and interpret limnological data, and apply limnological information to surface water management.
CEO_2	Explain how physics, biology, geology and nutrient cycles interact in aquatic ecosystem.
CEO_3	Students will be able to communicate effectively with the community of aquatic scientists, managers and policy makers
CEO_4	Students will identify the skills required to understand and address aquatic ecosystem management challenges.

Master of Natural Resource Management
(M.Sc. Programme)

SUBJECT: HUMAN VALUES AND ETHICS (NUES) for all PG Courses of USS

Course Code: HVE-102 (Proposed) L – 2/week Credits - 2

Course Objectives:

CO_1	To develop a universal approach towards human values
CO_2	To be able to strike a balance between aspirations and happiness
CO_3	To understand that humans are a part of nature and how being close to nature bring in joy and satisfaction
CO_4	Select classical short stories from Indian context will expose the students to diverse and multifaceted subsections in Indian society

Unit I **6 Hrs**

The Problem and Paradox of Happiness: Twin goals: happiness and just order; role of value education. Concept of good life-quality of life and subjective well-being; happiness, life satisfaction and positive affect; studying quality of life through surveys; and findings of quality of life surveys. Moral and Institutional approaches; and the inherent conflict between the two. Man and Society

Unit II **6 Hrs**

Happiness and Nature: Biophilia hypothesis- connections with nature and co-existence with other forms of life, Deep Ecology, Importance of meaningful contact with the natural world, solutions for a healthier, greener tomorrow, Indigenous and traditional knowledge system and its intellectual roots.

Unit III **6 Hrs**

Basics of Professional Ethics, Ethical Human Conduct: Human Conduct- based on acceptance of basics Human Values, Humanistic Constitution and Universal Human Order-skills, sincerity and fidelity. To identify the scope and characteristics of people-friendly and eco-friendly production systems..

Unit IV **6 Hrs**

Encompassing Different Stories/ narratives on Human Values from Indian Context.

References:

1. Gaur, R.R., Sangal, S.and Bagaria, G., "A Foundation Course in Human Values and Professional Ethics", New Delhi: Excel Books, 2010.
2. Mike, W. Martin, "Paradoxes of Happiness", Journal of Happiness Studies, 2008, pp. 171-184.
3. Giddens, Anthony, "Sociology", 5th edition, Cambridge: Polity Press, 2006.
4. Ambedkar, B.R., Buddha and his dhamma, http://www.scrubd.com/doc/16634512/Buddha-and-His-Dhamma-by-B-R-Ambedkar-Full [accessed on 21 October, 2010]
5. Beteille Andre, "Antinomies of Society: Essays on Ideologies & Institutions", New Delhi: Oxford University Press, 2000.
6. Fikret Berkes, "Sacred Ecology", Second Edition Routledge Taylor & Francis Group, 2008.
7. Richard Louv, "Last Child in the Woods", Algonquin Books, 2008.
8. Ramakrishnan, E.V., "Indian Short Stories": (18700-200). Sahitya Akademi, 2012.
9. Davidar, David., "Cluch of Indian Masterpieces", Aleph Book Company, 2016.
10. "Contemporary Indian Short Stories", Sahitya Akademi, 2014.

Course Outcomes:

CEO_1	The students will get sensitized about the role of value education and learn to balance ambition & happiness
CEO_2	The students will be able to understand the importance of living in harmony with nature
CEO_3	The students will be able to see the relevance of Professional behavior and ethics
CEO_4	They will draw inspiration from the classical Indian literature narrated to them in the form of select short stories

Master of Natural Resource Management
(M.Sc. Programme)

Generic Elective (Any One)

ENVIRONMENTAL MODELLING

Course Code: EMNRMGE 616 **L-04,** **Credits – 04,**
(Generic Elective)

Course Objectives:

CO_1	Understanding of the basics of application of various models in environmental systems.
CO_2	Shall delve in elaborating the tools in mathematical modelling of environmental systems
CO_3	Elaborate the methodology required for modeling of both water and air quality
CO_4	Deliberate on various approaches and explain the limitations in application of various models in environment

UNIT -I **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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).

UNIT -IV **12 Hrs**

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.

Suggested Readings and References:

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.
3. Hipel, K.W. and Mcleod, A.I. (1994). Time series Modelling of Water Resources and Environmental Systems. Elsevier Science B.V. Amsterdam, Netherlands.
4. Zannetti, P. (1990). Air Pollution Modelling, Theories, Computational Methods and available Software.Van Nostrand Reinhold, New York.
5. Buonicore, A.J. and Davis, W.T. (1994). Air Pollution Engineering Manual.Air and Waste Management Association, New York, Van Nostrand Reinhold.
6. Nirmalkhandan N. (2001) Modeling Tools for Environmental Engineers and Scientists, CRC Press, Boca Raton, Florida.

Course Expected Outcomes:

CEO_1	Imparting a basic understanding of various environmental systems
CEO_2	How the systems can be categorized for modelling
CEO_3	Prediction of fate and transport of pollutants in the environmental matrices.
CEO_4	Overview of application of generic models of air and water quality.

Master of Natural Resource Management
(M.Sc. Programme)

ECOTECHNOLOGY FOR NATURAL RESOURCE MANAGEMENT

Course Code: EMNRMGE 618 **L-04,** **Credits – 04,**
(Generic Elective)

Course Objectives

CO_1	To provide a basic understanding on systems approach and ecological modelling
CO_2	To provide knowledge on the principles and applications of Ecotechnology in environment management
CO_3	To provide knowledge about various ecologically sound restoration approaches based on case studies
CO_4	To make the student understand application of eco-technology in industry

Course Contents

UNIT-I **12 Hrs**

Systems approach- Concept of a system, application of systems theory in ecosystem management, ecosystem stability; Resource apportionment models and stability. Ecosystem cybernetics. Ecological modelling: Matrix Model, Compartment model, System transfer functions, mathematical and statistical models for ecosystem management.

UNIT-II **12 Hrs**
Ecotechnology: Definitions, Differences between environmental engineering and ecological engineering; Ecological engineering principles; Ecosystem principles governing ecotechnology; Application of Ecotechnology for sustainable development and societal welfare; Tools and applications of ecotechnology; Concept of Buffer zones; Green belts; Ecosystem dynamics; Ecological footprints

UNIT-III **12 Hrs**
Ecorestoration Approaches: Principles and approaches, rehabilitation of salt-affected and water-logged lands, Riparian zone restoration; Ecorestoration of mined area and degraded lake;

Phytoremediation technology for decontamination of polluted sites by rhizofiltration, phytoextraction, phytostabilisation and phytotransformation; Building resilience of soil and soil fertility management using eco-technological methods, vermitechnology.

UNIT-IV **12 Hrs**

Ecotechnology in industrial practices: Balancing inputs and outputs, Industrial metabolism, life cycle planning, eco-design, eco-efficiency and Cradle to cradle approach for sustainability. Constructed wetland (CW) technology: Types, designs and applications in wastewater treatment, mechanisms of removal of N and P, role of macrophytes and rhizoflora in CW functioning

Suggested Readings and References:

1. Mitsch, W.J. and. Jørgensen, S.E. (1989). Ecological Engineering: An Introduction to Ecotechnology, John Wiley and Sons, Inc. New York
2. Jørgensen, S.E (2012).Inroduction to Systems Ecology. CRC Press/ Taylor & Francis
3. Kangas, P.C. (2004). Ecological Engineering: Principles and Practice. Lewis Publishers, CRC Press, Florida
4. Mitsch, W.J. and. Jørgensen, S.E. (2004). Ecological Engineering and Ecosystem Restoration" John Wiley and Sons, Inc., New York
5. Cairns Jr., J. (Ed.), 1994. Rehabilitating Damaged Ecosystems, Vol I. CRC Press
6. Robert H. Kadlec and Scott Wallace. (2005). Treatment Wetlands, 2nd Ed. CRC Press

Course Expected Outcomes

CEO_1	The students will develop a systemic approach to address environmental problems
CEO_2	The students will learn the principles and application of ecotechnology tools
CEO_3	The students will learn basic and applied approaches to restore various types of polluted and environmentally degraded systems in eco-friendly manner
CEO_4	The students will learn the latest eco-efficient approaches to be used in industry to promote circular economy and sustainable development

Master of Natural Resource Management
(M.Sc. Programme)

CLIMATE CHANGE AND CARBON MANAGEMENT

Course Code: EMNRMGE 620 **L-04,** **Credits – 04,**
(Generic Elective)

Course Objectives:

CO1	To introduce the concepts and science of climate change and its effects on various ecosystems
CO2	To impart knowledge about international protocols/ treaties on climate change and techniques for carbon absorption in different sectors
CO3	To introduce various techniques of carbon sequestration to overcome the problem of climate change
CO4	To introduce and understand carbon management practices, certifications and related policies for reducing emissions from deforestation activities

UNIT-I **12 Hrs**

Energy issues and climate change: Climate change, global warming and greenhouse effect, greenhouse gases (GHGs) and their sources, quantifying CO_2 and methane emissions, global warming potential (GWP), the radiative balance, earth's carbon reservoirs and carbon cycle. Impacts of climate change in different ecosystem: Energy balance and one layer atmosphere model, Global and Indian changes including temperature rise, sea level rise, coastal erosion and flooding, positive feedbacks, Climate change refugees and environmentally displaced persons.

UNIT-II **12 Hrs**

Controlling carbon dioxide (Policies and Protocols): Efforts to restrict carbon dioxide levels: Kyoto Protocol, key aspects of Paris Agreement, National Determined Contribution (NDC) Targets of India for 2030, methods to increase carbon dioxide absorption in power production, agricultural production, forestry, and industry, the Copenhagen Summit and its implications, future predictions.

UNIT-III **12 Hrs**

Carbon sequestration technologies and impacts: Carbon management through abiotic sequestration, geological and deep saline aquifers deposit, carbon sequestration in vegetation, ocean carbon absorption, Post Combustion CO_2 capture with chemical absorption, Human and

environmental risks of amines and derivatives associated with CO_2 capture, carbon farming and carbon trading, carbon auditing, methane source and sinks, methane emissions from rice paddy and wetlands.

UNIT-IV **12 Hrs**

Strategic management of carbon emissions:

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

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.

Suggested Readings and References:

1. Dieter Helm (2020), Net Zero: how we stop causing climate change, William Collins publication.
2. Brohe, Arnaud, Nick Eyre, and Nicholas Howarth. 2009. Carbon Markets: An International Business Guide (Environmental Market Insights), Routledge
3. Gilbert, M. Masters and Wendell P. Ella. (2015). Introduction to environmental engineering and science, Pearson Education Inc., New Delhi
4. Egbert Boeker and Rienk van Grondelle (2013). Environmental science Physical Principles and Applications.
5. Labatt, Sonia, and Robert R. White. 2007. Carbon Finance: The Financial Implications of Climate Change (Wiley Finance). Wiley Finance.
6. A.P. Mitra et. al. (2004). Climate Change and India: Uncertainty Reduction in Greenhouse Gas Inventory Estimates, Universities Press (India) Pvt. Ltd.

Course Outcomes:

CEO1	Students will be able to learn and understand the concept of climate change and its impacts on various ecosystems.
CEO2	Students will be able to enhance their knowledge about international programmes and their importance in climate change.
CEO3	Students will be able to get knowledge about various carbon sequestration techniques for better management of climate.
CEO4	Students will be able to learn about the current management practices and some climate change mitigation programme.

Master of Natural Resource Management
(M.Sc. Programme)

WATERSHED MANAGEMENT

Course Code: EMNRMGE 622 **L-04,** **Credits – 04,**
(Generic Elective)

Course Objectives:

CO_1	To introduce the concept of watershed, Govt. policies and guidelines of watershed management.
CO_2	To introduce the importance of watershed characteristics and its ecosystem services.
CO_3	To impart the knowledge about watershed hydrology, its components and measurements of various hydrological parameters.
CO_4	To introduce and understand watershed planning and implementation of Govt. guidelines and policies in the watershed management programs for the conservation of natural resources.

UNIT-I **12 Hrs**

Watershed Definition and scope: Watershed concept, delineation from topographical maps, watershed problems, types of watershed, watershed function, important principles and objectives in management and development, components of watershed management, sustainable watershed approach, agents of watershed change, watershed management programme in India, common Govt. guidelines and policies for watershed development.

UNIT-II **12 Hrs**

Watershed Characteristics: Landuse, vegetation, drainage, morphometry, climate, soils, geology, slope and aspect, socio economic characteristics, types and causes of erosion soil erosion and estimating the soil loss, Universal Soil Loss Equation (USLE), Revised Universal Soil Loss Equation (RUSLE), land capability classification, ecosystem services of watershed.

UNIT-III **12 Hrs**

Watershed Hydrology: Hydrological cycle and its components, drainage system, classifications of

water resources, surface runoff, rainfall-runoff relationship, stream flow estimation, erosion control, water conservation, management of water quality, flood and drought management. water harvesting structures.

UNIT-IV **12 Hrs**

Watershed Planning and management: Watershed management, multi-objective planning, watershed restoration and prioritization, landuse practices, community participation, integrated watershed development, watershed management strategies, project implementation, monitoring and evaluation of watershed management,, economics of watershed protection, risks, climate change adaptation and mitigation in watershed, impacts and management of natural hazards, Jal Jeevan Mission of GoI.

Case studies – Success stories of Watershed Management in India.

Suggested Readings and References:

1. Singh, Rajvir. 2000. Watershed Planning and Management. Yash Publications.
2. Maitra, M.K. 2019. Watershed Management A Compendium for Field Practitioners
3. Rajora, Rajesh 2019. Integrated Watershed Management. Rawat Publication, Jaipur.
4. Common Guidelines for Watershed Development Projects-2008 Revised Edition – 2011. National Rainfed Area Authority Planning Commission Government of India
5. Jim Smyle, Crispino Lobo, Grant Milne, and Melissa Williams 2014. Watershed Development in India an Approach Evolving Through Experience. Agriculture and Environmental Services
6. Operational Guidelines for the Implementation of Jal Jeevan Mission (Har Ghar Jal). Ministry of Jal Shakti Department of Drinking Water and Sanitation National Jal Jeevan Mission. 2019

Course Expected Outcomes:

CEO_1	Students will be able to learn about the importance of Govt guidelines and policies about the watershed management.
CEO_2	Students will be able to acquire the knowledge about the role of various watershed characteristics and their importance in watershed conservation.
CEO_3	Students will be able to learn about the different methods of rainfall, streamflow measurements and sediment load estimation.
CEO_4	Students will be able to get the knowledge about systematic approach to apply different catchment area conservation methods for watershed development and implemental of Govt. policies for sustainable watershed management for natural resource conservation and societal benefit.

Master of Natural Resource Management
(M.Sc. Programme)

URBAN FORESTRY, BIODIVERSITY & LANDSCAPE

Course Code: EMNRMGE 624 **L-04,** **Credits – 04,**
(Generic Elective)

Course Objectives:

CO_1	To understand the concept of urban ecosystem and how urban forestry and biodiversity is important for society.
CO_2	What are the component of urban biodiversity, how to measure urban biodiversity for planning and conservation?
CO_3	What are the different methods of managing urban forest?
CO_4	How urban forest planning and implementation is done in our country?

UNIT-I **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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.

Suggested Readings and References:

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.
3. Konjendijk, et al. 2005.Urban Forests and Trees. Springer.
4. Kuchelmeister, G. 1998.Urban Forestry in the Asia – Pacific Region: Status and Prospects. APFSOS Working Paper #44, Food and Agriculture Organization
5. Bradley, Gordon A., (editor) Urban Forest Landscapes: Integrating Multidisciplinary Perspectives.
6. Gilbert OL. 1989. The Ecology of Urban Habitats. London: Chapman and Hall.

Course Expected Outcomes:

CEO_1	Understanding the overall concept of urbanization, urban landscape and urban forestry.
CEO_2	How urban biodiversity contribute in reference to health, culture and environment for the people live in urban area.
CEO_3	Learning in reference to urban landscape planning, maintenance and management in city environment.
CEO_4	Understanding the concept of smart cities and role of urban green. Understanding from case study, how green space management is taken up in various important cities in India.

Master of Natural Resource Management
(M.Sc. Programme)

PLANT ECOLOGY AND TAXONOMY LAB

Course Code: EMNRM 652 **P-04,** **Credits – 02,**

Course Objectives:

CO_1	To imbibe hands-on training to understand ecological factors effecting plant community and methods collection of plant materials
CO_2	To equip students on scientific description of plants systematically and taxonomic position.
CO_3	To familiarize student on local flora, habitat ecology and other environmental parameters

Course contents **4 Hrs/Week**

1. To Familiarize Local Flora

   To study local angiosperm plant families: Vegetative and Floral Characteristics of Common Plants Available during the whole semester (Malvaceae, Cucurbitaceae, Solanaceae, Fabaceae, Rutaceae, Asteraceae, Poaceae, Leguminoceae, Euphorbiaceae, Apocynaceae, etc)

2. To learn techniques of plant/specimen collection and preparation of herbarium of mesophytic plant.
3. Assessment techniques for study of herbaceous tree and woody communities
4. To study habitats of plant community- in aquatic ecosystem, grass land and waste lands.
5. To learn techniques of plant collection and preparation of herbarium of hydrophytes and xerophytic plants.
6. Collection and assessment of natural seedbank in a vegetation
7. Use of computer/internet facilities in plant collection and identification

Suggested Readings and References:

1. Sambamurty A. V. S. S. 2010. Taxonomy of Angiosperms. I. K. International Pvt Ltd

2. Gurcharan Singh. 2020. Plant Systematics: Theory and Practice. 4th edition, Oxford & IBH/CBS

3. Sharma, O.P. 2009. Plant Taxonomy, Tata McGraw-Hill Education Pvt. Ltd, New Delhi

4. Naik, V.K. 1984.Taxonomy of Angiosperms. Tata McGraw-Hill Education, New Delhi

5. Pandey, S.N and Misra, S.P. 2009. Taxonomy of Angiosperms. Anne Book Pvt. Ltd. New Delhi.

6. Pullaiah, T. and Karuppusamy, S. 2018. Taxonomy of Angiosperms. Astral International (P). Ltd. New Delhi.

Course Expected Outcomes:

CEO_1	The students will be acquainted with various groups of plants
CEO_2	They will be able to systematically identify, describe and classify of plants in future.
CEO_3	They will be able to carry out independent research and consultancy in the field of taxonomy, ecological habitat and conservation.

Master of Natural Resource Management
(M.Sc. Programme)

FOREST VEGETATION ASSESSMENT LAB

Course Code: EMNRM 654 **P-04,** **Credits – 02,**

Course Objectives:

CO_1	To inculcate clear understanding of the structure and functions of plant communities in natural and managed forest ecosystems
CO_2	To study equip students with various tools and techniques of sampling so that can carry out field research independently in future
CO_3	To assess the ecological condition of surrounding environment

Course contents **4 Hrs/Week**

1. Vegetation Inventory of grasslands and forests
   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 sampling methods - Belt, Line, Point, Centre Quadrat for forest vegetation analysis.
3. Assessment of leaf photosynthetic area.
4. Forest Carbon Assessment - below ground and above ground

Suggested Readings and References

1. Kangas, Annika and Maltomo Mattis 2006 Forest Inventory : Methods & Application, Springer.
2. Misra, R. (1968): Ecology Work Book. – Oxford & IBH Publishing Co., New Delhi..

3. Poffenberger, Mark, Betsy McGean, Arvind Khare and Jeff Campbell (eds). (1992). Joint Forest Management Field Methods Manual Vol. 2: Community Forest Economy and Use Patterns: Participatory Rural Appraisal (PRA) Methods in South Gujarat, India. New Delhi: Society for Promotion of Wasteland Development.
4. Ravindranath**, N.H.,** Ostwald, Madelene (2008). 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 Expected Outcomes:

CEO_1	Graduated students will gain practical knowledge about dynamics of forest ecosystem
CEO_2	Graduated students will become skilled professional in restoration and management of forest ecosystem in sustainable ways

Master of Natural Resource Management
(M.Sc. Programme)

ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATIONS LAB

Course Code: EMNRM 656 **P-04,** **Credits – 02,**

Course Objectives:

CO_1	Prepare students to apply basic statistical concepts in environmental problems.
CO_2	Enhance the basic understanding of application of various tests depending on the problem
CO_3	Data visualization and reasoning of statistical results
CO_4	Interpretation of results through computer programming

Course Content **4 Hrs/Week**

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.

Suggested Readings and References:

1. Wayne R Ott (1994). Environmental Statistics and Data Analysis, Lewis Publishers, New York.
2. Framework for the development of Environmental Statistics (2013) , United nations

3. Gilbert, R.O. (1987). Statistical Methods for Environmental Pollution Monitoring, New York, Van Nostrand Reinhold.
4. McBeen, E.A. (1999). Statistical Procedures for Analysis of Environmental Monitoring Data.
5. Keith, L.H. (Ed.) (1988). Principles of Environmental Sampling ACS Professional References, American Chemical Society.
6. Berthouex, P.M. and Brown, L.C. (1994). Statistical for Environmental Engineers. Lewis Publishers, CRC Press.

Course Expected Outcomes:

CEO_1	Understanding the basics of sampling and data generation techniques
CEO_2	Learning various parametric and non-parametric tests
CEO_3	Application of various statistical tests on environmental data
CEO_4	Interpretation of the results

THIRD SEMESTER

Master of Natural Resource Management
(M.Sc. Programme)

ENVIRONMENTAL IMPACT ASSESSMENT & AUDITING

Course Code: EMNRM 701 **L-04,** **Credits – 04,**

Course Objectives:

CO1	To introduce the need, purpose and legal framework of EIA
CO2	To impart knowledge on EIA methods and environment evaluation system
CO3	To introduce various impact mitigation methods with case studies
CO4	To introduce the concepts of environmental auditing

UNIT-I **12 Hrs**

Introduction to EIA: origin and development of EIA, objectives and purpose, hierarchy in EIA; Legislative requirements and administrative procedures for EIA in India, EIA Gazette Notification, 1994 and 2006, National Environmental Policy Act (NEPA); National Environment Policy (NEP), India; General EIA methodology; Environmental baseline data -collection and significance

UNIT-II **12Hrs**

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, Human and environment impact of post combustion carbon capture from amine based solvents on air, water, soil and biological environment, Impact evaluation: multi attribute utility theory, environmental evaluation system- Cost benefit analysis, Economic valuation of intangibles, Social impact assessment

UNIT-III **12 Hrs**

Mitigation 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 **12 Hrs**

Environmental Audit: Guidelines for environmental auditing, importance of environmental

auditing, types of audits, general audit methodology and basic auditing structure, elements of 1SO 14000, Environmental Audit rules under environmental Protection Act of 1986, first- and third-party audits, definitions of consumption audits, pollution audits, hazardous issues audits.

Suggested Readings and Reference:

1. Canter, Larry W. Environment Impact Assessment.1996. McGraw-Hill.
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. 2006. Environmental Management. Capital Publishing.
4. M. haskar, A.K. Environmental Audits. 1986. Enviro Media Publications.
5. Eccleston, C. H. 2011. Environmental Impact Assessment: A Guide to Best Professional Practices. CRC P.
6. D.P. 2003 Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons

Course *Outcome:*

CO1	Students will be equipped with the systematic procedure of EIA
CO2	Students will get acquainted with various EIA methodologies
CO3	Students will be able to familiarize themselves with environmental impact mitigating methods and practical implications based on EIA case studies
CO4	Students will learn the procedure and principles of environmental auditing

Master of Natural Resource Management
(M.Sc. Programme)

AGRO-ECOSYSTEMS AND AGROFORESTRY

Course Code: EMNRM 703 **L-03,** **Credits – 03,**

Course Objectives:

CO_1	What are the concept and scope of agro ecosystem and agro forestry?
CO_2	Why agro forestry is important for the farmers to adopt in their farming system?
CO_3	What are the various traditional and modern agro forestry practices are available in the country and elsewhere globally?
CO_4	How agro forestry practices help for the industries to develop raw materials?

UNIT-I **12 Hrs**

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 **12 Hrs**

Technical Applications inAgroforestry– 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 **12 Hrs**

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. Framers 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 **12 Hrs**

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

Suggested Readings and References:

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

Course Expected Outcomes:

CEO_1	Understanding the overall concept of agro ecosystem and agro forestry to adopt sustainable agricultural practices.
CEO_2	Various types of agro forestry system practiced in our country in

	different agro ecological zone.
CEO_3	Understanding the technical aspect of agro forestry management.
CEO_4	Learning from case studies, how different approaches of agro forestry help in sustainable land development practices and support the income generation for the society.

Master of Natural Resource Management
(M.Sc. Programme)

NATURAL RESOURCE POLICY, GOVERNANCE AND LIVELIHOOD

Course Code: EMNRM 705 **L-04,** **Credits – 04,**

Course Objectives:

CO_1	What is the concept of natural resource governance system? How local institutions are traditionally managing natural resources at grass roots level.
CO_2	What are the important policy instruments available for natural resource management in India?
CO_3	How livelihoods and natural resources are complementary to each other? What is the contribution of non-timber forest products in rural economy?
CO_4	How various national and international stakeholders contributing for natural resource management?

UNIT-I **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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 **12 Hrs**

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

Suggested Readings and References:

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

Course Expected Outcomes:

CEO_1	This course will provide understanding of natural resource governance, characteristics of good governance and various strategies for managing natural resources.
CEO_2	Understanding of key policy provision for natural resource management through act, policy, notification and guidelines issued by state and central government.
CEO_3	How various stakeholders (government, civil societies, industries and international community) contribute for promotion of natural resource sustainability?
CEO_4	This course will provide understanding of natural resource governance, characteristics of good governance and various strategies for managing natural resources.

Master of Natural Resource Management
(M.Sc. Programme)

WILDLIFE MANAGEMENT

Course Code: EMNRM 707 **L-03,** **Credits – 03,**

Course Objectives:

CO_1	To understand the intricacies of wildlife conservation and management
CO_2	To empower the students as future conservation practitioners with thorough understanding of contemporary conservation issues.
CO_3	To make aware about various methods and methodologies of wildlife population monitoring
CO_4	Students will be taught to understand the behavioural ecology and theories to learn about unseen life of wild animals.

UNIT-I **6 Hrs**

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. Values and Ethics in Wildlife Conservation, Ecocentrism; Religious traditions and conservation

UNIT-II **16 Hrs**

Field ecology and methodology for wildlife monitoring:

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

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,

UNIT-III **8 Hrs**

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, Human-wildlife conflict, Poaching, Illegal trading, conflict management,

UNIT-IV **6 Hrs**

Wildlife Management

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

Suggested Readings and References

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.
3. Woodroffe R., Thirgood S. and Rabinowitz A. (2005). People and Wildlife, Conflict or Co-existence? (Conservation Biology) Cambridge University.
4. Caughley, G. (1977). Analysis of vertebrate populations. John Wiley and Sons, New York.
5. Caughley G. and Sinclair A.R.E. (Eds.) (1994) Wildlife Ecology and Management,Blackwell Science, Cambridge.
6. 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.

Course Expected Outcomes:

CEO_1	Student will learn various issues and dimensions of wildlife conservation.
CEO_2	They will be able to make judicious decision to wildlife management in human dominated landscape
CEO_3	Students will come out with better understanding of wildlife population monitoring programs.
CEO_4	They will be able to become a good field biologist with sound knowledge of various field methods.

Master of Natural Resource Management
(M.Sc. Programme)

PROJECT MANAGEMENT AND FINANCIAL ANALYSIS

Course Code: EMNRM 709 **L-03,** **Credits – 03,**

Course Objectives:

CO_1	The course aims at making the student understand the concept of project and its management with the help of various tools and techniques that are used in managing a business project from planning to control stage.
CO_2	The course gives insights into the process of Project Identification, Selection and Planning, Techniques of resource allocation, Project Presentation, Project risk analysis, Computation of project costs, production costs.
CO_3	The course aims at making the student comfortable with the concept of FM, IFM, TVM, Cost of capital, different types of Leverages, management of Long-term and short-term financial decisions.
CO_4	The course aims at acquainting the students with marketing, market, environment, market segmentation, value supply chain and other marketing related strategies.

Course Contents:

UNIT-I **9 Hrs**

Project Identification, Selection, Planning and Resource Allocation: Introduction, Project Identification Process, Project screening, Pre-Feasibility Study, Feasibility Studies and Reports (marketing, technical, financial, and risk analysis), Project Break-even point and its managerial implications. Introduction, Project Planning, Project Life Cycle, Project Planning Process. Resource Allocation, Project Scheduling/Network Techniques in Project Management, CPM and PERT Analysis. Microfinance and micro credit concept and their application in rural development and livelihood generation.

UNIT-II **9 Hrs**

Project Presentation, Risk Management, Project Costs and Finances: Socio-economic consideration in project formulation, social infrastructure projects for sustainable development,

investment opportunities, and presentation for decision making, capacity expansion, diversification. Types of Risks, Risk management, Role of Risk Management in Overall Project Management, Risk Identification, Risk Analysis, Risk reduction. Calculating project costs, production costs, break-even analysis, financing methods, tax aspects, role of the financial institution in project finance.

UNIT-III **9 Hrs**

Financial analysis: Basics of financial management and international financial management**,** time value of money, Long-term investment decisions, cost of capital, operating and financial leverages, capital structure, Short-term financial decisions including working capital management problems and receivables management, Financial and Economic appraisal.

UNIT-IV **9 Hrs**

Marketing Management: Basic concept of Marketing, Marketing Environmental Analysis, Customer Behaviour and competitor analysis, Market segmentation, Value supply chain analysis, Brand development and Competitive Marketing strategy with the help of Natural resource example.

Note: **Students are advised to undertake live projects for better understanding and clarity of the subject.**

Suggested Readings and References:

1. Bhavesh, M. Patel. (Latest Edition). Project Management: Strategic Financial Planning Evaluation and Control. Vikas Publishing.
2. Prasana Chandra, (Latest Edition). Projects: Planning, Analysis, Selection, Financing, Implementation, and Review : Theory and Practice. McGraw Hill.
3. Kotler Philip, Koshy Abraham, & Mithileswer Jha (Latest Edition), Marketing Management. Person Education.
4. Wysocki, R. K. (2011). Effective Project Management: Traditional, Agile, Extreme. Wiley International. 816 pp.
5. R.P. Rustagi, Fundamentals of Financial Management, Taxxmann (Latest Edition)
6. Choudhury, S. Project Management (Latest Edition),Tata Mc GrawHill.

Course Expected Outcomes:

CEO_1	After reading Unit-I of this course the student will be able to identify, screen, select, plan, do feasible studies and allocate resources to the best available project.
CEO_2	After reading Unit-II of this course the student will be able to make project presentation, do risk management, compute different types of costs and identify best available source of finance to make the project operational.

CEO_3	After reading Unit-III of this course the student will be able to identify financial analysis related problems with best available solution within the given limitations
CEO_4	After reading Unit-IV of this course the student will be able to understand the marketing concept, market environment and market related problems and their solutions within known parameters.

Master of Natural Resource Management
(M.Sc. Programme)

ENTREPRENEURIAL MINDSET (MANDATORY COURSE)

Course Code: USMS112 **L-02** **Credits – 02**

Course Objectives

CO_1	To provide a foundation for basic entrepreneurial skills and to acquaint them with the world of entrepreneurship and inspire them to set up and manage their businesses.
CO_2	To acquaint students with the process of creativity and innovation
CO_3	To expose students to various aspects of entrepreneurship and business
CO_4	To expose students to case studies on successful entrepreneurs

Unit I: **7hrs**

Introduction: The Entrepreneur; Theories of Entrepreneurship; Characteristics of successful entrepreneurs, myths of entrepreneurship; entrepreneurial mindset- creativity (steps to generate creative ideas, developing creativity) and innovation (types of innovation)

Unit II: **7 Hrs**

Promotion of a Venture and Writing a business plan: Opportunity Analysis; External Environment Analysis Economic, Social and Technological Analysis. Business plan- What is business plan, parts of a business plan. Writing a Business Plan

Unit III: **7 Hrs**

Entrepreneurship Support: Entrepreneurial Development Programmes (EDP): EDP, Role of Government in Organizing EDPs. Institutions supporting small business enterprises: central level, state level, other agencies, industry associations.

Unit IV

Practicals:

- Presenting a business plan
- Project on Startup India or any other government policy on entrepreneurship
- Discussion on why startup fails, role of MSME etc.
- Discussion on role of entrepreneur in economic growth.
- Discussion on technology park.
- Case study discussion on successful Indian entrepreneurs.

Suggested Readings:

1. Charantimath (8th Ed., 2014), Entrepreneurship Development and Small Business Enterprise, Pears Education.

2. Bamford C.E (1st Ed 2015), Entrepreneurship: A Small Business Approach, McGraw Hill Education.

3. Hisrich et al. (2013) Entrepreneurship, McGraw Hill Education

4. Balaraju, Theduri (2012), Entrepreneurship Development: An Analytical Study, Akansha Publishing House.

5. David, Otis, (2014), A Guide to Entrepreneurship, Jaico Books Publishing House, Delhi.

6. Kaulgud, Aruna, (2012), Entrepreneurship Management, Vikas Publishing House, Delhi.

7. Chhabra, T.N. (2014), Entrepreneurship Development, Sun India.

Course Expected Outcomes:

CEO_1	Students form a foundation for basic entrepreneurial skills
CEO_2	Students understand creativity and innovation for opportunity recognition
CEO_3	Students learn abo opportunity analysis and writing a business plan
CEO_4	Students are inspired by examples of successful entrepreneurs.

Master of Natural Resource Management
(M.Sc. Programme)

WATER QUALITY ANALYSIS LAB

Course Code: EMNRM 751 P-04, Credits – 02,

Course Objectives:

CO_1	The practical course is designed to impart basic knowledge about various physico chemical parameters of water.
CO_2	To aware the students about drinking water standards and the health impacts of contaminated water
CO_3	Enable students to learn about various instruments available in lab for water quality analysis.
CO_4	To provide hands on training of different instruments

Course contents **4 Hrs/Week**

LIST OF EXPERIMENTS

1. To determine the pH value of given water samples.
2. Determination of Acidity in given water samples.
3. Determination of Alkalinity of given water sample.
4. To determine hardness of given water sample.
5. Estimation of chlorides in water sample by Mohr's method.
6. To determine TSS, TDS and TS in given water sample.
7. To determine turbidity of given water sample.
8. Estimation of Sulphate in water sample by spectrophotometric method.
9. Estimation of Phosphate in water sample by spectrophotometric method.
10. Estimation of Fluoride in water sample by SPADNS method.
11. Determination of Dissolved Oxygen (DO) in waste water.
12. Determination of Chemical Oxygen Dem and (COD) of waste water.

Suggested Readings and References:

1. Garg S.K., (2019). Water Supply Engineering, 33rd ed., Vol.1, Khanna Publishers.
2. CPCB, Guide manual: water and wastewater analysis.
3. Fssai manual of methods of analysis of food, water, (2015). Ministry of Health and Family Welfare, GOI, New Delhi.
4. Trivedi, P.R., (2007). Environmental water and soil analysis, Akashdeep Publishing House.
5. Singh, D., Chhonkar, P.K., Dwivedi, B.S., (2005). Manual on soil plant and water analysis. Westville Publishing House.

6. APHA (2005), Standard Methods for the Examination of Water and Wastewater. 21st Edition, American Public Health Association.

Course Outcomes:

CO_1	The course will provide necessary information and knowledge about the various water quality parameters to check the current status of water resources.
CO_2	Students will be able to learn about types, sources and impacts of water pollutants
CO_3	Course will help them to learn about the analytical techniques and importance of water resources.
CO_4	Students will learn to perform on various instruments by their own to improve their skills.

Master of Natural Resource Management
(M.Sc. Programme)

INDUSTRY AND FIELD VISITS-REPORTS AND PRESENTATION

Course Code: EMNRM 753 **Credits – 01,**

Course Objectives:

CO_1	To facilitate students to get an exposure and experiences to the world of industry
CO_2	To interact and learn from professionals on practical aspects of natural resources management
CO_3	To gain practical knowledge on conservation and restoration of natural resources
CO_4	Find the opportunities for livelihood enhancement of the rural people.

At the end of first year students will have to go for two months summer internship in a reputed organization (such as Research/academic institutes, NGO's, international agencies, consultancy firms and industries) based on his/ her interest, which will expose them to the professional environment and also strengthen their research acumen.

In preparation, a range of skills required in common and emerging research practices and methods employed in natural resource management, related policy formulation and research will be utilized. Students will also be able to understand how an organization functions, its hierarchy and implementation of work.

All these components are evaluative and supervised by experienced faculty members; students can get firsthand practical knowledge through such activities; credit weightage is given in the scheme.
Industry visit increases a student's employability with our alumni at various government & non-government organisations, conservation projects, consultancy work.

Course Expected Outcomes:

CEO_1	Graduated students will be well equipped with practical

	approaches to solving the problems of natural resource management
CEO_2	Students are expected to be champions for rural communities in terms of creation of livelihood enhancement opportunities
CEO_3	The graduated students will be leaders in conservation and sustainable utilization of available natural resources
CEO_4	Students are expected to create linkages between local communities and government agencies on any policy frameworks related to natural resource management

Master of Natural Resource Management
(M.Sc. Programme)

SUMMER INTERNSHIP/TRAINING REPORT AND PRESENTATION

Course Code: EMNRM 755 **Credits – 03,**

Course Objectives:

CO_1	To provide extensive exposure to the students on practical training in a corporate/organizational setting
CO_2	To give them an opportunity to work in live projects with experts in the field.
CO_3	To learn field/lab based practical study guided by the organization on a given topic
CO_4	To provide students with an opportunity to apply knowledge and techniques learned during the course and get hands-on experience

Course contents:

The summer internship is an opportunity for the students to interact with the industry, reputed research/academic organizations and other universities working in natural resource management. They get an exposure to work in live projects and professional environment. Completing the summer internship is primarily student's responsibility. They should consult with supervisor and course coordinator, to make sure the goals considered are appropriate and feasible for summer training work. The student is expected to submit the internship report after the approval from supervisor and course coordinator. The students are expected to defend their summer internship in front of faculty members by making a power point presentation and submit a hard copy of the report.

Contents of Summer internship report:

1. The organization of the Final Report should be in sequence and it should help the reader to obtain a clear understanding of the detailed points presented in the report.
2. Topics within the report should be coherent, clear and concise. Discussions should be focused on work-oriented.
3. The report should be illustrated with appropriate tables, diagrams and graphs where necessary. Tables and graphs should be properly labeled.
4. Any facts and figures about the company where the internship was completed should be supported by references, internal company reports, etc.
5. The report should be within 40 pages.

6. The report should describe your work in your own words as plagiarism shall be checked.
7. The report should have a bibliography/references

Course Expected Outcomes:

CEO_1	Students have opportunity to apply acquired knowledge, gain experiences and formulate practical solutions.
CEO_2	In addition to learning the specialized skills of a particular field, skills such as communication, teamwork, and computer proficiency are also obtained in an internship, fully preparing interns to enter the workforce.
CEO_3	Taking on an internship allows students to work in their desired field, helping them decide if the field is right for them.
CEO_4	Internship should prove the ability of student to learn and work in an organization, understand and present specific information and to develop overall communication skills.

Master of Natural Resource Management
(M.Sc. Programme)

CLIMATE CHANGE MITIGATION & ADAPTATION

Course Code: EMOE 731 **L-04,** **Credits – 04,**
(Open-Elective)

Course Objectives:

CO_1	To introduce the concepts and science of climate change and its effects on various ecosystems.
CO_2	To introduce basics of climate models and to aware students about various techniques of carbon sequestration and management to overcome the problem of climate change.
CO_3	To impart knowledge about climate change & its impacts assessment and Indian response to various climate issues.
CO_4	To introduce and understand international protocols, treaties and conventions on climate change and Indian commitment for international agreements.

UNIT-I **12 Hrs**

Basic concepts and mechanisms: Define weather and climate**,** Science of climate change, global warming, radiative balance, energy budget, El-Nino and La Nina, greenhouse gases in the atmosphere – sources, levels and mechanisms of action. **Effects:** Rise in earth's temperature; effects on forests, agro-ecosystems; desertification, freshwater ecosystems, sea level rise; melting of polar ice and glaciers; rainfall patterns; extreme events, socio-economic and public health consequences, climate change effects on migration, impact of black carbon on climate and feedback mechanism.

UNIT-II **12 Hrs**

Climate Change Policy-Mitigation: Earth's carbon reservoirs and carbon cycle, Carbon storage and sequestration, carbon management through biotic sequestration-forests, wetlands; soil carbon sequestration oceanic and geologic injection, scrubbing and mineral carbonation; bio fuels, carbon farming and carbon trading.

UNIT-III **12 Hrs**

Climate Change Policy – Adaptation: Climate change impact assessment – applications for agriculture, vulnerability assessment; economics of adaptation, measurement of adaptation

cost; issues in financing adaptation; case studies; **Indian scenario**: Projected impact of climate change in India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change.

UNIT-IV **12 Hrs**

International response: Intergovernmental Panel for Climate Change (IPCC) and its role; United Nations Framework Convention on Climate Change (UNFCCC), CDM and Kyoto Protocol; Bali road map; The Copenhagen Accord; future actions; ethics of climate change, key aspects of Paris Agreement, India's actions vis-a-vis international programmes , National Determined Contribution (NDC) Targets of India for 2030.

Suggested Readings and References:

1. Dieter Helm (2020), Net Zero: how we stop causing climate change, William Collins publication.
2. Egbert Boeker and Rienk van Grondelle (2013). Environmental Science- Physical Principles and Applications, John Wiley & Sons, Ltd., New York
3. Akimasa Suni, Kensuke, F., and Ai, Hiramatsu.(2010). Adaptation and mitigation strategies for climate change. Springer.
4. Sushil Kumar. (2007). Climate change: An Indian perspective. Cambridge University Press India. New Delhi.
5. 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. Cambridge University Press, Cambridge, UK, 7- 22.
6. 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 Expected Outcomes:

CEO_1	Students will be able to learn and understand the concept of climate change and its impacts on various ecosystems.
CEO_2	Students will be able to get knowledge about various carbon sequestration techniques for better management of climate
CEO_3	Students will be able to learn about impacts related to climate change and Indian response to climate change
CEO_4	Students will be able to enhance their knowledge about international and national programmes and their importance in climate change.

Master of Natural Resource Management
(M.Sc. Programme)

DISASTER RISK REDUCTION AND MANAGEMENT

Course Code: EMOE 733 **L-04,** **Credits – 04,**
(Open-Elective)

Course Objectives:

CO_1	To provide a holistic knowledge about triggering of disaster, its vulnerability and risk assessment.
CO_2	To understand the disaster management cycle, damage assessment, recovery and reconstruction-before, during and after disaster.
CO_3	To understand the disaster risk reduction tools and capacity building to minimize the impact.
CO_4	To introduce and understand disaster management processes for Disaster Risk Reduction (DRR) in our country.

UNIT-I **12 Hrs**

Introduction: Concepts and definitions of hazard, disaster, vulnerability, resilience, and risks; Inter relationship between hazard, vulnerability and disaster risk, Factors affecting vulnerabilities, classification of disasters; brief introduction of Geological/Natural 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; Issues and Impact of Climate Change on disasters, Gender and social issues during disasters, Relevance of indigenous knowledge and appropriate technology.

UNIT-II **12Hrs**

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; case studies of risk management. Post-disaster Damage and Needs Assessment; Restoration of

Critical Infrastructure; Recovery and Reconstruction.

UNIT-III **12 Hrs**

Disaster Risk Reduction tools and capacity building: Prevention and Mitigation of Disasters, Early Warning System; Disaster Communication Systems (Early Warning and Its Dissemination); Preparedness, adaptive ecosystems management for disaster risk reduction; awareness during Disasters; Geoinformatics in Disaster Management (RS, GIS, GPS); Land Use Planning and Development; Disaster safe designs and constructions; Structural and Non Structural Mitigation of Disasters; 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, policies for disaster preparedness program, preparedness, planning roles and responsibilities.

UNIT-IV **12 Hrs**

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, State Disaster Response Force (SDRF), National Disaster Response Force (NDRF), Prime Minister National Relief Fund (PMNRF), Chief Minister Relief Fund and role, 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.

Case studies: Bhopal gas tragedy, Gujarat earthquake, Indian cyclones, Uttarakhand disasters, COVID – 19, Other major disasters of India. etc.

Suggested Readings and References:

1. Bimal Kanti 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.
3. Jack Pinkowski (Ed.) (2008). Disaster Management Handbook, CRC Press -Taylor & Francis Group, 595p.
4. Joseph F. Gustin (2010). Disaster & Recovery Planning: A Guide for Facility Managers, 5th Edition, Taylor &Francis., 436p.
5. Yacov Y. Haimes (2009). Risk Modeling, Assessment and Management, Third Edition, A John Wiley & Sons, Inc. Publication, 1033p.
6. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).

Course Expected Outcomes:

CEO_1	Students will be able to understand the fundamental causes, vulnerability and risk assessment and consequences of disasters.
CEO_2	Students will be able to get the knowledge about the utility and importance of disaster management cycle.
CEO_3	Students will be able to learn how capacity building and risk reduction tools are important in disaster management
CEO_4	Students will be able to understand about the significance of Disaster Risk Reduction and management (DRR), role of different Government institutions for the benefit of natural resource management and society.

Master of Natural Resource Management
(M.Sc. Programme)

URBAN BIODIVERSITY STRATEGIES FOR CONSERVATION

Course Code: EMOE 735 **L-04,** **Credits – 04,**
(Open-Elective)

Course Objectives:

CO_1	The students will be taught about how cities have evolved as a Novel Ecosystem and a human dominated Biome.
CO_2	They will get an insight about its biodiversity, species and communities and how are they different from wild counterparts.
CO_3	To apprise them of evolving strategies to conserve urban biodiversity
CO_4	They will learn the importance of urban biodiversity for the physical, mental and spiritual well being of human society.

Course Contents:

Unit I : **12 Hrs**

The Urban Ecosystem

Introduction to the Urban Ecosystem as a Novel Ecosystem in Anthropocene; Definition of Urban , Urbanization, Anthropocene ; Introduction to Urban Ecology; Global and Local Patterns of Urbanization :Exo-urbanization, Suburbanization, Disurbanization , Reurbanization, Slums, Shanty Towns; Causes of Urbanization; Urban climate; Heat Island Effect.

Unit II : **12 Hrs**

Urbanization, Anthromes and Biodiversity

Introduction of Cities as human biomes / Anthromes; Impacts of Urbanization on Biodiversity (positive,negative,extinction), , Biotic Homogenization and Differentiation; Biodiversity in urbanized areas:; Urban Species and Communities: Native Species , Non-native species Urbanophilics, Urbanophobics, Synanthropes, Archaetypes, Neotypes, Impacts of Non-native/invasive/exotic species ;Urban Ecosystem Services.

Unit III: **12 Hrs**

Biodiversity Conservation Strategies in Urban Areas

Urban planning and green infrastructure: Green roofs; Green spaces; Urban Parks , Gardens

and Landscaping; Living walls; Vertical Gardening ; Singapore/City Biodiversity Index, Biophilic Cities, Resilient Cities, Sustainable Cities ,Cities and Sustainable Development Goals; Green Delhi Movement in NCT of Delhi.

Unit IV: **12 Hrs**

Urban Biodiversity and Human Well Being

Urban Biodiversity for human health and well-being , Diseases in Urban Environment, Urban Biodiversity and Conservation Education; Conservation and Society, Motivations for Conserving Urban Biodiversity, Future Strategies for Urban Biodiversity, Cities and Convention on Biodiversity and Conservation; National Biodiversity Strategy and Action Plan, Local Biodiversity Strategy and Action Plan.

Suggested Readings and References:

1. Lugo A.E., Winchell K.M. and Carlo T.A. 2018. Novelty in Ecosystems. In: Dominick A., Della Sala, and Michael I. Goldstein (eds.) The Encyclopedia of the Anthropocene, vol. 3, Pp. 259-271. Oxford: Elsevier.
2. Hobbs, R. J., Higgs, E. S.and Hall,C. M.2013. Novel ecosystems: intervening in the new ecological world order. John Wiley & Sons, Chichester, UK.
3. Pickett, S.T.A. and J.M. Grove. 2009. Urban Ecosystems: What would Tansley Do? Urban Ecosystems 12: 1-8.
4. Gilbert OL. 1989. The Ecology of Urban Habitats. London: Chapman and Hall.
5. Ellis, E.C. 2013 Sustaining biodiversity and people in the world's anthropogenic biomes. *Current Opinion in Environmental Sustainability*, 5:368–372.
6. 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, UK.

Course Expected Outcomes:

CEO_1	The students would be able to understand how and why world is getting urbanized.
CEO_2	They will learn about the urban species and communities and their relationship with the human beings and how they have adapted different habitats within human dominated biomes.
CEO_3	They would be able to understand that in urban planning,environment, biodiversity and their conservation should be substantially incorporated for cities to be sustainable and biophilic.
CEO_4	They will become learned professionals to inculcate the need of nature, motivate and educate the urban Society for their well being.

Master of Natural Resource Management
(M.Sc. Programme)

HUMAN ASPECTS OF BIODIVERSITY AND ENVIRONMENT

Course Code: EMOE 737 **L-04,** **Credits – 04,**
(Open-Elective)

Course Contents:

CO_1	In the present era when we are witnessing global pandemic and moving towards 6th extinction, this course will provide an insight about various human dimensions of biodiversity and environment.
CO_2	To appreciate the existence of socio-cultural diversity and its role in biodiversity conservation.
CO_3	To bring awareness on various conservation related initiatives and polices being implemented by government and NGOs on local/national/international level.
CO_4	To arrive at conscious decision related to ethical issues related to use/treatment of bioresources.

Unit 1: **12 Hrs.**

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 2: **12 Hrs.**

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.). 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'.

Unit 3: **12 Hrs.**

Concepts and applications wrt 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 4: **12 Hrs.**

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.

Suggested Readings and References:

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.
3. Wood, P.M. 2000. Biodiversity and Democracy: Rethinking Society and Nature. University of British Columbia Press.
4. Groom, M.J., Meffe, G.R. and Carroll, C.R. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
5. Primack, R. 2006. Essentials of Conservation Biology. Sinauer Associates, Inc.

Course Expected Outcomes

CEO_1	To make conservation professionals informed citizens about various dimensions of human activities impacting biodiversity/ environment that will enable them to actively participate and contribute in various capacities to reduce/mitigate such impacts through direct participation in conservation related activities at grassroot level or policy making.
CEO_2	To address the linkages between environment, biodiversity and mankind for a healthy and sustainable local/ national/ global ecosystem that will make proper understanding of the gap areas where environmentalist/conservationist has to play a role and find/create job opportunity.

Master of Natural Resource Management
(M.Sc. Programme)

SUSTAINABLE ECOTOURISM

Course Code: EMOE 739 **L-04,** **Credits – 04,**
(Open-Elective)

Course Objectives:

CO_1	What is the concept and principle of ecotourism? Various ecological, economics and social dimension of ecotourism.
CO_2	How ecotourism is classified? What are the various policy and practices available to support ecotourism in India?
CO_3	How carrying capacity of destination is assessed?
CO_4	What are the global experiences of ecotourism from practicing world?

UNIT-I **12 Hrs**

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 **12 Hrs**

The ecotourism perspectives: High value may also be high impact, bulk ecotourism and problems, stakeholder challenges. Ecotourism Policy and practices, national policy frame work, 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 **12 Hrs**

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 **12 Hrs**

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.

Suggested Readings and References

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

Course Expected Outcomes:

CEO_1	Student will understand, what is ecotourism how it is different from mass-tourism?
CEO_2	What are the challenges in ecotourism implementation? Understanding the role of stakeholders in ecotourism.
CEO_3	How ecotourism practices help to improve biodiversity conservation and livelihood promotion for the society?
CEO_4	Understanding ecotourism implementation prospect through case studies from field.

FOURTH SEMESTER

Master of Natural Resource Management
(M.Sc. Programme)

SEMINAR AND PROGRESS REPORT

Course Code: EMNRM 702 **Credits – 04,**

Course Objectives:

CO_1	To give a seminar presentation of the dissertation synopsis/proposal which a student wants to pursue during the dissertation work.
CO_2	Seminar shall contain all components of the synopsis, a plan of work and month-wise activity schedule during the 6 month dissertation.
CO_3	Plan, and engage in, an independent and sustained critical investigation and evaluation of a chosen research topic relevant to environment and society
CO_4	Students will get an opportunity to present their mid-term progress and difficulties, if any.

Course Contents:

The dissertation is the final stage of the Masters degree and provides the opportunity to show that what student has gained the necessary skills and knowledge in order to organize and conduct a research project.
Seminar should demonstrate that students are skilled in identifying an area, or areas, suitable for research: setting research objectives; locating, organizing and critically analyzing the relevant secondary data and authoritative literature; devising an appropriate research methodology; and if appropriate making relevant recommendations and indications of areas for further research.
Students are expected to present their progress report through power point presentation

Course Expected Outcomes:

CEO_1	Student will develop their dissertation proposal and plan of work
CEO_2	Suggested changes in the dissertation proposal, if any; shall be incorporated
CEO_3	Students will gain understanding and clarity regarding the process of completing the dissertation

(M.Sc. Programme)

DISSERTATION

Course Code: EMNRM 704 **Credits – 22,**

Course Objectives:

CO_1	To enable you to develop research skills commensurate with the accomplishment of a master's degree
CO_2	To enable you to produce a coherent and logically argued piece of writing that demonstrates competence in research and the ability to operate independently
CO_3	To enable you to address issues of research design, methodology, ethics and theoretical arguments, and locate a piece of research within these
CO_4	To enable you to apply the knowledge about research design and methods that you have gained from the taught components to develop your dissertation project

Course Contents:

M.Sc. Dissertation aims to provide the students an opportunity to attain specialization in an area of study covered in the programme.
Student will select a dissertation topic of the project in consultation with their mentors and based on their elective specialization in the 2nd and 3rd Semester. In the 3rd Semester, students are expected to develop their dissertation synopsis/ proposal in discussion with their allotted internal dissertation guides.
Students will implement the project and submit M.Sc. dissertation in the Fourth semester. Final evaluation of the dissertation will be done through presentation and Viva-voce as per, examination rules.

- The dissertation presents a major piece of guided independent research on a topic agreed between the student and their internal and external supervisors.
- It typically involves a literature review and an appropriate form of critical analysis of sources of primary and /or secondary data; it may involve field and/or laboratory work.
- The dissertation shall have a proper structure- Abstract, Table of contents, Introduction, Objectives, Problem statement, Literature Review, Methodology, Results and Discussion, Conclusion and Reference.
- Plagiarism shall be checked, refrain from copying. The sources of articles to be reviewed should be peer-reviewed journal articles and books; and properly referenced throughout the contents of dissertation. References should be in APA/Harvard format.
- The assessment shall be based on criteria – viz. contents and clarity in dissertation, presentation, adherence to the deadline, plagiarism report.
- The dissertation shall be submitted through a softcopy and a hard copy to the dean office through approval of internal dissertation supervisor.
- The students have to duly document their research and also aim for publications.

- The dissertation needs to be duly signed by the internal and external supervisor before submitting the thesis for final examination.
- Students are expected to defend their thesis in front of external examiner and internal examiner and faculty members, via presentation and viva-voce.

Course Expected Outcomes:

CEO_1	Student will be able to produce a dissertation thesis following the prescribed format given by the university
CEO_2	To systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions
CEO_3	To engage in critical review of appropriate and relevant literature and theories.
CEO_4	To appropriately apply qualitative and/or quantitative evaluation processes to original data