Department of Environmental Biology and Wildlife Sciences
Panbazar, Guwahati- 781001, Assam, India

Postgraduate Syllabus
For
M. Sc. in Environmental Biology and Wildlife Sciences

2022

1. Introduction/Preamble

The Stockholm Conference in 1972 pioneered to strive towards protecting the environment from degradation. India realized the international commitment and made important amendments in the Constitution of India to accommodate environmental responsibilities and duties - the inclusion of Article 48A and 51A(g). With rapid urbanization, industrialization and conversion of wildlife habitats for other land use, the environmental concerns has grown in the recent decades. It is now apparent that interventions are needed to understand the environmental effects of pollution, biodiversity loss, climate change and its impacts on the hydrological regime and consequently on the biodiversity, agriculture, livelihood, and the economy. Thus, environmental education has become pertinent in the national and global context. The M.Sc. in Environmental Biology and Wildlife Science programme envisages to address the need for creating skilled manpower to engage with the environmental issues at all scales. The interdisciplinary approach of the discipline is reflected in the curriculum and research and learning have been kept at the core of the program. The programme strives to address regional environmental and conservation issues with a goal to contribute towards global solutions.

1.1 Objectives of the programme

- The prime objective of the programme is to scientifically understand contemporary environmental and conservation issues and explore possible strategies to prevent and mitigate them.
- It aims to produce skilled and employable human resources in the field of Environment, Wildlife and allied disciplines.
- This programme envisaged to develop manpower for promoting environmental R&D, awareness, academia, industry and policy.

1.2 Learning Outcomes-based Approach to Curriculum Planning and Development

The basic objective of the learning outcome-based approach to curriculum planning and development is to focus on demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of

graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study.

The expected learning outcomes are used to set the benchmark to formulate the course outcomes, programme specific outcomes, programme outcomes and graduate attributes. These outcomes are essential for curriculum planning and development, and in the design, delivery and review of academic programmes. They provide general direction and guidance to the teaching-learning process and assessment of student learning levels under a specific programme.

The overall objectives of the learning outcomes-based curriculum framework are to:

- help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;
- enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values) or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study;
- maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility; and
- provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

1.3 Key outcomes underpinning curriculum planning and development

The learning outcomes-based curriculum framework is a framework based on the expected learning outcomes and academic standards that are expected to be attained by graduates of a programme of study. The key outcomes that underpin curriculum planning and development

include Graduate Attributes, Programme Outcomes, Programme Specific Outcomes, and Course Outcomes.

1.3.1 Graduate Attributes

The disciplinary expertise or technical knowledge that has formed the core of the university courses. They are qualities that also prepare graduates as agents for social good in future. Some of the characteristic attributes that a graduate should demonstrate are as follows:

1. **Disciplinary knowledge**: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines
2. **Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating
3. **Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others
4. **Critical thinking**: Capability to apply analytic thought to a body of knowledge
5. **Problem solving**: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems
6. **Communication Skills**: Ability to express thoughts and ideas effectively in writing and orally
7. **Information/digital literacy**: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
8. **Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
9. **Cooperation/Team work**: Ability to work effectively and respectfully with diverse teams
10. **Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective
11. **Reflective thinking**: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

12. **Multicultural competence**: Possess knowledge of the values and beliefs of multiple cultures and a global perspective
13. **Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work
14. **Leadership readiness/qualities**: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
15. **Lifelong learning**: Ability to acquire knowledge and skills, including 'learning how to learn', that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

1.3.2 Programme Outcomes (POs) for Postgraduate programme

1. **In depth knowledge**: Acquire a systematic, extensive and coherent knowledge and understanding to their academic discipline as a whole and its applications, and links to related disciplinary areas/subjects of study; demonstrate critical understanding of the latest developments in the subject, and an ability to use established techniques of analysis and enquiry within the subject domain.
2. **Understanding Theories**: Apply, assess and debate the major schools of thought and theories, principles and concepts, and of a number of advanced and emerging issues in the academic discipline.
3. **Analytical and critical thinking**: Demonstrate independent learning, analytical and critical thinking of a wide range of ideas and complex problems and issues.
4. **Critical assessment**: Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.
5. **Research and Innovation**: Demonstrate comprehensive knowledge about current research and innovation; and to acquire techniques and skills required for identifying

problems and issues to produce a well-researched written work that engages with various sources employing a range of disciplinary techniques and scientific methods applicable.

6. **Interdisciplinary Perspective:** Commitment to intellectual openness and developing understanding beyond subject domains; answering questions, solving problems and addressing contemporary social issues by synthesizing knowledge from multiple disciplines.
7. **Communication Competence:** Demonstrate effective oral and written communicative skills to covey disciplinary knowledge and to communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study
8. **Career development**: Demonstrate subject-related knowledge and skills that are relevant to academic, professional, soft skills and employability required for higher education and placements.
9. **Team work**: Work in teams with enhanced inter-personal skills and leadership qualities.
10. **Commitment to the society and to the Nation:**Recognise the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

1.3.3 Program Specific Outcomes (PSOs) in Environmental Biology and Wildlife Sciences

Programme specific outcomes include subject-specific skills and generic skills, includingtransferable global skills and competencies, the achievement of which the students of aspecific programme of study should be able to demonstrate for the award of the degree. Theprogramme specific outcomes would also focus on knowledge and skills that prepare studentsfor further study, employment, and citizenship. They help ensure comparability of learninglevels and academic standards across universities and provide a broad picture of the level ofcompetence of graduates of a given programme of study. The attainment of PSOs for aprogramme is computed by accumulating PSO attainment in all the courses comprising theprogramme.

1. Basic concept: Ability to interpret and analyze various concepts and theories of Environmental and Wildlife Sciences.

2. Human-environmental relationship: Ability to understand and analyse the anthropogenic influence on the natural environment and the effect of environmental degradation on biological and physical systems.

3. Environmental Management: Ability to apply the knowledge for designing effective measures for addressing contemporary environmental issues.

4. Tools and techniques: To Understand, apply and analyse concepts and principles of Geospatial tools, statistical techniques and instrumentation for addressing environmental and conservation issues and natural resource management.

5. Field knowledge and case study: Conducting field works to understand the relationship between physical and biological components of the environment, spatial patterns and processes. Application of case study-based analysis to identify solutions to various environmental issues.

6. Applied dimension: Identification of the critical problems of the environment for various applications and decision making including Pollution abatement, Wildlife conservation, Resource management, Waste management, Disaster mitigation, Land Use Planning, Forest and biodiversity management, Sustainable agriculture together with Climate Change Mitigation and Adaptation etc.

7. Research and Innovation: Ability to apply scientific knowledge and experimental skill-based environmental strategies and techniques to address the environmental and wildlife problems and for sustainable development at local, regional, or global level.

8. Public Policy: Understand existing global and national policies and apply and evaluate them in a specific study context. Develop a sense of responsibility to safeguard the natural resources and biodiversity of the region as a constitutional duty.

9. Critical thinking: Able to develop critical thinking and problem-solving skills to carry out interdisciplinary research and continue learning.

10. Communication Skill: Communicate scientific data and concepts effectively using oral, written, and graphical forms and disseminate the knowledge in formal or informal settings.

3.4 Course Level Learning Outcome Matrix

1.3.4.1 Course Outcomes (COs) and Programme Outcomes (POs) matrix for Core Courses

Programme Outcomes (POs)	701	702	703	704	705	801	802	803	804	805	901	902	903	1001	1004
1. In-depth knowledge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Specialised knowledge and skills	✓		✓		✓	✓	✓			✓	✓	✓		✓	✓
3. Analytical and critical thinking	✓		✓		✓	✓	✓	✓		✓	✓	✓		✓	✓
4. Research and Innovation											✓				✓
5. Interdisciplinary Perspective	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6. Communication Competence															✓
7. Career development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8. Teamwork					✓					✓	✓	✓			✓
9. Commitment to the society and the Nation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Course Outcomes (COs) and Programme Outcomes (POs) matrix for Special Courses

Programme Outcomes (POs)	806	904SP1	904SP2	905OE1	1002SP1	1002SP2	1003OE2
1. In-depth knowledge	✓	✓	✓	✓	✓	✓	✓
2. Specialised knowledge and skills	✓	✓	✓		✓	✓	
3. Analytical and critical thinking	✓	✓	✓	✓	✓	✓	✓
4. Research and Innovation			✓		✓	✓	
5. Interdisciplinary Perspective	✓	✓	✓	✓	✓	✓	✓
6. Communication Competence	✓						✓
7. Career development	✓	✓	✓	✓	✓	✓	✓
8. Teamwork			✓			✓	
9. Commitment to the society and the Nation	✓	✓	✓	✓	✓	✓	✓

1.3.4.2 Course Outcomes (COs) and Programme Learning/Specific Outcomes (PSOs) matrix for Core Course

Programme Outcomes (POs)	701	702	703	704	705	801	802	803	804	805	901	902	903	1001	1004
1. Basic Concepts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Human-environmental relationship	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Environmental Management				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Tools and techniques	✓		✓		✓	✓	✓			✓	✓	✓		✓	✓
5. Field knowledge and case study	✓				✓	✓	✓	✓		✓	✓	✓			✓
6. Applied dimension	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7. Research and Innovation				✓				✓	✓		✓				✓
8. Public Policy	✓	✓		✓		✓	✓	✓			✓		✓	✓	✓
9. Critical thinking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10. Communication Skill															✓

Course Outcomes (COs) and Programme Learning/Specific Outcomes (PSOs) matrix for Special Course

Programme Outcomes (POs)	806	904SP1	904SP2	905OE1	1002SP1	1002SP2	1003OE2
1. Basic Concepts	✓	✓	✓	✓	✓	✓	✓
2. Human-environmental relationship		✓	✓	✓	✓		
3. Environmental Management		✓	✓	✓	✓	✓	
4. Tools and techniques	✓		✓		✓	✓	
5. Field knowledge and case study		✓	✓		✓	✓	
6. Applied dimension	✓	✓	✓	✓	✓	✓	✓
7. Research and Innovation		✓	✓		✓	✓	✓
8. Public Policy	✓	✓		✓	✓		✓
9. Critical thinking	✓	✓	✓	✓	✓	✓	✓
10. Communication Skill	✓						✓

1.4 Teaching-learning process

The department of Environmental Biology and Wildlife Sciences, Cotton University has student-centric teaching-learning pedagogies to enhance the learning experiences of the students. All classroom lectures are interactive in nature, allowing the students to have meaningful discussions and question and answer sessions. Apart from the physical classes, lectures are also held in online mode where students can have doubt clearing and discussions with the teachers. Most of the teachers use ICT facilities with power-point presentations, e-learning platforms and other innovative e-content platforms for student-centric learning methods.

The Department has adopted participative teaching-learning practices, which includes seminars, presentations and group discussions. These participative teaching-learning practices are included in the curricula of almost all the courses. Apart from these, field visits, special lectures by invited experts, workshops, and National/International seminars are held to augment knowledge, encourage innovative ideas and expose the students to global academic and research advancement.

The dissertation projects, research projects, assignments and field works, which are the integral components of all the courses, enable the students to solve practical problems. Students are also being engaged in sample surveys, data collection and analysis works of the in-house and external research projects for acquiring experiential learning. The laboratories of the department offer hands-on learning experiences to the students.

1.5 Assessment methods

A variety of assessment methods that are appropriate to the discipline are used to assess progress towards the course/programme learning outcomes. Priority is accorded to formative assessment. Progress towards achievement of learning outcomes is assessed using the following: closed-book examinations; problem based assignments; practical assignment; laboratory reports; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva voce interviews; computerized testing and any other pedagogic approaches as per the context.

PART II

Structure of Post-Graduate programme in Environmental Biology and Wildlife Sciences

I. Outline of the courses under Choice Based CreditSystem:

The Postgraduate programmes consist of four semesters with minimum credits requiredfor the complete programme being 84.

Each course in a programme will be from one of the following categories:

1. **Core Course (Core)**: A course that should compulsorily be studied by a candidate as a core requirement is termed a Core Course. Each core course is of 4credits.

2. **Lab Course (LAB)**: A Lab (Laboratory) course is a compulsory course in the first two semesters of the M.Sc. programme where the major part of the study involves laboratory work. Each Lab course is of 4credits.

3. **Elective Course**: A course that can be chosen from a pool of courses and which may extend the discipline/subject of study or provides exposure to some other discipline/subject or which enhances the student's proficiency or skill is termed an Electivecourse.

   (i) **Special Paper (SPL)**: A course within the parent department that will lead tospecialized knowledge and expertise. Each SPL course is of 5credits.

   (ii) **Open Elective (OPE)**: An elective course offered under the main discipline/subject of study is an Open Elective and may be offered to students of other disciplines. A student from a given discipline will be eligible to take one open elective inthethirdsemesterandoneinthefourthsemester.EachOPEcourseisof4credits.

   (iii) **Skill Enhancement Course (SEC):** These courses may be chosen from a pool of courses designed to provide skill-based knowledge and should ideally contain both theory and lab/hands-on/training/fieldwork. The primary purpose is to provide

students with lifeskillsin hands-on mode to increase their employability. Each SEC course is of 2credits.

4. **Practical/Tutorials**: A practical or tutorial component (or both) is to be provided with every core and special paper/open electivepaper.

5. **Dissertation/Project Work (DPW)**: A course designed for students to acquire special/ advanced knowledge that they study on their own with advisory support by a teacher/faculty member is a dissertation/project work. A DPW course is of 6credits.

- The credits for a course will be of the structure L+T+P, where L, T and P stand for lecture, tutorial and practicalrespectively.
- Each 4 credit course with practical is of the pattern 3+0+1=4 and for a 4 credit course without practical, the pattern is3+1+0=4.
- For the 5 credit courses with practical the credit division will be either 3+0+2=5 or3+1+1=5 and will be decided by the department offering that course. For a course without practical, the structure will be4+1+0=5.
- The credit division for the Lab course of 4 credits will be 0+0+4=4. For certain disciplines, the 4 credits may be divided between fieldwork andlaboratory.
- Each Open Elective OPE course will be open to students from other disciplines subjectto requirements of previous knowledge required to take thatcourse.
- A student may choose an OPE course from his/her own discipline or any other discipline.The decision of whether an OPE course may be offered to students of other departmentsas well as students of the parent department will be taken by the department and the coursedesignedaccordingly.
- For the purpose of computation of workload, the mechanism adoptedwill be:

1 credit = 1 theory period of 1 hour duration per week.
1credit=1tutorialperiodof1hourdurationperweek.
1 credit = 1 practical period of 2 hours duration per week.

II. Distribution of Courses andCredits

Postgraduate Programme (Science)

A student in the M.Sc. programme will take the following minimum number of courses in different categories of courses:

Table 1: Credit distribution for courses: M.Sc.

Category	Number of courses	Credits for each course	Total Credits
Core	12	4	48
LAB	2	4	8
SEC	2	2	4
SPL	2	5	10
OPE	2	4	8
DPW	1	6	6
			84

The distribution of credits and courses in each of the four semesters for the M.Sc. programme will be according to the following scheme:

Sem	Core	LAB	SEC	SPL	OPE	DPW	Credit
I	C1(4) C2(4) C3(4) C4(4)	LAB1(4)	SEC1(2)				22
II	C5(4) C6(4) C7(4) C8(4)	LAB2(4)	SEC2(2)				22
III	C9(4) C10(4) C11(4)			SPL1(5)	OPE1(4)		21
IV	C12(4)			SPL2(5)	OPE2(4)	DPW(6)	19
Credit	48	8	4	10	8	6	84

III. Course code and Title along with credits detail

Semester	Paper Code	Paper Name	Credit (L+T+P)
I	EWS701C	Natural History, Evolution and Biogeography	4 (3+1+0)
	EWS702C	Ecology and Behaviour	4 (3+1+0)
	EWS703C	Environmental Chemistry and Pollution	4 (4+0+0)
	EWS704C	Climatology and Climate Change	4 (3+1+0)
	EWS705L	Ecological Field Work and Practical-I	4 (0+0+4)
	-------706S	SEC-1 (offered by other department)	2
II	EWS801C	Wildlife Biology	4 (3+1+0)
	EWS802C	Habitat Ecology	4 (3+1+0)
	EWS803C	Pollution Control and Waste Management	4 (4+0+0)
	EWS804C	Environmental Stress Biology	4 (3+1+0)
	EWS805L	Ecological Field Work and Practical-II	4 (0+0+4)
	EWS806S	SEC-2 (Science Management, Communication and Writing Skills)	2 (1+1+0)
III	EWS901C	Conservation Biology and Wildlife Management	4 (3+0+1)
	EWS902C	Environmental Microbiology and Biotechnology	4 (3+0+1)
	EWS903C	Environmental Toxicology and Risk Assessment	4 (4+0+0)
	EWS904SP1	Earth System Science	5 (4+1+0)
	EWS904SP2	Quantitative Ecology	5 (4+1+0)
	EWS905OE1	Global and Regional Environmental Issues	4 (3+1+0)
IV	EWS1001C	Ecology and Society	4 (3+0+1)
	EWS1002SP1	Soil, Agriculture and Environment	5 (4+1+0)
	EWS1002SP2	Remote Sensing and GIS	5 (4+1+0)
	EWS1003OE2	Fundamentals of Research	4 (3+1+0)
	EWS1004DPW	Dissertation/Project Work	6
		TOTAL CREDITS TO BE FULFILLED	84

- **Paper Categories:** C=Core; L=Lab; S=Skill Enhancement Course (SEC); SP=Special Paper; OE=Open Elective; DPW=Dissertation/Project Work
- **Credit distribution format:** Lecture + Tutorial + Practical (L+T+P)
- In Semesters I and II, the students will opt for an SEC paper from the pool of such papers floated by the University
- In semesters III and IV, the students will opt for any one of the special papers (SP1, SP2,.....etc.) offered by the department

SEMESTER – I

PAPER: **EWS701C**

NATURAL HISTORY, EVOLUTION AND BIOGEOGRAPHY

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Understanding** the patterns of the global distribution of animals and plants and the processes that shape them.

CO2: **Understanding** the core concepts of evolutionary biology underpinning ecology and conservation science.

CO3Analyze the natural history to **understand** the core concept of ecology, evolution and conservation biology.

CO4:Analyze the concept of probability to **understanding** ecological patterns

Unit 1: Art and Science of Natural History (10 lectures)

What is natural history and why it is important; a history of natural history; the skill of observation, illustrations, taking field notes and journal writing; natural history of Guwahati city; natural history collections; basic principles and concepts in systematics and taxonomy

Unit 2: An introduction to evolution (10 lectures)

An introduction to evolutionary biology; the trees of life; natural selection and adaption;mechanism of evolution: mutation and variation, the genetical theory of natural selection, phenotypic evolution, genetic drift, evolution in space, species and speciation; products of evolution; macroevolution and the history of life; evolution and society

Unit 3: **Biogeography (10 lectures)**

The history of biogeography; patterns of distribution; patterns of biodiversity; plate tectonics; island biogeography; dispersal, vicariance and endemism; ice and change; conservation biogeography; biogeographical realms, provinces and ecoregions; the biogeographic affinities of the fauna and flora of the Indian sub-continent; India's biogeographic classification

Unit 4: Plant-animal Interaction (8 lectures)

Species interactions and the evolution of biodiversity; the history of associations between plants and animals; plant insect interactions in terrestrial ecosystems; mammalian herbivory in terrestrial environments; pollination by animals; seed dispersal by vertebrates, ant-plant interaction; anthropogenic impacts on plant-animal interactions

Unit 5: Basics of Statistics (10 lectures)

Statistics and samples; displaying data; describing data; estimating with uncertainty; probability; hypothesis testing; analysing proportions; fitting probability models to frequency data; contingency analysis: associations between categorical variables.

Suggested Readings

1. Anderson JGT (2013). *Deep Things out of Darkness: A History of Natural History.* University of California Press, California, USA
2. Futuyma D and Kirkpatrick M (2017). *Evolution (4th Edition).* Sinauer Associates, Inc, Sunderland, Massachusetts USA
3. Cox CB, Moore PD and Ladle RJ (2016). *Biogeography: An ecological and evolutionary approach (9th edition).* Wiley Blackwell
4. Mani MS (1974). *Ecology and Biogeography in India*. Springer Netherlands
5. Herrera CM and Pellmyr O (2002). *Plant-Animal Interactions: An Evolutionary Approach*. Wiley-Blackwell
6. Whitlock MC and Schluter D (2015). *The Analysis of Biological Data*. Roberts and Company Publishers

SEMESTER – I

PAPER: **EWS702C**

ECOLOGY AND BEHAVIOUR

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Understanding** animal behavioural from an evolutionary perspective.

CO2: **Understand** the hierarchy of the ecological organisation and the key population, community, and ecosystem theories.

CO3: **Analyze** whether there are general laws in ecology and how ecological science is a unique subject among natural sciences.

CO4: **Illustrate** the historical perspective of studying ecology and analyze of the roots of ecology

Unit 1: An Introduction to Ecology (6 lectures)

An introduction to ecology; history of ecology; laws, theories, and patterns in ecology

Unit 2: Population Ecology (12 lectures)

Properties of populations; exponential and logistic growth models; age-structured population growth; metapopulation dynamics; competition, predation

Unit 3: Community Ecology (12 lectures)

History of community ecology; patterns of biological diversity; the commonness and rarity of species; biodiversity and ecosystem functioning; fundamentals of predator-prey interactions; interspecific competition: simple theory; beneficial interactions in communities: mutualism and facilitation; species interactions in ecological network; food chains and food webs: controlling factors and cascading effects; metacommunity and neutral theory; species co-existence in variable environments; evolutionary community ecology; diversity and stability debate

Unit 4: Ecosystem Ecology (6 lectures)

History of ecosystem ecology; energy in the ecosystem, pathways of elements in ecosystems, nutrient regeneration in terrestrial and aquatic ecosystems

Unit 5: Behavioural Ecology (12 lectures)

Introduction to animal behaviour; genes, environments and learning; finding food and avoiding predators; communications, sexual selection and sperm competition; mating system and sex allocation; parental care and conflict; social behaviour

Suggested Readings

1. Ghazoul J (2020). *Ecology: A very short Introduction*. Oxford University Press, UK
2. Dodds W (2009). *Laws, theories and patterns in ecology*. University of California Press.
3. Gotelli NJ (2008). *A primer of ecology (4th edition).* Oxford University Press, USA
4. Mittelback (2012). *Community Ecology (1st Edition)*. Sinauer Associates, Inc
5. Raffaelli DG and Frid CLJ (ed) (2010). *Ecosystem Ecology: A New Synthesis*. Cambridge University Press
6. Ricklefs RE (2008). *The Economy of Nature.* W H Freeman and Company, USA
7. Davies NB, Krebs JR and West SA (2012). *An Introduction to Behavioural Ecology (4th Edition)*. Wiley-Blackwell

SEMESTER-I

PAPER: **EWS703C**

ENVIRONMENTAL CHEMISTRY AND POLLUTION

CREDITS: 4 (4+0+0)

Course outcomes:

CO1: **Understand** the concept of environmental chemistry and ability to explain various aspects of water, soil and air quality

CO2: **Ability** to identify the type, sources and effects of water, soil and air pollutants

CO3: **Ability** to recognize and appraise the intensity of environmental pollution problem

Unit 1: Introduction to Environmental Chemistry (16 lectures)

Scope and importance of environmental chemistry; acid base reactions; pH and pOH; solutions; solubility and solubility product; chemical equilibrium; laws of thermodynamics; redox reaction; concept of green chemistry; instrumentation for environmental analysis

Unit 2: Aquatic Chemistry and Pollution (16 lectures)

Characteristics of water; water quality parameters and their significance; water quality criteria and standards; distribution of chemical species in water; concept of oxygen demand; solubility of gases in water; carbonate system; types and sources of water pollution; effects of water pollution; arsenic and fluoride contamination in groundwater of northeast and other parts of India

Unit 3: Soil Chemistry and Pollution (16 lectures)

Weathering of rocks and soil formation; physical, chemical and biological properties of soil; macro and micronutrients; sources of soil pollution: agrochemicals, industries and urban discharges; radioactive pollution; land degradation; effects of soil pollutants

Unit 4: Atmospheric Chemistry and Air Pollution (16 lectures)

Chemical composition of atmosphere-particles; ions and radicals; ozone layer depletion; types, properties, sources of air pollutants; effects of air pollution; acid rain; indoor air pollution; air quality indices; smog; PAN (Peroxy-Acyl-Nitrate); acid rain; dispersion of air pollutants

Suggested Readings

1. Manahan SE (2001).*Fundamentals of Environmental Chemistry (2nd Edition*).CRC Press, Inc., USA
2. Sawyer CN, McCarty PL, Parkin GF (2003). *Chemistry for Environmental Science and Engineering*,Tata-McGraw-Hill Edition
3. De AK (2000).*Environmental Chemistry (4th Edition)*.New Age International (P) Ltd., New Delhi, India
4. Skoog DA, Holler FJ, Crouch SR (2006).*Principles of Instrumental Analysis*, 6th Edition, Thomson

5. Gilbert M (2008). *Introduction to Environmental Engineering and Science*, Pearson Education

SEMESTER-I

PAPER: **EWS704C**

CLIMATOLOGY AND CLIMATE CHANGE

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Understanding** of the atmosphere and climate as integral part of the physical environment.
CO2: **Analyze and evaluate** the interaction between earth and atmosphere system and use meteorological knowledge in the matrices of environmental research.
CO3: **Understand and compare** of Earth's past, present, and future climates and exploring the underlying causes of climate change.
CO4:Analyze and evaluate the impacts of climate change on natural and human systems.

Unit 1: Earth's Atmosphere (10 lectures)

An introduction to Earth's atmosphere, composition of the atmosphere, permanent and variable gases; Origin and evolution of the earth's atmosphere; Vertical structure of the atmosphere on the basis of composition, temperature profile; Atmospheric humidity and clouds, expression of humidity, concept of pressure and density; Concept of cloud formation, cloud condensation nuclei and its importance, cloud classification

Unit 2: Movement of Air (10 lectures)

Earth's radiation balance and albedo; Forces acting on horizontal movement of air; Local wind systems- thermal circulation, sea and land breezes, monsoon, mountain and valley breezes, katabatic wind, chinook winds, Santa Ana wind, *El-Nino*, *La-Nina*, ENSO; General circulation of the atmosphere; Air masses and source regions; Fronts and weather systems

Unit 3: Climate change and its causes (08 lectures)

History of the Earth's climate; paleoclimatology; natural and anthropogenic causes of climate change; greenhouse gases-sources and sinks; greenhouse gas emissions from economic sectors; global warming potential, radiative forcing and climate feedback loops; future climate scenarios

Unit 4: Impacts of climate change (10 lectures)

Changes in atmospheric and oceanic circulation; polar ice melting and glacier retreat; sea level rise; impact on water resources including freshwater and marine ecosystems; impact on land resources and terrestrial ecosystems; impact on biodiversity with special reference to northeast India; impact on ecosystem goods and services; impact on global food security; impact on human health

Unit 5: Adaptation and Mitigation (10 lectures)

Difference between adaptation and mitigation approaches; natural resource management for climate resilience; energy conservation and efficiency; disaster management; agricultural management; geo-engineering; carbon sequestration; carbon trading; organizations and policies dealing with climate change

Suggested Readings

1. Ahrens CD and Henson R (2018).*Meteorology Today* (latest edition), Brooks Cole, U.S.A.
2. Rafferty JP (ed) (2011). *Climate and Climate Change (The living Earth)*, Britannica Educational Publishing, New York
3. Eggleton T (2013). *A Short Introduction to Climate Change*. Cambridge University Press, New York
4. Wredford et al (2010). *Climate Change and Agriculture: Impacts, Adaptation and Mitigation,* OECD Publications
5. Lobell D and Burke M (eds) (2010). *Climate Change and Food Security: Adapting Agriculture to a Warmer World*. Springer
6. Ringler et al (eds) (2010). *Global Change: Impacts on Water and Food Security*. Springer

7. Jeffries MA (2006). *Biodiversity and Conservation (2nd Edition)*. Routledge (Taylor and Francis Group), London and New York
8. Sumi et al (eds) (2010). *Adaptation and Mitigation Strategies for Climate Change*. Springer

SEMESTER – I

PAPER: **EWS705L**

ECOLOGICAL FIELDWORK AND PRACTICAL - I

CREDITS: 4 (0+0+4)

Course Outcomes:

CO1: **Understanding** the role of long-term field observations

CO2: **Illustrate** various ecological techniques and natural history observations.

CO3: **Designing** field studies in ecology and **formulating** hypotheses to test them.

CO4: **Demonstrate** key practical skills in working with air, soil, and water quality parameters and ability to do environmental analysis

Unit 1: Fieldwork 1 - Orientation to Field Biology and Natural History

Use of basic field equipment: compass, binoculars, GPS, range finder, spherical densiometer, camera trap, altimeter.

Unit 2: Field work 2 - Technique Tour

Behavioural sampling; animal and vegetation sampling

Unit 3: Hands-on Practical

The measurement of biodiversity: estimating species richness, estimating species diversity and evenness; detecting populations and estimating their size: distance sampling, occupancy, mark-recapture

Unit 4: Long-term observation

Select two tree species in the University campus and document its natural history and phenology observe its phenology weekly for six months.

Unit 5: Mini project

The student needs to ask an ecological question, design a study to answer it, collect and analyse data, write it in the form of a manuscript and present it.

Unit 6: Practicals on Environmental Chemistry and Pollution

1. Estimation of pH and conductivity of water
2. Estimation of total dissolved solids in water samples
3. Analysis of turbidity in water samples
4. Estimation of alkalinity, hardness and chloride in water samples
5. Estimation of sulphate and fluoride in water samples
6. Estimation of biological oxygen demand and chemical oxygen demand in water samples
7. Analysis of soil pH and conductivity
8. Analysis of soil organic carbon and macronutrients
9. Gaseous and particulate matter sampling and analysis

Suggested Readings

1. Bruaude S and Low BS (eds) (2010). *An Introduction to Methods and Models in Ecology, Evolution and Conservation Biology*. Princeton University Press
2. Handerson PA (2003). *Practical Methods in Ecology*. Blackwell Publishing
3. Southwood TRE and Henderson PA (2000). *Ecological Methods (3rd Edition)*. Blackwell Science
4. Krebs CJ (1999). *Ecological Methodology (2nd Edition)*. Addison-Wesley Educational Publishers, Inc.
5. Manahan SE (2001). *Fundamentals of Environmental Chemistry(2nd Edition)*. CRC Press, Inc., USA
6. Sawyer CN, McCarty PL and Parkin GF (2003). *Chemistry for Environmental Science and Engineering*. Tata-McGraw-Hill Edition
7. Clesceri LS (1998). *American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater Analysis (20th Edition).*American Public Health Association, Washington, DC

SEMESTER – I

PAPER: **.....706S**

SEC - I

CREDITS: 2

(OFFERED BY OTHER DEPARTMENT)

SEMESTER – II

PAPER: **EWS801C**

WILDLIFE BIOLOGY

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Understand** the diversity, biological and ecological traits of the specified taxa (mammals, birds, herpetofauna, and primates).

CO2:Understanding various statistics concepts and applying them in biological systems.

CO3:Illustrate various field methods to study mammals, birds, reptiles, amphibians and primates.

Unit 1: Mammalogy (10 lectures)

The evolution, phylogeny, global diversity and biogeography of major groups of mammals: global and Indian scenario; environmental adaptations; Sexual selection, parental care and mating systems; social behaviour; dispersal, habitat selection, and migration; populations and life history; community ecology of mammals; conservation status of Indian mammals; methods for studying mammals; the literature on the natural history and ecology of Indian vertebrates

Unit 2: Ornithology (10 lectures)

Bird anatomy, morphology, physiology; bird phylogeny and diversity: world, India; bird migration; bird vocalisation and communication; life history strategies (focus on annual cycles, breeding and nesting); breeding systems, social organisation and sexual selection; mixed flocks, guilds and community structure; bird extinctions and threatened birds; bird conservation issues and case studies; methods to study birds: surveys, censuses, migration and behaviour

Unit 3: Herpetology (9 lectures)

Evolution of tetrapod vertebrates; biogeography; classification and identification: amphibians; classification and identification: reptiles; community ecology; ecology of threatened species; survey and techniques (research methodologies); reproductive biology and behaviour; conservation: practices and challenges; books, journals, websites for herpetological research

Unit 4: Primatology (9 lectures)

Global diversity and primate taxonomy, biogeography adaptive radiations of primates; morphology, anatomy and their adaptations in primates; community ecology of primates; primate sociality, behaviour, life-history strategies and cultural traditions; primate cognition and communication; urbanisation of primates and human-primate relationships; conservation and management of primate populations; history and philosophy of primatological studies; methods in primatology: demography, ecology, field behaviour and laboratory studies

Unit 5: Basics of Statistics (10 lectures)

Comparing numerical means: the normal distribution, inference for a normal population, comparing two means, handling violations of assumptions, comparing means of more than two groups; regression and correlation; limitations of null hypothesis significance testing, and alternative approaches.

Suggested Readings

1. Feldhamer GA, Drickamer LC, Vessey SH and Merrit JF (2003). *Mammalogy: Adaptation, Diversity and Ecology (2nd Edition).* McGraw Hill, New York
2. Lovette IJ and Fitzpatrick JW (eds) (2016). *Handbook of Bird Biology (3rd Edition)*. Cornell University
3. Cowlishaw G and Dunbar R (2000). *Primate Conservation Biology*. The University of Chicago Press
4. Fleagle JG (2013). *Primate Adaptation and Evolution (3rd Edition)*. Elsevier
5. Vitt, LJ and Janalee P Caldwell (2013). *Herpetology: An Introductory Biology of Amphibians and Reptiles*. Academic Press
6. DuellmanWE and T Linda (1986). *Biology of Amphibians*. JHU Press
7. Whitlock MC and Schluter D (2015). *The Analysis of Biological Data*. Roberts and Company Publishers

SEMESTER – II

PAPER: **EWS802C**

HABITAT ECOLOGY

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Understanding** the distribution and ecological characteristics of tropical forests, grasslands, freshwater and wetland ecosystems, and high-elevation habitats and their threats.
CO2: **Understanding** the key threats to these habitats.
CO3: **Developing** the scientific skills i.e. how to approach and pursue a scientific question.
CO4: **Developing** data analysis skills.

Unit 1: Tropical Forest Ecology (10 lectures)

What and where are the tropics; biogeography and evolution in the tropics; importance of tropical forests; characteristic of tropical forests; structure of the tropical rain forests; rainforest development and dynamics; carbon flux and climate change in tropical ecosystems; nutrient cycling and tropical soils; human as part of tropical ecosystem; tropical lowland rain forest of northeastern India, their composition, function and biodiversity; introduction to canopy ecology; animal communities of tropical forests.

Unit 2: Grassland Ecology (10 lectures)

Introduction to grasslands; general description of world grasslands; traditional versus modern views of grass classification; characteristics of Poaceae; C3 and C4 photosynthesis; secondary compounds; anti herbivores defences and allelochemicals; succession; when is a 'forest' a savanna and why does it matters; drivers of savanna structure and function-bottom-up and top down control of savannas; Indian savanna and its extent; animal communities of grassland.

Unit 3: Freshwater and Wetland Ecology (10 lectures)

Ecology of freshwater and wetland ecosystem; definition of wetland; wetland classification; wetland hydrology; wetland soils; wetland soil and biogeochemistry; wetland vegetation and succession; human impacts and management of wetlands; wetland laws and protection; wetland ecosystem services; wetlands and climate change; faunal communities of wetland; wetlands of Assam

Unit 4: High Elevation Ecology (10 lectures)

Ecology of high altitude habitats (alpine, subalpine and upper temperate); species diversity and abundance, vegetation structure and composition; quantification of habitats and animal use, conservation issues and management practices; research in the high altitudes of the Himalaya; animal communities of high altitudes of Indian Himalayas and determinant of their structure

Unit 5: Study Design and power analysis (8 lectures)

How to ask scientific questions? designing successful field studies: manipulative experiments, natural experiments, snapshot versus trajectory experiments, press versus pulse experiments; replication; data independence; confounding factors; replication and randomisation; four classes of experimental designs: regression design, ANOVA designs, tabular designs, power analysis and effect size

Suggested Readings

1. Gibson DJ (2009). *Grasses and Grassland Ecology.* Oxford University Press
2. Mitsch WJ and Gosselink JG (2015). *Wetland (5th Edition).* Wiley
3. Turner IM (2004). *The Ecology of Trees in the Tropical Rain Forest*. Cambridge University Press
4. Lowman MD and Rinker HB (eds) (2004). *Forest Canopies (2nd Edition)*. Elsevier Academic Press
5. Kricher J (2011). *Tropical Ecology*. Princeton University Press
6. Montagnini F and Jordan CF (2005). *Tropical Forest Ecology – The basis for conservation and management*. Springer
7. Gotelli NJ and Ellison AM (2012). *A Primer of Ecological Statistics (2nd Edition).* Oxford University Press

SEMESTER-II

PAPER: **EWS803C**

POLLUTION CONTROL AND WASTE MANAGEMENT

CREDITS: 4 (4+0+0)

Course Outcomes

CO1: **Understand** various aspects of treatment technologies for water, air and noise pollution.

CO2: Ability to **appraise** and suggest pollution control measures and management options for water, air and noise pollution

CO3: **Understand and develop** the ability to appraise solid wastes characteristics and various aspects of solid waste management processes.

Unit 1: Wastewater Management (18 lectures)

Types of wastewater and their characteristics; primary treatment: screening, sedimentation; secondary treatment: activated sludge process; trickling filter; rotating biological contactors, up flow anaerobic sludge blanket (UASB); advanced treatment process; echo-technological approaches for wastewater treatment; laws and acts related to water pollution and management

Unit 2: Air Pollution Control and Management (16 lectures)

General methods of control of gaseous pollutants: adsorption, absorption, combustion and condensation; control of particulate matter; indoor air quality control; green belt development; laws and acts related to air pollution and management

Unit 3: Noise Pollution Control and Management (12 lectures)

Sources of noise pollution; effects of noise pollution on animals and human health; noise pollution control; laws and acts related to noise pollution and management

Unit 4: Waste Management (18 lectures)

Sources and generation of solid waste, their characterization; solid waste management: segregation, collection, storage, and disposal; scenario of solid waste management in India; composting; vermicomposting; hazardous wastes management; biomedical waste management and e-wastes management; construction and demolition waste management; laws and acts related to waste management

Suggested Readings

1. Gilbert M (2008). *Introduction to Environmental Engineering and Science*, Pearson Education
2. Metcalf and Eddy (2003). *Wastewater Engineering-Treatment and Reuse*, Tata McGraw Hill, New Delhi
3. Sincero AP and Sincero GA (1996). *Environmental Engineering: A Design Approach,* Prentice Hall
4. Hammer MJ and Hammer Jr MJ (2000). *Water and Wastewater Technology* (3^{ed} Edition). Prentice Hall of India
5. Peavy HS, Rowe DR and Tchobanoglous G (2017). Environmental Engineering, McGraw Hill Education India

SEMESTER-II

PAPER: **EWS804C**

ENVIRONMENTAL STRESS BIOLOGY

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Recall** the basic concepts of physiology and biochemistry in both plants and animals.

CO2: **Discuss** the effects of abiotic and biotic stress on organisms and **understand** their stress avoidance and tolerance mechanisms.

CO3: **Understand** the role of plant growth hormones in stress avoidance and tolerance.

Unit 1: Primer of Physiology and Biochemistry (14 lectures)

Cell structure and function; biomolecules; pigments; cell signaling, gene expression and immune responses; growth, development and reproduction; photomorphogenesis, photoperiodism, thermoperiodism, thermogenesis, vernalization and movement in plants; circulation, digestion and excretion; homeostasis; gas exchange

Unit 2: Environmental Stress, Impacts and Adaptive Mechanisms (20 lectures)

Definition of environmental stress; significance of environmental stress physiology and biochemistry; abiotic stress (water- drought and flood, temperature– high and low, salinity, light, chemical pollutants, radiation, nutrient toxicity and deficiency); biotic stress (pathogens, bacteria, viruses, fungi, parasites, insects, herbivores, weeds); impacts of abiotic and biotic stresses on plants, animals and ecosystems; oxidative stress and anti-oxidative defence system; stress avoidance and tolerance

Unit 3: Hormonal Regulation of Stress Tolerance in Plants (14 lectures)

General characteristics of plant growth hormones; major classes of plant hormones; biosynthesis pathways; hormone interactions and effects; role in plant growth and development; hormones as mediators of stress responses; hormones in abiotic stress tolerance and plant defence

Suggested Readings

1. Tuteja N and Gill SS (eds) (2014). *Climate Change and Plant Abiotic Stress Tolerance*. Wiley Blackwell
2. Rai AK and Takabe T (eds) (2006). *Abiotic Stress Tolerance in Plants: Toward the Improvement of Global Environment and Food.* Springer
3. Davis PJ (ed) (2004). *Plant hormones: Biosynthesis, Signal Transduction, Action*. KluwerAcademic Publishers
4. Srivastava LM (2002). *Plant Growth and Development: Hormones and Environment*. Academic Press, USA
5. Khan et al (eds) (2012). *Phytohormones and Abiotic Stress Tolerance in Plants*. Springer

SEMESTER – II

PAPER: **EWS805L**

ECOLOGICAL FIELDWORK AND PRACTICAL - II

CREDITS: 4 (0+0+4)

Course outcomes:

CO1: **Developing** field skills in identification of key wildlife groups in their natural habitats.
CO2: **Developing** study design, data analysis and presentation.
CO3: Ability to **demonstrate** the effects of environmental stress in plants through biochemical analysis
CO4: **Understand and demonstrate** adsorption process for pollutant removal and appraise waste management and water treatment process.

Unit 1: Fieldwork and Hands-on Exercises

1. Visit a wildlife habitat and document the diversity of mammals, birds, herpetofauna and primates using appropriate sampling techniques.

2. Document the feeding and ranging behaviour of any animal found in the Cotton University campus and use appropriate methods to analyse the data.

3. **Mini project:** The student needs toask an ecological question, design a study to answer it, collect and analyse data, write it in the form of a manuscript and present it.

Unit 2: Laboratory Work

1. Study of nutrient deficiency and toxicity
2. Study of leaf stomata in stress conditions
3. Leaf chlorophyll estimation
4. Proline estimation in leaf
5. Nitrate reductase estimation in leaf
6. Seed germination percentage under stress conditions
7. Determination of Relative Leaf Water Content (RLWC)
8. Determination of optimum coagulant dose by jar test
9. Adsorption studies
10. A field trip to a waste management or recycling facility or water treatment facility will be undertaken which will help the students in understanding pollution management aspects of environmental sciences.

Suggested Readings

1. Gibbs JP, Hunter Jr ML and Sterling EJ (2008). *Problem-solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory.* Blackwell
2. Boitani L and Fuller TK (2000). *Research Techniques in Animal Ecology: Controversies and Consequences*. Columbia University Press
3. Cappuccinno JG (2014). *Microbiology: A Laboratory Manual (10th Edition)*. Pearson
4. Aneja KR (2017). *Experiments in Microbiology, Plant Pathology and Biotechnology (4thEdition)*. New Age International(P) Ltd
5. Mirajkar SR, Kale P and Shingote P (2017). *A Practical Manual for Plant Physiology and Biochemistry*. Lambert Academic Publishing
6. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, Environmental Engineering, McGraw Hill Inc., New York. 1995
7. Metcalf and Eddy (2003). *Wastewater Engineering-Treatment and Reuse*, Tata McGraw Hill, New Delhi

SEMESTER – II

PAPER: **EWS806S (SEC-II)**

SCIENCE MANAGEMENT, COMMUNICATION AND WRITING SKILLS

CREDITS: 2 (1+1+0)

Course Outcomes:

CO1: **Understand and develop** soft and technical skills in science communication and science advocacy.

CO2: **Developing critical** thinking on the role of science in science-public-policy interface.

CO3: **Develop** soft skill that are essential for research purposes and introduction to various open source software.

Unit 1: Science Communication and Academic Writing (8 Lectures)

Reading, interpreting, writing and reporting a scientific paper; Precise interpretation of scientific tables and figures; Asking the right questions, critical thinking, and constructive criticism; Why communicate science? Processes and methods of science communication and advocacy; Making of effective oral and poster presentations; Communicating science through popular science writing, photographs, graphs and diagrams; Social media and science communication; Elements of a sound scientific proposal and principles of managing a scientific project; Reference management; Plagiarism and research ethics

Unit 2: Academic Soft and Technical Skills (8 lectures)

An introduction to soft skills; Writing an effective statement of purpose and curriculum vitae; Communicating through effective academic emails; Working in a group; Self-management and interpersonal skills, including managing expectations; Diplomacy and negotiation; Conflict and stress management, ensuring the mental wellbeing of oneself and of others; Use of mind maps to plan and execute tasks; Familiarity with a basic set of software, including word processing, spreadsheets, presentation software, developing collaborations using Google Suite products, image processing (GIMP), and vector software (Inkscape); Setting alerts in Google and journal publications

SEMESTER – III

PAPER: **EWS901C**

CONSERVATION BIOLOGY AND WILDLIFE MANAGEMENT

CREDITS: 4 (3+0+1)

Course Outcome:

CO1: **Understanding** the key issues of Conservation Science and Wildlife Management.

CO2: **Applying** the core concept of natural history, ecology, evolution, behaviour, human behaviour and genetics in solving conservation and wildlife management problems.

CO3. **Designing** conservation projects through hands-on exercises.

Unit 1: Conservation Biology (14 lectures)

The pathology of biodiversity loss: the practice of conservation; the history and distinction of conservation biology; conservation values and the ethics of conservation of biodiversity; traditional versus 'new' conservation; key conservation issues: extinction; logging and deforestation; habitat loss and fragmentation; hunting and poaching; livestock grazing; impacts of extractive uses; invasive species; linear infrastructure; shifting cultivation; oil palm and rubber plantation; large dams; human-wildlife interaction; climate change and biodiversity

Unit 2: Conservation Practice (12 lectures)

Conservation priorities: identifying need, taking action and evaluating success; levels of approach: on the appropriate scales for conservation interventions and planning; biological corridors and connectivity; relocation of wildlife; restoration, rewilding and re-introductions; citizen science and nature conservation; plant conservation: the seeds of success; the 'why', 'what' and 'how' of monitoring for conservation; conservation and human behaviour; five paradigms of collective action underlying the human dimension of conservation; designing effective solutions to conservation planning problems; leadership and listening: inspiration for conservation mission and advocacy, psychology of sustainability

Unit 3: Wildlife Management (10 lectures)

Legal instruments for managing forests, other wildlife habitats and wildlife in India; international

conventions; species conservation projects; tiger, rhino, vultures, pygmy hog etc.; forest working plans and wildlife management plans; National Forest Policy, eco-development programme; joint forest management; economic instruments for nature conservation; tackling unsustainable wildlife trade; management of species outside the protected areas, wildlife diseases and wildlife crime.

Unit 4: Conservation Genetics (12 lectures)

What is genetic diversity?; measuring genetic diversity; processes contributing to genetic diversity: mutation, migration, random mating; natural selection; random genetic drift; Allele and genotype frequencies; ideal population and Hardy-Weinberg equilibrium; evolutionary processes in small and large populations (evolutionary impacts of selection, mutation, migration, random genetic drift and random mating on small and large populations); fixation; population bottlenecks; inbreeding and inbreeding depression; measuring population size (effective population size); population fragmentation; advantages of molecular tools over conventional method in resolving taxonomic uncertainty; concept of cryptic species; introduction to PCR; concept of DNA barcoding for species identification and biodiversity conservation; landscape genetics

Practical

Unit 1: Mini Project: The student needs to ask a conservation question, design a study to answer it, collect and analyse data, write it in the form of a manuscript and present it.

Unit 2: Hands-on Exercises

- Diagnosing declining populations.
- Edge effects: designing a nest predation experiment.
- Explore through a mapping exercise what happens to a tropical forested landscape as it undergoes the fragmentation process and to predict what will happen to the biota residing within the landscape as a result of these change.
- Understand some basic analyses behind allocating land to different types of forest management as a vehicle for understanding the key issues involved in managing ecosystems to balance production of a commodity while maintaining biodiversity.
- Basic technique to prioritise conservation at a regional scale and to identify the top priority “hotspots” for allocating resources for conservation.

- Apply island biogeography theory to test basic assumption about the role of nature reserve in protecting biodiversity.
- Mapping and analysing distribution of Western hoolock gibbon for reserve design.
- Develop technical expertise in as well as a conceptual understanding of modeling species distribution in relation to changing climatic conditions; Learn the basics of climate envelop modeling, examine the climatic adaptation of a species, predict the entire geographic range of a species

Suggested Readings

1. Macdonald DW and Willis KJ (ed) (2013). *Key topics in Conservation Biology 2*. Wiley-Blackwell
2. Dyke FV (2008). *Conservation Biology: Foundations, Concepts, Applications (2nd Edition)*. Springer
3. Hunter Jr ML and Gibbs JP (2007). *Fundamentals of Conservation Biology (3rd Edition)*. Blackwell Publishing
4. Gibbs JP, Hunter Jr ML and Sterling EJ (2008). *Problem-solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory.* Blackwell Publishing

SEMESTER-III

PAPER: **EWS902C**

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

CREDITS: 4 (3+0+1)

Course outcomes:

CO1: **Understand** the basics of environmental microbiology, molecular biology and biotechnology

CO2: **Ability to understand and identify** biotechnological interventions for environment and wildlife management.

CO3: Ability to **demonstrate** microbial analysis and DNA isolation from environmental samples.

Unit 1: Microbes of Environmental Importance (16 lectures)

Introduction to environmental microbiology; role of microbes in biogeochemical cycles, carbon sequestration, wastewater treatment, plant growth and defence; microorganisms as bio-indicators

Unit 2: Basic Concepts of Molecular Biology and Environmental Biotechnology (16 lectures)

Basic concepts of molecular biology: genetic material; gene structure; protein synthesis and its regulation in prokaryotes and eukaryotes; definition and scope of biotechnology: basic techniques in genetic engineering; basic of environmental biotechnology

Unit 3: Applications of Biotechnology in Environmental Management (16 lectures)

Biosensors for the detection of pollutants; genetic control of industrial pollution through natural and genetically engineered micro-organisms: bioremediation of soils and water; biotechnology in forestry and wasteland development; biotechnology in sustainable agriculture; gene banks, germplasm banks and their management; concept of DNA sequencing; concept of environmental metagenomics

Practicals

1. Estimation of bacteria in soil through dilution plate method
2. Estimation of fungi in soil through dilution plate method
3. Estimation of microflora in water samples through dilution plate method
4. Coliform count in water samples by MPN technique
5. DNA isolation from environmental samples
6. PCR analysis of DNA

Suggested Readings

1. Sayler G, Fox S and Blackburn J (eds) (1991). *Environmental Biotechnology for waste treatment*. Planum Press
2. Atlas RM and Bastha R (1997). *Microbial Ecology: Fundamentals and Applications,* Benjamin/Cummings Publication
3. Evans GM and Furlong JC (2002). *Environmental Biotechnology.* Willey

4. Ivanov V (2011).*Environmental Microbiology for Engineers,* CRC Press
5. Bertrand et al (2011).*Environmental Microbiology: Fundamentals and Applications, Microbial Ecology*, Springer

SEMESTER-III

PAPER: **EWS903C**

ENVIRONMENTAL TOXICOLOGY AND RISK ASSESSMENT

CREDITS: 4 (4+0+0)

Course Outcomes:

CO1: **Understand** the concept of toxicology and summarize the most relevant terms and principles in environmental toxicology

CO2: **Ability to understand** toxicity mechanism and biochemical aspects of toxic chemicals affecting the human health

CO3: Ability **to understand** and **demonstrate** the concept of environmental risk assessment.

Unit 1: Introduction to Environmental Toxicology (16 lectures)

Definition and scope; historical context of environmental toxicology; principles of toxicology; xenobiotics; emerging contaminants; toxic chemicals in the environment; metal toxicity and metal tolerance in plants; environmental issues due to emerging contaminants.

Unit 2: Toxicity-Mechanism and Effects (16 lectures)

Dose response relationships; synergism and antagonism; wildlife ecotoxicology; biomarkers; carcinogens, mutagens and teratogens; biochemical aspects of toxicity of arsenic, cadmium, lead, mercury, carbon monoxide, O_3 and PAN (Paroxy Acyl Nitrate), methyl isocyanate; pesticides.

Unit 3: Disease Ecology (14 lectures)

Occupational health hazards; epidemiological issues: goitre, fluorosis, arsenic poisoning; vector borne diseases: Japanese encephalitis, malaria, tuberculosis and AIDS; waterborne diseases.

Unit 4: **Environmental Risk Assessment (18 lectures)**

Definition of risk, basic steps in risk assessment – hazard identification, dose-response assessment, exposure assessment, risk characterization, risk communication and risk management; human health and ecological risk assessment; nanomaterials, classification and applications of nanomaterials; environmental risks of nanotechnology; environmental impact assessment (EIA).

Suggested Readings

1. Phillip RB (1995). *Environmental Hazards and Human Health*, Lewis, Boca Raton
2. *Casarett and Doull's Toxicology*, *The basic Science of poisons*, 2nd Den, Editors, J. Doull, C.D. Klaassen, M.O. Amdur, Macmillan Publishing Co. Inc., NY.
3. Shatkin JA (2008).*Nanotechnology Health and Environmental Risks*. Perspectives in Nanotechnology. CRC press
4. Gilbert M (2008).*Introduction to Environmental Engineering and Science*, Pearson Education
5. Richards IS (2008).*Principles and Practice of Toxicology in Public Health*. Jones and Bartlett Publishers, London
6. Canter LW (1996).*Environmental Impact Assessment (2nd Edition)*.McGraw-Hill, New York

SEMESTER-III

PAPER: **EWS904SP1**

EARTH SYSTEM SCIENCE

CREDITS: 5 (4+1+0)

Course Outcomes:

CO1. **Understand** the geological, geophysical and Earth surface processes and different landforms.

CO2. **Analyze** how geophysical processes translate into natural hazard.

CO3. **Understand and analyze** the human interface with the natural hazards and the different mitigation approaches, their choices and alternatives.

Unit 1: Earth's Geodynamics (16 lectures)

Origin and evolution of the earth; Interior of Earth; Isostasy and isostatic adjustments; Epirogenic and orogenic movements; Concepts of folds and faults; Plate tectonics - sea floor spreading and continental drift, Earthquake and earthquake hazard: Origin and severity of earthquakes, effects of earthquake, seismic hazards and its zonation in India; Volcano and volcanic hazard: Origin and types of volcanic activities; Types of Lava, Classification of Volcanoes; Volcanic belts; Volcanic hazard and mitigation.

Unit 2: Earth's Materials and geosystems (16 lectures)

Rocks and rock types - Igneous, Metamorphic and Sedimentary; Composition and formation, Minerals- formation and classification; Weathering of rocks - physical, chemical and biological; Controls on weathering, Rock cycle; Mass-wasting, slope instability and landslide hazard: Causes and destabilizing forces; Mass movement types.

Unit 3: Hydrology (16 lectures)

Hydrologic cycle and hydrologic budget; Drainage basin characteristics, surface and sub-surface environment; Stream classification and ordering. Ground water: Definition - soil moisture, water table, aquifers; Ground water flow; Environmental influences on ground water; Ground water recharging; Flood hazard and its management; Flood prone areas of India and associated hazards; Flood mitigation and management in Northeast India.

Unit 4: Geomorphology (16 lectures)

Erosion, transportation and deposition of earth's materials and development of landform features; Wind erosion, deposition and Aeolian features; Karst topography; erosional and depositional features of running water, Glaciers and glacial erosion and deposition and the associated landforms.

Suggested Readings

1. Grotzinger J and Jordan TH (2014).*Understanding Earth* (7th ed.). W.H. Freeman and company.
2. Valdiya KS (1987).*Environmental Geology.* Tata McGraw-Hill.
3. Strahler AN and Strahler AH (1973).*Environmental Geoscience - Interaction between Natural Systems and Man.* Santa Barbara, California: Hamilton Publishing.

4. Bell FG (2003).*Geological Hazards: Their Assessment, Avoidance & Mitigation.* Taylor and Francis.
5. Anderson DL (1989).*Theory of the Earth.*Blackwell Scientific Publications.
6. Singh VP (1994).*Elementary Hydrology.* Prentice-Hall, India.
7. Chow VT (1964).*Handbook of Applied Hydrology*. McGraw-Hill, New York.
8. Sear DA (2009). *Guidebook of applied fluvial geomorphology.* InNewson MD and Thorne CR edition, Thomas Telford ltd.
9. Leopold LB, Wolman MG and Miller JP (1992). *Fluvial processes in geomorphology*. Dover Publications, New York.

SEMESTER – III

PAPER: **EWS904SP2**

QUANTITATIVE ECOLOGY

CREDITS: 5 (4+1+0)

(64 lectures)

Course Outcomes:

CO1: **Practicing** the programme languages in R

CO2: **Developing** skills for statistical analysis.

Introduction to R, Study design, data distributions in ecology, linear models (LMs): the linear regression, generalised linear models (GLMs): Poisson and logistic regressions; LMs and GLMs with categorical predictors: the ANOVA; Multiple regression and interacting predictors – I; Multiple regression and interacting predictors—II; the ANCOVA; Linear mixed effects models; Generalised linear mixed effects models; Multiple models—I: Candidate model sets and model selection; Multiple models – II: Model averaging; Graphics and data visualisation in R; Dealing with spatial and temporal autocorrelation in ecological data; Multivariate statistics; non-parametric statistics; packages in R for specialised ecological statistics / visualisation; selecting the right statistical test.

Suggested Readings

1. Manly BFJ and Alberto JAN (2017). *Multivariate Statistical Methods: A Primer (4th Edition)*. CRC Press
2. Gotelli NJ and Ellison AM (2012). *A Primer of Ecological Statistics (2nd Edition)*. Oxford University Press
3. Anderson D and Burnham K (2002). Model selection and multi-model inference. *Second. NY: Springer-Verlag*
4. Bolker BM, Brooks ME, Clark CJ, Geange SW, Poulsen JR, Stevens MH, White JS (2009). Generalized linear mixed models: a practical guide for ecology and evolution. Trends EcolEvol 24(3):127-35

SEMESTER-III

PAPER: **EWS905OE1**

GLOBAL AND REGIONAL ENVIRONMENTAL ISSUES

CREDITS: 4 (3+1+0)

Course outcomes:

CO1: **Understand** the causes and control measures of contemporary global environmental issues.
CO2: **Understand** and **analyze** environmental issues related to human society at the global and national levels.
CO3: **Understand** and **analyze** environmental issues specific to North East India.

Unit 1: Global Environmental Issues (20 lectures)

Global warming and climate change; environmental pollution; natural resource depletion; waste disposal; deforestation; biodiversity loss; ozone layer depletion; ocean warming and acidification; genetically modified organisms; nuclear hazards; migration; agriculture and environment

Unit 2: Social Issues and the Environment (08 lectures)

Growth and distribution of world's population; impact of growing population- global and Indian issues; urbanisation and environmental challenges; epidemiological issues; resettlement and

rehabilitation issues

Unit 3: Environmental Issues of North East India (20 lectures)

Changes in forest cover, issues and concerns related to sacred forests and sacred groves; issues and problems associated with shifting agriculture; industrialization; coal and lime stone mining; quarrying of sand from hills and rivers; environmental and socio-economic implications of mega hydroelectric projects; floods, landslides and earthquakes

Suggested Readings

1. Singh OP (2006). *Environment and Natural Resources*, Regency Publications, New Delhi
2. Singh OP (2005). *Mining Environment*. Regency Publications, New Delhi
3. Saxena KG, Liang L and Rerkasem K (2007). *Shifting Agriculture in Asia*, BS MPS Dehradun
4. Ramakrishnan PS (2000). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge,* Oxford and IBH, New Delhi

SEMESTER – IV

PAPER: **EWS1001C**

ECOLOGY AND SOCIETY

CREDITS: 4 (3+0+1)

Course Outcome:

CO1: **Understanding** the interdisciplinary nature of wildlife study and research

CO2: **Appraise** the historical as well as contemporary dimensions of the human-nature interface in wild and urban areas.

Unit 1: Ecological History (12 lectures)

Critical reading of selected chapters from the following books: Beinart and Coastes (1995), Rangarajan and Sivaramakrishnan (2014), Guha (2000), Rangarajan (2007), Cederlöf and Rangarajan (2018);Ecological history of northeast India: paleoecology and pre-historic ecology; agriculture expansion, domestication of rice and other crops; geography and geology of the region: flood, fire, climate and monsoon pattern, formation of alluvial flood plain; society: hunting,

shifting cultivation, forest villages; grazing; economy: nature, commerce and mobility, tea environmental history; state and environment: the Ahom rulers and the colonial state.

Unit 2: Ecology and Economics of Human Societies (10 lectures)

Human ecology and its importance in understanding conservation issues; different modes of resource use and differences with respect to technology, economy, social organization, ideology, and nature of ecological impact; population and scarcity; markets and commodities; ecological economics; institutions and "The Commons"

Unit 3: Political Ecology (12 lectures)

Introduction to political ecology; political versus apolitical ecologies; conceptual and methodological challenges, challenges in ecology, social construction and explanation, dominant narratives of political ecology - degradation and marginalisation, conservation and control, environmental conflict and exclusion, environmental subjects and identities and political objects and actors with examples from India and northeastern India; gender and environment (case study of Narmada Dam project in India); environmental identity and social movements in India and across the world—chipko, silent valley, navdanya, national park movement, Aldo Leopold's land ethics, Rachel Carson and Silent Spring; role of civil society, non-governmental organisation, media, individuals, literary figures in environmental awareness and actions.

Unit 4: Urban Ecology (14 lectures)

Introduction to urban ecology; urban environment; population-and species-level responses to urbanisation; community-level response to urbanisation; ecosystem-level responses to urbanisation; ecosystem services in urban areas; evolution of life in urban environments; human–wildlife interactions in urban areas; urban ecology and human health; multifunctional green infrastructure planning to promote ecological services in the city; building for biodiversity: accommodating people and wildlife in cities; nature based solutions for climate resilience; urban ecosystems and environmental justice

Practical

Participant observation; qualitative interviews and focus groups; questionnaires; documenting local environmental knowledge and change; community workshops and the PRA toolbox; participatory mapping

Suggested Readings

1. Beinart W and Coates P (1995). *Environment and History: The taming of nature in the USA and South America*. Routledge, London and New York.
2. Rangarajan M and Sivaramakrishnan K (2014). *Shifting Ground: People, Mobility and Animals in India's Environmental Histories.* Oxford University Press
3. Guha R (2000). *Environmentalism: A global history*. New York: Longman
4. Rangarajan (2007). *Environmental Issues in India: A Reader*. Pearson Longman, India
5. Cederlöf G and Rangarajan M (2018). *At Nature's Edge: The Global Present and Long-term History*.Oxford University Press, India
6. Robbins P (2012). *Political Ecology: A critical Introduction (2nd Edition)*. Wiley-Blackwell
7. Robbins P, Hintz J and Moore SA (2014). *Environment and Society (2nd Edition)*. Wiley-Blackwell
8. Saikia AJ (2013). *Forests and ecological history of Assam, 1826-2000*. Oxford University Press
9. Saikia AJ (2005). *Jungles, Reserves, Wildlife: A History of Forests in Assam.* Wildlife Area Development Trust, Guwahati
10. Newing H (2011). *Conducting Research in Conservation: Social Science Methods and Practice*. Routledge
11. Parris KM (2016). *Ecology of Urban Environments*. Wiley Blackwell
12. Niemelä J (2011) (ed*). Urban Ecology: Patterns, Processes, and Applications*. Oxford University Press
13. Douglas I, Anderson PML, Goode D, Houck MC, Maddox D, Nagendra H, Tan PY (eds 2021). *The Routledge Handbook of Urban Ecology (2nd Edition).* Routledge

SEMESTER – IV

PAPER: **EWS1002SP1**

SOIL, AGRICULTURE AND ENVIRONMENT

CREDITS: 5 (4+1+0)

Course outcomes:

CO1: **Understand** the general characteristics and ecology of the soil system.
CO2: **Understand** the evolution of agriculture and the concept of sustainable agriculture.
CO3: **Analyze** the interrelationships among soil, agriculture and environment.
CO4: **Analyze** and **evaluate** the role of agriculture in society and economy.

Unit 1: General Introduction to the Soil System (14 lectures)

Lithosphere and pedosphere; pedology and edaphology; soil formation; soil horizons; soil composition; physical, chemical properties and biological properties of soil; plant roots and the rhizosphere

Unit 2: Soil Ecology (14 lectures)

Soil biodiversity; soil food web; functions of soil biodiversity; effect of root growth on soil properties; root-microbe interactions - root exudates, nutrient availability and plant uptake; vesicular arbuscular mycorrhizae; plant growth promoting rhizobacteria

Unit 3: Soil and Agriculture (14 lectures)

Origin of agriculture and history of crop domestication; Green Revolution; agronomy and agro-ecology; conventional and sustainable agriculture; cropping systems; agro-biodiversity; agricultural pests and their control; factors affecting agricultural production-soil organisms, soil health, water and air quality, other environmental factors (light, temperature, moisture etc.); traditional and high yielding crop varieties

Unit 4: Environmental Impacts of Agriculture (14 lectures)

Air, water and soil pollution; agriculture as a source of greenhouse gas emissions; depletion of water resources; deforestation, loss of habitat and biodiversity; genetically engineered crops and dominance of weeds; waterlogging and salinization; soil erosion and degradation; impact on soil biota; impact on insect pollinators

Unit 5: Socioeconomic Dimensions of Agriculture (8 lectures)

Agriculture and food security; agriculture dependent livelihoods of local communities; markets for agricultural produce; participation of women in agriculture; agricultural practices in north east India - *Jhum* or shifting cultivation, traditional rice cultivation practices in Assam; rice agriculture and the economy of Assam

Suggested Readings

1. Bardgett D (2005). *The Biology of Soil: A Community and Ecosystem Approach.* Oxford University Press
2. Dion P (ed) (2010). *Soil Biology and Agriculture in the Tropics*. Springer
3. Wall DH (ed) (2012). *Soil Ecology and Ecosystem Services*. Oxford University Press
4. Lavelle P and Spain AV (2003*). Soil Ecology*. Kluwer Academic Publishers
5. Paul EA (ed) (2014). *Soil Microbiology, Ecology and Biochemistry (4th edition)*. Academic Press
6. Martin K and Sauerborn J (2013). *Agroecology*. Springer
7. Lockie S and Carpenter D (eds) (2010). *Agriculture, Biodiversity and Markets*. Earthscan, London, Washington D.C
8. Cauvin J (2000). *The Birth of the Gods and the Origins of Agriculture*. Cambridge University Press
9. Sundh et al. (eds) (2012). *Beneficial microorganisms in Agriculture, Food and the Environment*. CAB International
10. Maxted et al. (eds) (2012). *Agrobiodiversity Conservation: Securing the diversity of crop wild relatives and landraces*. CAB International

SEMESTER-IV

PAPER: **EWS1002SP2**

REMOTE SENSING AND GIS

CREDITS: 5 (4+1+0)

Course Outcomes:

CO1: **Understanding** of Remote Sensing and Geographic Information System (RS-GIS) as a powerful tool for geospatial analysis and its application in tackling environmental issues.

CO2: **Understand and appreciate** RS data sources and analysis and manipulation of RS data in GIS platform.

CO3: **Apply** skills and functional knowledge of RS-GIS to carry out RS-GIS based project.

Unit 1: Principles of Remote Sensing (16 lectures)

Concepts of Remote Sensing; Types of orbits, swaths; Different types of resolution: spatial, radiometric, spectral and temporal, types of sensor; Satellites and their sensors; Data products; Applications of remote sensing in environmental monitoring and management.

Unit 2: Physics of Remote Sensing (16 lectures)

Energy sources and radiation principles; Electromagnetic spectrum and its properties; Laws governing the properties of radiation and its implication for remote sensing; Electromagnetic radiation and its interaction with the atmosphere and Earth surface features; concept of spectral signature.

Unit 3: Digital Image Processing & Image interpretation (16 lectures)

Principles, image rectification, image enhancement and mosaicing; Image Classification-Supervised, Unsupervised, Ground truth data and training set manipulation; Classification accuracy assessment; Elements of image interpretation, interpretation keys.

Unit 4: Geographical Information System (GIS) & Global Positioning System (GPS) (16 lectures)

Basic principles, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography; Basic principles of GPS; Applications to environmental studies.

Suggested Readings

1. Jensen JR (2013).*Remote Sensing of the Environment-An earth resource perspective* (2nd ed.). Pearson Education, India.
2. Chipman JW, Kiefer RW and Lillesand TM (2011).*Remote sensing and Image interpretation*. Wiley.
3. Burrough PA, Mcdonell RA and Lloyd CD (2016).*Principles of Geographical Information System* (International 3rd ed.). Oxford University Press, U.K.
4. Hofmann-Wellenhof B, Lichtenegger H and Collins J (1997).*Global Positioning System: Theory and Practice*. Springer-Verlag, Netherlands.

SEMESTER-IV

PAPER: **EWS1003OE2**

FUNDAMENTALS OF RESEARCH

CREDITS: 4 (3+1+0)

Course Outcomes:

CO1: **Understand** and appreciate the methods and processes involved in research.

CO2: **Demonstrate** ability to search and query databases for relevant literature, design sampling methods and choose the appropriate data analysis methods.

CO3: **Demonstrate and develop** the ability to communicate the research, choose correct journals and avoid predatory publishing.

CO4: **Understand and analyze** the different citation and referencing styles, reference management and the importance of ethics in scientific publications.

Unit 1: Introduction to research (14 lectures)

Introduction and definition of research, Motivation and objectives; Types of research– Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical, concept of applied and basic research process, criteria of good research; Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review- acceptable sources of literature, web as a source, searching

the web, identifying what to read, critical review of the literature, identifying gap areas from literature and research database, development of working hypothesis.

Unit 2: Sampling Techniques and Data Analysis (08 lectures)

Population and sample; Advantages of sampling over complete census and its limitations; Different techniques of sampling-simple random sampling, stratified random sampling, systematic sampling; Relative advantages and disadvantages of different techniques; data processing, analysis, presentation and interpretation

Unit 3: Science communication (14 lectures)

Science communication and its importance, different types of scientific communication- poster, oral, original article, review article, commissioned review, book chapter, book, thesis, dissertation, report etc.; Drafting a journal article, IMRAD format, Journal databases, Journals and journal selection, journal matrices- impact factor, five-year impact factor, immediacy index, SJR, cite score, abstracting and indexing, citation indices-citations, H-index, i10 index. Good journal vs Bad journal, predatory journals, UGC-CARE journals.

Unit 4: Research and publication ethics (12 lectures)

Ethics and ethical issues in research, use of human or animal samples, consent of participants; Plagiarism in research and publication, authorship, acknowledgements; Concepts of citation, reference, bibliography, paraphrasing and quotation; Referencing and citation style- APA, Vancouver, MLA, Chicago, IEEE etc., Use of reference management tools.

Suggested reading:

1. Kothari CR (1990) Research Methodology: Methods and Techniques. New Age International, India.
2. Creswell JW, Creswell JD (2017) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE publications.
3. Colomb GG, Williams JM, BoothWC (2008) The craft of research. University of Chicago Press, Third edition, USA.

4. Journal databases and journal home page.

SEMESTER-IV

PAPER: **EWS1004DPW**

DISSERTATION / PROJECT WORK

CREDITS: 6