

# SYLLABUS

*For*

## 2 YEARS MSC ENVIRONMENTAL SCIENCE PROGRAMME

*(Revised Syllabus Approved by Academic Council)*



*Dept. of  
Earth Science*

**JUNE, 2019**

**UNIVERSITY OF SCIENCE & TECHNOLOGY, MEGHALAYA**

Techno City, 9<sup>th</sup> Mile, Baridua, Ri-Bhoi, Meghalaya, 793101

**M.SC. ENVIRONMENTAL SCIENCE  
DEPARTMENT OF EARTH SCIENCE  
UNIVERSITY OF SCIENCE AND TECHNOLOGY, MEGHALAYA**

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## **1. About the Department of Earth Science**

Vision: *To establish the department as the magnet of the brightest students for higher education and research activities in Geography and Environmental Science so that it can be the finest in its field and contribute towards the development of higher education in India in general and the North East India in particular.*

Mission:

1. To develop the state of the art infrastructure for teaching and learning including the designing application oriented curriculum and research plans.
1. To carry out R&D activities adopting multidisciplinary approach with special focus on exploration of resource potential, optimum resource utilization, harmonious social and cultural development including sustainable development in NorthEast India.

Department objectives:

- To build professional and research oriented mindset among students.
- To enhance conceptual and application skills of students in the fields of study.
- To explore opportunities towards employability both in public and private sectors.

## **2. Academic Focus:**

The global academic scenario has become so multifaceted that it is always good to have a degree with diverged applicability and scope. Environmental Science is a multidisciplinary subject which is relevant to all other subjects and is applicable almost in every aspect of life. Considering Environmental Science as one of the burning and an emerging subject of global concerned University of Science and Technology, Meghalaya started Master Degree programme (M.Sc.) in Environmental Science from 2012. The department as a part of USTM has made collaborations with ISRO-NESAC, CSIR-NEIST, CRRI-New Delhi, Hi-Tec Ireland, IITs, many national and international universities and R&D organizations.

### Career Scope

There is a growing recognition in both public and private spheres of the need for greater environmental protection. The course provide a wide variety of employment opportunity in government as well as private sector(s), NGOs, international organizations, consultancies, national/multinational firms, academics and researches, refineries & mines, fertilizer plants, food processing units, engineering, journalism, pollution control boards and many other sectors like forestry, agriculture, water resource management, rural & urban development, tourism, biodiversity & wildlife management, disaster management, etc.

## **3. Programme Details:**

Masters of Science (M.Sc.) in Environmental Science

Duration: 2 Years (Four Semesters)

### Admission Eligibility

Any Science Graduate or Graduate in allied subject(s) with at least 55% marks (5% relaxation in reserved categories) studied from any recognised university/college.

Intake Capacity: 30 students

## **4. Programme Objectives s of M.Sc. Environmental Science:**

- i) To generate resourceful degree holders enabled with professional and research oriented knowledge and skills so as to explore and implement in diverse fields of applicability and employability that

significantly helps in the process of planning, evaluation, decision making and management of sustainable environment, sound societal development and overall nation building.

- ii) To prepare students to become a role player/transformer/leader/entrepreneur in multiple aspects to address the challenges of environmental problems and finding solutions to meet the sustainable dimensions at local, national, regional and global context.
- iii) To transfer the contemporary skilful knowledge to students to address the real life issues with strong sense of ethical values, scientific intellectuality, social responsibility and national integrity.

#### **5. Programme Specific Outcomes of M.Sc. Environmental Science:**

- i) Students will be able to critically investigate, evaluate and synthesize complex information on various problems of environmental and allied disciplines.
- ii) Students will be able to conduct assessment and periodic monitoring of different ecosystems of the region and its complex interactions with the local communities, thereby can address the threats and can develop conservation strategies.
- iii) Students can investigate and analyse the wildlife and biodiversity of the region and its complex interactions with the community.
- iv) Students can use sophisticated tools like Geoinformatics/Geospatial Technologies for monitoring, modeling and analysis to address local environmental pollutions and natural resource management.
- v) Students will be able to disseminate environmental knowledge and awareness among local mass.
- vi) Students will be able to pursue higher studies (M.Phil and Ph.D.) and can appear in various competitive examinations like CSIR-NET, UGC-NET, ICAR-NET, GATE, etc. through which they can join different scientific projects to build a promising career in the field of scientific research.

- 6. Programme Structure:** The M.Sc. programme is a two year course divided into four semesters. The programme is of 88 credits and for the award of degree a student will be required to complete the credits as per the University norm.

# COURSE STRUCTURE OF M.Sc. ENVIRONMENTAL SCIENCE



## SEMESTER -I

Paper code	Paper Title	Nature of paper	Credit	Distribution of Marks		
				IA	ES	Total
MEV 101	Fundamentals of Ecology (CC 1)	T	4	30	70	100
MEV 102	Environmental Chemistry (CC 2)	T	4	30	70	100
MEV 103	Environmental Pollution (CC 3)	T	4	30	70	100
MEV 104	Statistical Techniques and Computer Applications (SEC 1)	T	4	30	70	100
MEV 105	Laboratory I (CC 4)	P	4	30	70	100
<b>Total</b>			<b>20</b>	<b>150</b>	<b>350</b>	<b>500</b>

## SEMESTER- II

Paper code	Paper Title	Nature of paper	Credit	Distribution of Marks		
				IA	ES	Total
MEV 201	Natural Resources and Biodiversity (CC 5)	T	4	30	70	100
MEV 202	Soil and Freshwater Ecology (CC 6)	T	4	30	70	100
MEV 203	Environmental Biotechnology (SEC 2)	T	4	30	70	100
MEV 204	Environment and Society (CC7)	T	4	30	70	100
MEV 205	Laboratory II (CC 8)	P	4	30	70	100
<b>Total</b>			<b>20</b>	<b>150</b>	<b>350</b>	<b>500</b>

## SEMESTER -III

Paper code	Paper Title	Nature of paper	Credit	Distribution of Marks		
				IA	ES	Total
MEV 301	Research Methodology (CC 9)	T	4	30	70	100
MEV 302	Climate Change and Environmental Management (CC 10)	T	4	30	70	100
MEV 303	Fundamentals of Geoinformatics (CC 11)	T	4	30	70	100
MEV 304 A	Wildlife Ecology: Wildlife Habitat and Population (DSE 1)	T	4	30	70	100
MEV 304 B	Hazards and Disaster Management: Basic Concepts (DSE 2)	T	4	30	70	100
MEV 304 C	Geoinformatics: Principles and Techniques of Remote Sensing (DSE 3)	T	4	30	70	100
MEV 304 D	Forest Ecology and Management: Basics of Forest Ecosystem (DSE 4)	T	4	30	70	100
MEV 304 E	Environmental Monitoring and Management: Basic Concepts (DSE 5)	T	4	30	70	100
MEV 305	Laboratory III: Practical on Fundamentals of Geoinformatics (General) (CC12)	P	4	30	70	100
MEV 306	Northeast India: Land, People and Culture (GE 1)	T	4	30	70	100
<b>Total</b>			<b>24</b>	<b>180</b>	<b>420</b>	<b>600</b>

## SEMESTER- IV

Paper code	Paper Title	Nature of paper	Credit	Distribution of Marks		
				IA	ES	Total

MEV 401	Environmental Geosciences and Meteorology (CC 13)	T	4	30	70	100
MEV 402 A	Wildlife Ecology: Conservation and Management (DSE 6)	T	4	30	70	100
MEV 402 B	Hazards and Disaster Management: Preparedness and Mitigation (DSE 7)	T	4	30	70	100
MEV 402 C	Geoinformatics: Principles and Techniques of GIS and GPS (DSE 8)	T	4	30	70	100
MEV 402 D	Forest Ecology and Management: Agroforestry and Forest Hydrology (DSE 9)	T	4	30	70	100
MEV 402 E	Environmental Monitoring and Management: Principles (DSE 10)	T	4	30	70	100
MEV 403 A	Wildlife Ecology: Wildlife Health and Wealth (DSE 11)	T	4	30	70	100
MEV 403 B	Hazards and Disaster Management: Issues and Policies (DSE 12)	T	4	30	70	100
MEV 403 C	Geoinformatics: Applications in Major Areas (DSE 13)	T	4	30	70	100
MEV 403 D	Forest Ecology and Management: Economics and Regulations (DSE 14)	T	4	30	70	100
MEV 403 E	Environmental Monitoring and Management: Analytical Methods (DSE 15)	T	4	30	70	100
MEV 404 A	Laboratory IV: Practical on Wildlife Ecology (DSE 16)	P	4	30	70	100
MEV 404 B	Laboratory IV: Practical on Hazards and Disaster Management (DSE 17)	P	4	30	70	100
MEV 404 C	Laboratory IV: Practical on Geoinformatics (DSE 18)	P	4	30	70	100
MEV 403 D	Laboratory IV: Practical on Forest Ecology and Management: Economics and Regulations (DSE 19)	P	4	30	70	100
MEV 403 E	Laboratory IV: Practical on Environmental Monitoring and Management: Analytical Methods (DSE 20)	P	4	30	70	100
MEV 405	Project Work (CC 14)	P	4	70	30	100
MEV 406	Disaster Management (GE 2)	T	4	30	70	100
<b>Total</b>			<b>24</b>	<b>220</b>	<b>380</b>	<b>600</b>

**IA**= Internal Assessment; **T**= Theory; **P**= Practical (*Fieldwork/Dissertation/Project etc.*)

**CC**= Core Course; **DSE**= Discipline Specific Elective; **GE**=Generic Elective (Multidisciplinary Course)

**SEC**=Skill Enhancement Course

**UNIVERSITY OF SCIENCE AND TECHNOLOGY, MEGHALAYA**  
**SYLLABUS FOR M.Sc. ENVIRONMENTAL SCIENCE**  
**SEMESTER I**



Paper Code	Paper Title	Nature of Paper	Credit	IA	ES	Marks
MEV 101	Fundamentals of Ecology (CC 1)	T	4	30	70	100
MEV 102	Environmental Chemistry (CC 2)	T	4	30	70	100
MEV 103	Environmental Pollution (CC 3)	T	4	30	70	100
MEV 104	Statistical Techniques and Computer Applications (SEC 1)	T	4	30	70	100
MEV 105	Laboratory I (CC 4)	P	4	30	70	100
<b>Total</b>			<b>20</b>	<b>150</b>	<b>350</b>	<b>500</b>

**IA**= Internal Assessment; **T**= Theory; **P**= Practical (*Fieldwork/Dissertation/Project etc.*); **ES**= End semester  
**CC**= Core Course; **DSE**= Discipline Specific Elective; **GE**=Generic Elective (Multidisciplinary Course)  
**SEC**=Skill Enhancement Course

**MEV 101: Fundamentals of Ecology (CC 1)**

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide concept and information on understanding of ecology and environmental biology. This includes knowledge about origin, components, structure and functions of the earth, ecosystem and population.

**Course outcomes:**

1. One objective is to give concept and understanding of ecology and environmental biology.
2. Students will understand functions of different ecosystems.
3. Students will be able to gain knowledge about components & structure of the earth.
4. Students will understand topics of population ecology.
5. Students will have knowledge on origin and evolution of life.

**Unit I: Ecology and Ecosystem**

Environment and Ecology: Basic concepts, Scope, Interdisciplinary nature and relevance; Environmental components and factors; Structure and composition of atmosphere, hydrosphere and lithosphere; Biosphere concept; Ecosystem: concept, structure, function(energy flow, food chain, food web, trophic levels, ecological pyramids); Biogeochemical cycles; Productivity: types, methods of estimation, factors affecting productivity; Aquatic ecosystems: structure and physico-chemical nature of fresh water, estuaries and marine ecosystem.

**Unit II: Population Ecology**

Population ecology: attributes of population- population density, fecundity, natality, mortality, migration, emigration, immigration, biotic potential, carrying capacity, survivorship and age structure; Population interactions and energetics; population dispersion and fluctuation.

**Unit III: Biotic Community**

Definition and types of biotic community, qualitative (Raunkair's classification, phonograph) and quantitative (density, abundance, frequency, relative density, relative frequency, relative dominance, Shannon diversity index, Simpson index) attributes of biotic community; Concepts of ecotone and ecotype; Ecological niche, Ecological Succession.

**Unit IV: Evolution**

Origin and Evolution of life, Theories of evolution, Concepts of species and speciation, adaptation, mutation and isolation; Origin and evolution of plant groups with special reference to flowering plants, evolution of insect pollination in angiosperms; Evolution and diversification of vertebrates with special reference to primates and man.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments - Structure and composition of atmosphere, hydrosphere and lithosphere; structure and function of ecosystem; biogeochemical cycles; estimation of productivity; population survivorship and age structure; ecological succession; ecological niche; theories of evolution of life; diversification of flowering plants. (*Compulsory - any four*).

**Essential Books:**

1. *Fundamentals of Ecology* – E.P. Odum, 1996, Natraj Publishers, Dehradun.
2. *Ecology and Environment* – P.D. Sharma, 2017 (13<sup>th</sup> ed.), Rastogi Publication.
3. *Concepts of Ecology* – E.J. Kormondy, 1996 (4<sup>th</sup> ed.), Pearson Education.
4. *Ecology and Field biology* – R.L. Smith, 1996 (5<sup>th</sup> ed.), Harper Collins Publisher, New York.

**Additional Books:**

1. *Fundamentals of Ecology* – M.C. Dash, 1993, McGraw Hill Book Company.
2. *Ecology: Individuals, Populations and Communities* – Begon, Harper and Townsend, 1996(3<sup>rd</sup> ed.), John Wiley & Sons.
3. *Ecology: the Experimental Analysis of Distribution and Abundance* – Charles J. Krebs, Addison, 1993(4<sup>th</sup> ed.), Harpercollins College Dev.

## MEV 102: Environmental Chemistry (CC 2)

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide information on fundamentals of environmental chemistry and to know the chemical composition and important reactions of air, water and soil. The paper also provides basics of instrumentation.

**Course outcomes:**

1. This course focuses to provide theoretical and conceptual knowledge on fundamentals of environmental chemistry.
2. Students will be able to understand the chemical composition and important reactions of air.
3. Students will understand water chemistry.
4. Students will know physical and chemical properties of soil.
5. Students will know different analytical methods.

### Unit I: Introduction to Environmental Chemistry

Basic concepts of Environmental Chemistry and Green Chemistry: Stoichiometry, Chemical Thermodynamics: Enthalpy, Concept of entropy, Laws of thermodynamics, Gibbs' free energy and chemical potential, chemical equilibrium, acid-base reactions, pH, solubility, buffer solutions, hydrolysis, oxidation-reductions, Gibb's energy; chemical potential; Gibb's phase equilibria; equilibrium of chemical reactions; Chemical Kinetics: Simple reaction mechanisms; order of chemical reactions; law of mass action. Chemistry of colloids, soaps, detergents, bleaching agents, lubricants and greases, phenols, CFCs, pesticides.

### Unit II: Atmospheric Chemistry

Atmospheric chemistry: composition and reactions in the lower and upper mesosphere, laws governing the behaviour of atmosphere; chemistry of air pollutants; Thermo-chemical and photochemical reactions in atmosphere; oxygen and ozone chemistry; PAN, acid rain, atmospheric aerosols, smog.

### Unit III: Water Chemistry

Physical and chemical properties of water; Parameters for water quality analysis- physical parameters, chemical parameters and biological parameters, Principle of analytical methods Titrimetry, Gravimetry, Colourimetry, Flamephotometry, Spectrophotometry, Flame Emission Spectroscopy, Chromatographic techniques, Atomic Absorption Spectrophotometry, Electrohoresis, Fluorescence.

### Unit IV: Soil Chemistry

Soil Chemistry: Chemical and mineralogical composition of soil; soil formation, soil types, soil profile, Physico-chemical properties of soil- texture, soil colour, bulk density, porosity, permeability, soil water, pH, soil organic matter, ion exchange, micro and macro nutrients, X-ray diffraction

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments chemical thermodynamics; atmospheric chemistry; acid rain and ozone chemistry; physio-chemical properties of water; spectrophotometry; chromatographic techniques; chemical and mineralogical composition of soil; formation of soil; physio-chemical properties of soil. (*Compulsory - any four*).

**Essential Books:**

1. *Environmental Chemistry* – A.K. De, 2014, New Age International (P) Limited, Seventh Edition.
2. *Environmental Chemistry* – S.E. Mannhan, 2009, CRC Press, Ninth Edition.
3. *Methods in Environmental Analysis: Water, Soil and Air* -- P.K. Gupta, 2002, Agrobios.
4. *Basic concept of Environmental Chemistry* – D.W. Connel, 2005, CRC Press.

**Additional Books:**

1. *Fundamental Concepts of Environmental Chemistry* – G.S. Sodhi, 2000, Alpha Science International Ltd.
2. *Environmental Chemistry* – B. K. Sharma and H. Kaur 2014, Goel Publishing House.
3. *Environmental Chemistry* – S.K. Banerji, 1999, PHI Learning Pvt. Ltd.

**MEV 103: Environmental Pollution (CC 3)**

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To understand the types, sources, effects, control measures and treatment processes of different types of environmental pollution.

**Course outcomes**

1. This course will enable students to learn and understand different environmental problems at local, national and global level.
2. Students will learn types, sources, effects, control measures and treatment processes of water, air and soil pollution
3. Students will know emerging water pollutants.
4. Students will know causes and impacts of radioactive pollution
5. One objective is to impart knowledge on noise control and abatement measures.

**UNIT I: Air Pollution**

Types and sources of air pollution; Criteria of air pollutants, Primary and secondary pollutants; determinants of air pollutants; Transports and diffusion of pollutants; Trans-boundary air pollution; Effects of pollutants on human beings, plants, animals, materials and on climate, Air quality standards, Methods of monitoring and control of air pollution, O<sub>3</sub> layer depletion, acid rain; Simple air pollution models – Box model, Gaussian plume model; festivals and air pollution.

**UNIT II: Water Pollution**

Types, sources and effects of water pollution; water quality standards, Eutrophication; Waste water treatment and recycling; Oil pollution; Marine pollution: sources and its control; Thermal pollution; Emerging water pollutants, festivals and water quality.

**UNIT III: Soil Pollution**

Sources of soil pollution, Physico-chemical sampling and analysis of soil quality, Interaction of waste effluents and heavy metals with soil component, effect of soil pollution, Soil pollution control; Pesticide pollution; Atmospheric deposition and soil health; Sources and effects of radioactive pollution

**UNIT IV: Noise Pollution**



Sources of noise pollution, measurement of noise pollution, noise exposure levels, effect of noise pollution control and abatement measures.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – types, sources effects and control of air pollution; primary and secondary air pollutants; methods of monitoring of air quality; types, sources, effects and control of water pollution; eutrophication; waste water treatment; thermal pollution; types, causes, effects and control of soil pollution; causes, effects and control of radioactive pollution; sources, effects and control of noise pollution.. (*Compulsory - any four*)

**Essential Books:**

1. *An Introduction to Air Pollution* – R.K. Trivedi, 2003, DVS Publication.
2. *Inorganic Contaminants of Surface Water* –W.Moore James, 1991, Springer-Verlag.
3. *Methods of Air Sampling and Analysis* – J.P. Lodge, 1988, Lewis Publishers.
4. *Air Pollution and Control* – K.V.S.G. Murlikrishan, 2016, Laxmi Publications Private Limited.
5. *Textbook of Noise Pollution and Its Control* – S.C. Bhatia, 2007, Atlantic Pulication.

**Additional Books:**

1. *Fundamentals of Ecology* – M.C. Dash, 1993, McGraw Hill Book Company.
2. *Environmental Engineering* – N.N. Basak, 2003, Tata McGraw-Hill Education.
3. *Climatology: An Atmospheric Science* –J.J. Hidore, J.E. Oliver, M. Snow and R. Snow, 2009, Pearson.

## MEV104: Statistical Techniques and Computer Applications (SEC 1)

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To make students know and familiar with the quantitative and qualitative processing and analysis of data, application of computer science and information technology with the knowledge of software and hardware.

**Course outcomes**

1. Students will learn basic concepts of statistics
2. Students will know different methods of statistical analysis and testing
3. Students will know how to use statistical tools.
4. Introduction to computer system will be easy.
5. Students will know data communication and networking.

### Unit I: Basic Statistics

Concepts and significance of statistics; Variables - Discrete and continuous; Tabulation and graphical representation of data- line diagram, bar diagram, histogram, frequency polygon, pie chart and pie diagram; Frequency distribution; Measures of central tendency- mean, mode and median; Measures of dispersion- variance, mean deviation and standard deviation; Standard error; Monte Carlo-Analysis- Moment, Skewness, Kurtosis.

### Unit II: Statistical Analysis and Testing

Concept of correlation and their types; Coefficient of correlation and their properties; Concept of regression; Coefficient of regression and their properties, Fitting of regression line; Multiple and partial correlations and regressions; Cluster analysis and its types; Principal Component Analysis (PCA); Probability theory, Hypothesis; null hypothesis; Test of hypotheses- chi square test, T-test, Z-test, F-test; Analysis of variance; basic applications of SPSS.

### Unit III: Introduction to Computer System

Introduction to computing: classification and generation of computers; building blocks of computer, concepts of hardware and software, memory; primary and secondary memories, different input, output and peripheral devices, classification of software; introduction to operating systems, functions and types of operating system.

### Unit IV: Application, Data Communication and Networking

MS DOS, M.S. Office, Presentation Tools, Spreadsheet Packages, DBMS, RDBMS Concepts. Information Technology, Concepts of Networks, Elementary Terminologies related to Networks, Internet – related Terminologies, Security and Maintenance.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – various statistical calculations, measurements and tests of significance; tabulation of data; graphical representation of statistical analysis; ANOVA; fundamental works of computer application have to be conducted and submitted by students. (Compulsory - any four).

### Essential Books:

1. *Statistical Methods* – S.P. Gupta and S.P. Gupta, 2005, Sultan Chand and Sons.
2. *B.Sc. Statistics* Vol. I and II – D. Bhattacharjee and D. Bhattacharjee, 2010, Kalyani Pulb., Ludhiana, India.
3. *Fundamentals of Computers* – V. Rajaraman, 2014(6<sup>th</sup> ed.), Prentice Hall of India, New Delhi.
4. *Fundamentals of Information Technology* – Deepak Bharihoke, 2012, Excel Books.
5. *Basic Computer Course Book* – P. Colleti, (8<sup>th</sup> ed.), 2018, Bolzano Bozen.

### Additional Books:

1. *Biostatistics* – B.G. Williams, 1993, Chapman and Hall, New York.
2. *Foundations of computing* – P.K. Sinha & P. Sinha, 2002, BPB Publication.

## MEV105: Laboratory I (CC 4)

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide a space and knowledge where students can utilize the theoretical knowledge with practical and manual applications.

**Course outcomes:**

1. Students will be able to do basic practicals in Ecology.
2. Identification and population estimation in a pond ecosystem
3. Students will be able to estimate different water quality parameters
4. Knowledge on identification and management options of solid waste.
5. Students will know hands on practicals on basic computer tools.

➤ **Practicals on Fundamentals of Ecology:**

1. Estimation of Leaf Area Index (LAI).
2. Visit to aquatic ecosystem, Identification and population estimation of macrophytes in a pond ecosystem.
3. Determination of population density, abundance & frequency by quadrat method.
4. Estimation of diversity indices (Shannon diversity index, Simpson index).
5. Estimation of similarity index.
6. Determination of abiotic factors in different terrestrial habitats.
7. Study of allelopathic effects of some common plant species.

➤ **Practicals on Environmental Chemistry and Pollution:**

1. Study of pH of water.
2. Measurement of turbidity in aquatic ecosystem by Secchi disc.
3. Estimation of free CO<sub>2</sub> in different water samples.
4. Analysis of water and effluent - Physical parameters, Chemical parameters, Nutrient parameters and Bacterial parameters.
5. Colorimetric experiments - Estimation of Fe<sup>2+</sup>, Fe<sup>3+</sup> and Ni<sup>2+</sup>
6. Study of sound level using decibel meter.
7. Identification of solid waste material inside the university campus.
8. Local Field visit.

➤ **Practicals on basics of Computer Application:**

1. Hands on practice on basic computer tools (specially MS Office tool)

**Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.

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**SEMESTER II**

Paper Code	Paper Title	Nature of Paper	Credit	IA	ES	Marks
MEV 201	Natural Resources and Biodiversity (CC 5)	T	4	30	70	100
MEV 202	Soil and Freshwater Ecology (CC 6)	T	4	30	70	100
MEV 203	Environmental Biotechnology (SEC 2)	T	4	30	70	100
MEV 204	Environment and Society (CC 7)	T	4	30	70	100
MEV 205	Laboratory II (CC 8)	P	4	30	70	100
<b>Total</b>			<b>20</b>	<b>150</b>	<b>350</b>	<b>500</b>

**IA=** Internal Assessment; **T=** Theory; **P=** Practical (*Fieldwork/Dissertation/Project etc.*); **ES=** End semester  
**CC=** Core Course; **DSE=** Discipline Specific Elective; **GE=** Generic Elective (Multidisciplinary Course)

**SEC=**Skill Enhancement Course

**MEV 201: Natural Resources and Biodiversity (CC 5)**

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide concept and information on understanding of biodiversity, its importance, threats and conservation strategies. The paper also deals with different types of natural resources and their utilization.

*Course outcomes*

1. Students will understand different natural resources, their utilization and management strategies
2. Students Will know conventional and non-conventional energy resources
3. This course will provide concept and information on understanding of biodiversity, its importance, threats and conservation strategies.
4. One objective is to make students familiar with different types of natural resources, their utilization and conservation.
5. Students will know different conventions and policies of Biodiversity.

**Unit I: Natural resources: utilization, management and conservation**

Natural Resources: definition and classification-Inexhaustible and Exhaustible resources; Concepts of Forest resources, Land resources, Water resources, Mineral resources, Food resources.

Energy resources: Non-renewable energy resources- (Coal, Petroleum, Oil and Natural gases) and renewable energy resources – (Hydropower, Biomass energy, Tidal power; Wind energy, Geothermal energy and solar energy); Conventional and Non-conventional energy resources.

**Unit II: Biodiversity and Biodiversity hotspots**

Biodiversity: Concept of biodiversity, level of biodiversity, values of biodiversity, threat to biodiversity, IUCN Red list, Global biodiversity, Biodiversity of India with special reference to NE India; Biogeographical regions of India; Biodiversity Hotspots; Mega diversity nations.

**Unit III: Conservation of Biodiversity**

Biodiversity conservation: Biodiversity conservation strategies; In situ conservation – (wildlife sanctuaries, national parks, biosphere reserves, community conservation areas); Ex-situ conservation – (botanical gardens, zoos, aquaria, homestead garden; herbarium; germplasm and gene bank); The Man and the Biosphere Programme; Ethnoecology; Indigenous approaches to biodiversity conservation; IPR in Biodiversity, TKDL.

**Unit IV: Conventions and policies of Biodiversity**

Biodiversity Conventions, Biodiversity Act (2002); Forest laws; National and International Programmes for biodiversity conservation. Wildlife of India, its distribution, values, threats and management system; role of WWF, WCU, CITES, TRAFFIC; Eco-tourism.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – types, utilization and management of forest resources, land resources, water resources, mineral resources; wind energy as resource; hydropower energy as resource; solar energy as resource; values and threats of biodiversity; conservation of biodiversity; biogeographical zones of India; biodiversity hotspots of the world and India; TKDL; eco-tourism; Biodiversity Act (2002); role of WCU, CITES and TRAFFIC in biodiversity conservation. (*Compulsory - any four*).

**Essential Books:**

1. *Biodiversity: an introduction*- K.G. Gaston, 2004 (2<sup>nd</sup> Edition), Blackwell Science Ltd.
2. *Biodiversity: monitoring, management, conservation and enhancement*. R.R. Geeta Bali, 2004, APH Publishing, New Delhi.
3. *Biodiversity concept, conservation and bioculture*. F.B. Mandal and N.C. Nandi, 2009, Asian Books Pvt. Ltd.

**Additional Books:**

1. *The Forest Types of India* – H.G. Champion and S.K. Seth, Govt. of India Publication, New Delhi, 1968,
2. *Ecology of Natural Resource* – F. Ramade, 1984, Wiley-Blackwell.
3. *Natural Resource Conservation: An Ecological Approach*– O.S. Owen and D.D Chiras, 1990, Macmillan.

**MEV 202: Soil and Freshwater Ecology (CC 6)**

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide concept and information on understanding of basics of soil and freshwater ecology. This includes knowledge about soil sciences, soil flora and fauna, freshwater communities and, ecosystems. Students also get the knowledge of major river systems of the country.

*Course outcomes:*

1. This course will provide concept and information on soil ecology. This includes knowledge about soil sciences, soil flora and fauna; and important soil processes.
2. Students will understand soil ecosystems.
3. Students will understand agro-ecosystems in India with reference to North East India
4. Topics of freshwater ecology will be understood.

The course will allow students to understand freshwater communities and ecosystems with knowledge of major river systems of the country.

**Unit I: Soil properties**

Soil formation and development; physical and chemical properties of soil (soil colour, texture, bulk density and porosity, soil water, soil air, soil temperature, pH, salinity, acidity, alkalinity, etc.); soil profile; soil nutrients and their availability; earthworm activity and vermicompost; green manuring; factors of soil formation; movement of water in soil; aeration of soils, soil organic matter.

**Unit II: Soil ecosystem**

Development of the soil ecosystem, soil microorganisms and plants (rhizosphere, mycorrhizae, rhizobium and root nodules); microbiological process and nutrient cycling; decomposition of organic matters by soil microorganisms and soil fauna; production of biofertilisers, pesticides by microorganisms and plants; soil for growth and development of plants; Agroecosystems in India with special reference to Northeast India; agro ecological zones of India.

**Unit III: Freshwater ecology**

Lentic and Lotic ecosystems – types, formation, distribution, zonation and stratification; major lakes and reservoirs in India, high altitude lakes; major rivers in India; wetlands – definition, classification, values, threats; watershed management; conservation and restoration of freshwater resources in India.

**Unit IV: Productivity in freshwater ecosystem**

Freshwater communities: phytoplankton, zooplankton, macrophytes, insects, invertebrates, vertebrates, fishes and aquaculture; Environmental factors affecting freshwater ecosystems, nutrient cycle and productivity in freshwater ecosystem.





## MEV 204: Environment and Society (CC 7)

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide the knowledge about the environment, society and economic relationship, importance of environmental studies in formal and non-formal education system, environmental movements and environmental conventions and treaties.

**Course outcomes:**

1. This course will make students able to understand the complex relationship between environment, society and economy.
2. Students will understand role of traditional ecological knowledge in environmental conservation.
3. This course provides the knowledge about the importance of environmental studies in education system
4. Students will know about different environmental awareness programmes, movements, treaties and conventions.

Students will understand environmental economics.

**Unit I: Environmental Sociology**

Concept of Environmental Sociology; Environmental history; Culture and Environment, Socio-Cultural and Environmental Theories; Social Inequality; Environmental Degradation and Social Integration; Social Gender Analysis; Role of traditional ecological knowledge in environmental conservation.

**Unit II: Environmental Education and Ethics**

Environmental education: Goals, objectives and components of environmental education; environmental education in India; value education, valuing nature and cultures; Environmental ethics: definition, history, scope and basic concepts; anthropocentrism, biocentrism; ecocentrism; deep ecology and ecofeminism.

**Unit III: Environmental awareness and movements**

Environmental awareness and action: Role of NGOs in environmental awareness; environmental movements in India- silent valley movement, Chipko movement, Narmada bachao andolan; environmental movements in the west- greenpeace, sierra club etc.; international efforts and government action; recent campaigns like *Swach Bharat Abhiyan* related to environment, health and sanitation.

**Unit IV: Environmental Economics**

Concept of Environmental Economics; Environmental behaviour and effectiveness of economics; environmental valuation methods; Environmental accounting of natural resources.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – socio-cultural and environmental theories; role of indigenous communities in environmental conservation; goal, objectives and models of environmental education; history of environmental education in world and in India; environmental ethics; environmental movements in India; *Swach Bharat Abhiyan*; environmental accounting of natural resources. (Compulsory - any four).

**Essential Books:**

1. *The Indian forest act, 1927 along with forest conservation act, 1980* -- Anonymous, Natraj Publisher's Dehradun.
2. *The Unquiet woods* -- R. Guha, 1989, Oxford University Press
3. *Social ecology* -- R. Guha (Ed.), 1994, Oxford University Press
4. *Ecology and society: an introduction*-- L.Martell, 1994, Polity press, Cambridge, U.K.

**Additional Books:**

1. *Ecological thought: An introduction* -- I.M. Hayward, 1995, Polity press, Cambridge.
2. *Text book of environmental studies* --: E. Bharucha, 2004, University Press, Hyderabad.
3. *Ecology (Key concepts in critical theory)* --C. Merchant, 1994, Humanities Press International
4. *Environmental studies* -- M. Tiwari, K.Khulbe and A. Tiwari, 2009, I.K. International, New Delhi.



## MEV 205: Laboratory II (CC 8)

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide a space and knowledge where students can utilize the theoretical knowledge with practical and manual applications. The paper also carries a mandatory field visit.

**Course outcomes:**

1. This course allows students to enhance practical knowledge on Biodiversity in baseline study.
2. Study of plant diversity and determination of dominant plant species in a forest ecosystem will be easy.
3. Students will be able to determine different physic-chemical properties of soil.
4. Study of zones of India from agroecological map and study of soil types in India will be easy.
5. Students will learn practicals of environmental biotechnology.

➤ **Practicals on Biodiversity:**

1. Baseline study of status of Biodiversity in the University campus and different threats to it.
2. Study on ethnobotanical and ethnozoological practices of tribes of NE India.
3. Study of plant diversity in a forest ecosystem.
4. Determination of dominant plant species in a forest ecosystem.

**Essential Books:**

1. *Ecology* – P.D. Sharma
2. *Fundamentals of Ecology* – M.C. Dash

➤ **Practicals on Soil Ecology:**

1. Practical: Determination of physic-chemical properties of soil sample: colour, bulk density, porosity, texture, pH, temperature, moisture, water holding capacity.
2. Practical: Determination of soil organic matter; determination of soil nutrients; study of zones of India from agroecological map (NBSS & LUP); study of soil types of India.

**Essential Books:**

1. *Atmosphere, Weather and Climate* – G.G. Barry and Chorley, Methuen and Co., London.
2. *Climatology* – D.S. Lal, Sharda Pustak Bhawan, Allahabad

➤ **Practicals on Environmental Biotechnology:**

1. Study of microbial diversity in rhizosphere and phytosphere in an ecosystem.
2. Bacteriological analysis of water (presumptive, confirmed and complete test).
3. Determination of BOD and COD of waste water.
4. Biodegradation of cellulose.
5. Determination of decomposition rate of litter.
6. Isolation of microorganisms from polluted sites.
7. Hydrolysis of starch and casein.
8. Composting of waste practices.

**Essential Books:**

1. *Environmental Science and Technology* – S.E. Manahan (1997), Lewis, New York.
2. *Wastewater Engineering: Treatment and Reuse* – Metcalf and Eddy (Eds.) 2003, Tata McGraw-Hill, New Delhi.
3. *Environmental Biotechnology: Theory and Application* – G.M. Evans and J.C. Furlong (2003) John Wiley and Sons.
4. *Biotechnology and Safety Assessment* – J.A. Thomas and R. Fuchs (2002) Academic Press.
5. *Advanced Physicochemical Treatment Processes* – L.K. Wang L.K., Y.T. Hung and N.K. Shamma 2006, Springer-Verlag, New York, LLC.

➤ **Field visit.**

- **Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There

should not be more than 7 days between these two dates for each exercise / home assignment completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.

**UNIVERSITY OF SCIENCE AND TECHNOLOGY, MEGHALAYA**  
**SYLLABUS FOR M.Sc. ENVIRONMENTAL SCIENCE**  
**SEMESTER III**

Paper Code	Paper Title	Nature of Paper	Credit	IA	ES	Marks
MEV 301	Research Methodology (CC 9)	T	4	30	70	100
MEV 302	Climate Change and Environmental Management (CC 10)	T	4	30	70	100
MEV 303	Fundamentals of Geoinformatics (CC 11)	T	4	30	70	100
MEV 304 A	Wildlife Ecology: Wildlife Habitat and Population (DSE 1)	T	4	30	70	100
MEV 304 B	Hazards and Disaster Management: Basic Concepts (DSE 2)	T	4	30	70	100
MEV 304 C	Geoinformatics: Principles and Techniques of Remote Sensing (DSE 3)	T	4	30	70	100
MEV 304 D	Forest Ecology and Management: Basics of Forest Ecosystem (DSE 4)	T	4	30	70	100
MEV 304 E	Environmental Monitoring and Management: Basic Concepts (DSE 5)	T	4	30	70	100
MEV 305	Laboratory III: Practical on Fundamentals of Geoinformatics (General) (CC 12)	P	4	30	70	100
MEV 306	Northeast India: Land, People and Culture (GE 1)	T	4	30	70	100
<b>Total</b>			<b>24</b>	<b>180</b>	<b>420</b>	<b>600</b>

**IA**= Internal Assessment; **T**= Theory; **P**= Practical (*Fieldwork/Dissertation/Project etc.*); **ES**= End semester  
**CC**= Core Course; **DSE**= Discipline Specific Elective; **GE**=Generic Elective (Multidisciplinary Course)

**SEC**=Skill Enhancement Course

**MEV 301: Research Methodology (CC 9)**

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To create a background and awareness of the nature of research process and inquiry. It will expose the student to the methodological problems encountered in interdisciplinary research.

**Course outcomes**

1. This course will allow students to create a basic knowledge and awareness about the nature of research process and inquiry.
2. It also provides student an exposure to the methodological problems encountered and ways to deal in interdisciplinary research.
3. This course will provide knowledge and foundation on different types of research options
4. Students will learn sampling, data collection and data processing.
5. The course will help students to know research process.

**Unit I: Introduction to Research**

Meaning and characteristics of science and scientific method, steps in scientific method, objectives of research, types of research, research design; hypothesis: meaning, types, formulation, importance and difficulties.

### Unit II: Sampling and Data Collection

Sampling - meaning, types, procedure, selection, merits and demerits, data collection - sources of data collection, primary and secondary; techniques of data collection - empirical observation, interview, questionnaire, interview and schedule.

### Unit III: Data Processing analysis

Salient features of processing of qualitative and quantitative data; variable construction, tabulation and charting; data processing tools- spreadsheets, SPSS, GIS software packages; hypothesis testing and validation; data interpretation, analysis and conclusion.

### Unit IV: Research process

Introduction to research problem; survey of literature; project formulation; structural elements of scientific report; moral and ethical issues of research; plagiarism; paraphrasing; copyright violation; importance of revisions; guidelines on punctuation, using quotations, footnotes, references and bibliography.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – hypothesis-meaning and types, techniques of data collection, importance of literature review in research; references and bibliography; plagiarism; problems in research; formulation of research proposal. (*Compulsory - any four*).

#### Essential Books:

1. *Writing Your Thesis*, 2013(3<sup>rd</sup> ed.), Paul Oliver, New Delhi: Sage.
2. *Research Methods in the Social Sciences* – Bridget Somekh and Cathy Lewin, 2004, Sage Publication.
3. *Research Methodology: Methods and Techniques* – C.R. Kothari, 2004, New Age International (P) Limited, Publishers, New Delhi.
4. *Research Methodology* – Ram Ahuja, 2001, Rawat Publ. Jaipur.

#### Additional Books:

1. *Methods In Social Research* – Wililam J. Goode and Paul H.Hatt, (Indian Edition), McGraw Hill, New Delhi.
2. *Survey Methods in Social Investigation* – Sir Claus Moser and Grahm Kalton, Dartmouth, New York.

## MEV 302: Climate Change and Environmental Management (CC 10)

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To make students understand the phenomena of climate change, concepts of environmental management and sustainable development.

#### Course outcomes

1. This course will make students understand the phenomena of climate change
2. Students will understand climate change mitigation and global responses.
3. The course also provides basic concepts on understanding the process of Environmental management.
4. Concept of sustainable development will be understood.
5. Environmental priorities in India for sustainable development and challenges will be understood.

### Unit I: Introduction to Climate Change

Climate change, global warming and greenhouse effect; indicators of climate change; greenhouse gases in the atmosphere: sources, levels and mechanisms of action; climate change effects on forests, agroecosystems, freshwater and marine ecosystems, rainfall pattern; socio-economic and public health consequences of climate change.

### Unit II: Climate Change Mitigation and Global responses

Carbon storage and sequestration; sequestration of forest, ecosystems and wetlands; Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol, REDD+; The Copenhagen Accord; India's response to climate change; Projected impact of climate change in India; National Action Plan on climate change. Role of India and Northeast India in response of climate change.

### Unit III: Introduction to Environmental Management

Concept of environmental management; Environmental Planning; EIA process; Projects screening, scoping, impact

identification, prediction, evaluation, mitigation and monitoring; Environmental Management Plan; Environmental auditing, Cost benefit analysis; Public participation in environmental decision making; ISO certification; Ecomark; EIA regulations and notifications in India.

#### Unit IV: Sustainable Development

Concept of sustainable development and sustainability; Indicators of sustainability; Sustainable management of renewable resources (land, water, forest etc.) and non-renewable resources (minerals, fossil fuels etc.); Strategies for Sustainable development; Environmental priorities in India for sustainable development; Challenges to meet sustainability; Sustainable Development Goals.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – global warming and green house effect; effect of climate change on forest ecosystem, effect of climate change on aquatic ecosystems; carbon sequestration; Kyoto Protocol; REDD+; International mitigation measure against climate change; EIA procedure in India; Ecomark; indicators of sustainability; United Nations SDGs and MDGs; challenges to meet sustainability. (*Compulsory - any four*).

#### Essential Books:

1. *Adaptation and mitigation strategies for climate change* – S.Akimasa, F. Kensuke and A. Hiramatsu, 2010, Springer.
2. *Climate Change: A multidisciplinary Approach* – W.J. Burroughs, 2007 (2<sup>nd</sup> ed.), Cambridge University Press.
3. *Climate Change: An Indian Perspective* – S.K.Dash, 2007, Cambridge University Press, New Delhi.
4. *Environmental planning, policies and programs in India* – K.D. Saxena.
5. *Introduction to Environmental Impact Assessment (2<sup>nd</sup> Ed.)* – J. Glasson, R. Therivel and A. Chadwick, UCL Press, Philadelphia, USA, 1994.

#### Additional Books:

1. *Emissions trading and carbon management* – A.N. Sarkar, 2010, Pentagon Earth.
2. *Climate change and developing countries* – N.H. Ravindranath, N. Ravindranath and J.A. Sathaye, 2002, Kluwer Academic Publisher.
3. *Climate Change 2014: Synthesis Report, Fifth Assessment Report, 2014*, IPCC, Geneva, Switzerland.

### MEV 303: Fundamentals of Geoinformatics (CC 11)

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To appraise the benefits of geo-informatics in geo-environmental studies and provide direction to take up research on thrust areas for future development in geo-informatics and its application.

#### Course outcomes

1. This course focuses to make students learn the basic concepts of remote sensing.
2. Students will understand Aerial Photographs and image interpretation.
3. Students will learn principles of Geographical Information System.
4. Principles and methodologies in Global Positioning System will be understood
5. Students will learn Global Navigation Satellite System

#### Unit I: Remote Sensing

Definition and basic concept of Remote Sensing, Its history of development; Electromagnetic spectrum and Spectral reflectance; Types of Remote Sensing based on sensor characteristics; Remote sensing Sensors and

satellites: Indian and other countries (LANDSAT, IRS, IKONOS, QUICK BIRD, CARTOSAT), Data products and their specifications.

### **Unit II: Aerial Photographs and Image interpretation.**

Aerial photography: Aerial photographs and their types and sensors; Scale and distortion of aerial photographs; Geometry of vertical aerial photographs, Steroscopy, Visual interpretation of aerial photographs and satellite images: Elements of image / photo interpretation and interpretation keys. An introduction to Digital Image Processing (DIP) Systems; DIP Techniques: Image enhancements; Supervised and Unsupervised classification.

### **Unit III: Geographical Information System**

GIS: Introduction, Principles and concept; GIS components and softwares; Spatial and non-spatial data; Raster and Vector data structure, their properties; Georeferencing: coordinate and projection system; datum concept; Thematic mapping of attribute data for points, lines and polygons, Map design and layout.

### **Unit IV: Global Positioning System and Global Navigation Satellite System**

GPS- Definition, history and fundamentals. Types of GPS; Accuracy of GPS, GPS Signal, Errors in Signals; Concept, principles and applications of DGPS; Navigation system – GNSS, GLONASS, Galileo, IRNSS; Application areas of GPS with focus on survey and navigation.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Home assignments - Drawing of Electromagnetic spectrum, List of Remote Sensing data products with specifications by satellite, Scale of aerial photograph, Image classification steps, Georeferencing and digitization flow charting, Data structures, Map Design and layout format, Thematic mapping steps (*Compulsory - any four*).

#### **Essential Books:**

1. *Remote Sensing Principles and Interpretation* – F.F. Sabins, 1987, W.H. Freeman & Co., New York.
2. *Remote Sensing for the beginner* – P.K. Guha, 2013, Affilate East West Publishers, New Delhi.
3. *Remote Sensing and Image Interpretation* – Thomas M. Lillesand, Ralph W. Keifer and J. Chipman (6<sup>th</sup> ed.), 2011, John Wiley, New York.
4. *Remote Sensing of the Environment: An Earth Resource Perspective* – J.R. Jensen, (2<sup>nd</sup> ed.), 2013, Pearson Education, New Delhi.
5. *An Introduction to GIS* – I. Heywood, S. Cornelius and S. Carver (4<sup>th</sup> ed.), 2012, Pearson, New Delhi.
6. *Remote Sensing in Land Evaluation* – R.S. Yadav, 1997, Rajesh Publication, New Delhi.

#### **Additional Books:**

1. *Introduction to Remote sensing* – G. Joseph, 1999, Universities Press, Hyderabad.
2. *Essential of GPS* – N.K. Agarwal, 2004, Spatial Networks Pvt. Ltd., Hyderabad.
3. *Global Positioning System Priciples and Applications-* S.Gopi, 2005, Tata McGraw Hill, New Delhi.
4. *Handbook of Aerial photography and Interpretation* – K.K. Rampal, Concept Pulb. Comp., New Delhi.
5. *Introduction to Geographic Information System* – Kang-tsung Chang (4<sup>th</sup> Ed.), Tata McGraw-Hill.
6. *Essentials of GPS* – N. K. Agarwal, 2004, Spatial Networks Pvt. Ltd., Hyderabad.

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide basic concept and information on wildlife, its importance, threats, management and conservation strategies. The paper also provides a space to know about the wildlife of the India with special reference to NE India.

**Course outcomes:**

1. This course helps students to know the basic concept and information on wildlife habitat and population.
2. It allows students to know about the wildlife of India with special reference to NE India.
3. It will help draw the students more and more connected to the nature and wildlife and their importance in nature.
4. Wildlife population and migration will be understood.
5. Students will know wildlife census and conflict issues.

**Unit I: Introduction to wildlife habitat I**

Characteristic, composition and distribution of terrestrial ecosystem (with special reference to grassland and forest ecosystems of N E India as wildlife habitat); Wetlands of NE India as wildlife habitat; Wildlife zones in India;

**Unit II: Introduction to wildlife habitat II**

Habitat fragmentation; Habitat assessment indices- community dominance index (CDI), canopy area coverage, foliage height diversity (FHD); Concept of key stone and umbrella species.

**Unit III: Wildlife population and migration**

Feeding and social behavior; Social organization in animals; animal migration, factors determining migration in animals; Migratory birds and migratory routes of birds in India; Amphibian and reptilian fauna of India; Herpeto-fauna in India; Lepidoptera in India; Big cats and mammals in India.

**Unit IV: Wildlife census and conflict issues**

Techniques of wildlife census and population survey; wildlife corridors, human dimensions in wildlife habitat; human-animal conflict issues and cases, factors leading to human-wildlife conflicts; Case studies of some important wildlife of India with special reference to N. E. India.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – forest as wildlife habitat; grasslands as wildlife habitat; wetlands as wildlife habitat; keystone and umbrella species; bird migration in India; Butterflies of India and northeast India; Hepeto-fauna diversity in northeast India; Elephants of India; Tigers of India; One horned Rhino of Assam; techniques of wildlife census; human dimensions in wildlife habitat; factors causing man-animal conflict; problems of elephant corridors in northeast India. (*Compulsory - any four*)

**Essential books:**

1. *A treatise on wildlife conservation in India* – C. Das, 2007, Eastern Book Corporation, New Delhi.
2. *Conserving wildlife* – S.K. Jacobson, 2002, Eastern Book Corporation, New Delhi.
3. *Endangered animals of India* – A.K. Mukherjee, 1982, Zoological Survey of India, Kolkata.
4. *Handbook of national parks, wildlife sanctuaries and biosphere reserves in India* – S.S. Negi, 2002, Eastern Book Corporation, New Delhi.
5. *Wildlife in India* – V.B. Saharia, 1990, Natraj Publishers, Dehradun

**Additional Books:**

1. *The wildlife protection act, 1972 (as amended up to 2004)* – Anonymous (2004), Natraj publisher, Dehradun.
2. *Threatened animals of India* – B.K. Tikadar, 1983, Zoological Survey of India. Kolkata.
3. *Wildlife in the Himalayan foothills: conservation and management* – P.C. Tiwari and J. Bhagwati, 1997, Eastern Book Corporation, New Delhi.
4. *Wildlife tourism and conservation*– A. Mallya , 2006, Eastern Book Corporation, New Delhi.



**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objectives:** To provide indepth knowledge on various types natural and human induced disasters and to understand the techniques and tools for preparedness, mitigation and overall management of various disasters.

**Course outcomes:**

1. This course provides concepts related to hazard and disaster.
2. Students will know disaster phenomena and events at global, national and regional levels.
3. Students will know mechanism, causes and consequences of different geological hazards.
4. Mechanism, causes and consequences of hydro-meteorological hazards will be understood.
5. Students will know the contribution of human activities to the cause of various disasters.

**UNIT I: Understanding Hazard and Disaster**

Definitions and concepts of hazard, risk, vulanerability, capacity and disaster; types, causes and effects of hazards; difference between hazard and disaster; stages of disaster; disaster phenomena and events (global, national and regional); disaster management cycle.

**UNIT II: Introduction to Geological Hazards and Disasters**

Mechanism, causes and consequences of geological hazards: earthquakes, volcanic eruption, landslides, tsunamis, mine fire.

**UNIT III: Introduction to Hydro-Meteorological Hazards and Disasters**

Mechanism, causes and consequences of hydro-meteorological hazards: floods, droughts, snow falls, cloudburst, cyclones.

**UNIT IV: Introduction to Man Made Hazards and Disasters**

Definitions, concepts and understanding of man-made disasters; fires and forest Fires; nuclear, biological, industrial and chemical disasters; accident related disasters; occupational hazards.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment-Hazard-Risk-Vulnerability, Disaster phenomena and events, Disaster Management Cycle, Earthquakes, Landslides, Floods, Droughts, Fires and Forest Fires, Nuclear, Biological, Industrial and Chemical disasters, Accident related disasters. (Compulsory – any four)

**Essential books:**

1. *Natural Hazards* – Bryant Edwards, 2005, Cambridge University Press, U.K.
2. *Disaster Management* – Carter, W. Nick, 1991, Asian Development Bank, Manila.
3. *Flood Atlas of India* – Central Water Commission, 1987, CWC, New Delhi.
4. *Manual of Flood Forecasting* – Central Water Commission, 1989, CWC, New Delhi.
5. *Vulnerability Atlas of India* – Government of India, 1997, New Delhi.
6. *Disaster Mitigation Experiences and Reflections* – Sahni, Pardeep et.al. (eds.) 2002, Prentice Hall of India, New Delhi.

**Additional Books:**

1. *Vulnerable India* – AnuKapur, 2010, Sage publications, New Delhi.
2. *Housing in Disaster prone areas, National Building Organization and U.N. Regional Centre.* G.C Mathur, 1986, ESCAP, New Delhi.
3. *Transforming adversity into opportunity: experiences from Gujarat earthquake reconstruction program World congress on Natural disaster mitigation proceedings*, 2004, P.K. Mishra, February.
4. *Natural Hazards and Disasters Management-Vulnerability and Mitigation*, R.B. Singh, 2006, Rawat Pulb.



**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To understand the principles and techniques of Remote Sensing and to develop competency in data processing and analysis by using the science and technology of geoinformatics.

*Course outcomes*

1. This course helps students to understand the principles and techniques of Remote Sensing.
2. Students will know Digital Image Processing techniques.
3. Students will know Digital Image classification techniques.
4. Students will know post classification analysis.
5. Students will know the various areas and application of remote sensing tools in solving environmental issues and crisis.

### **Unit I: Principles and Techniques of Remote Sensing**

Principles of remote sensing, Energy radiation processes, Remote Sensing platforms - Geosynchronous and Sun synchronous satellites, Spectral reflectance based on characteristics of earth surface (rocks, soils, vegetation, water); Remote Sensing data characteristics - Spectral resolution, radiometric resolution, spatial resolution and temporal resolution; Principles of thermal, hyper spectral and microwave remote sensing and Basic idea on Synthetic Aperture Radar (SAR) data.

### **Unit II: Digital Image Processing: Data Preparation**

Data sources and characteristics of data, Geometric and radiometric correction of Remote Sensing digital data; Image segmentation (point, line, edge and combined detection), subsetting; resampling techniques; Image enhancement: Spatial domain methods and frequency domain methods.

### **Unit III: Digital Image Classification Techniques**

Elements of image analysis - low, intermediate and high level processing; Image supervised classifiers - Maximum Likelihood, Minimum distance, Minimum Mahalanobis distance, Spectral angle; Theoretical framework of unsupervised classification/ ISODATA classification, Clustering by K-means, Intelligent classifiers.

### **Unit IV: Image Post Classification Analysis**

Ground truth collection by GPS or Spectrometer, Computation and interpretation of error matrix / confusion matrix, Kappa and Lamda coefficients for accuracy assessment; Change detection analysis, Advantages and disadvantages of classification techniques, Presentation of classification reports.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Home assignments - Drawing of Electromagnetic spectrum, List of Remote Sensing data products with specifications by satellite, Scale of aerial photograph, Image classification steps, Georeferencing and digitization flow charting, Data structures, Map Design and layout format, Thematic mapping steps (*compulsory - any four*).

### **Essential Books:**

1. Kumar, Meenakshi *Remote Sensing*, NCERT.
2. Guha, P.K., 2013: *Remote Sensing for the Beginner*, Affiliate East West Publishers, New Delhi.
3. Yavav, R. S. 1997: *Remote sensing in Land Evaluation*: Rajesh Publications, New Delhi.
4. Agarwal, N. K. 2004: *Essentials of GPS*, Spatial Networks Pvt. Ltd., Hyderabad.
5. Curran, Paul J., 1985: *Principles of Remote Sensing*, Longman, London & New York

### **Additional Books:**

1. Gupta, R. P., 2003, *Remote Sensing Geology*, Springer-Verlag.
2. Jensen, J.R., 2011, *Introductory Digital Image Processing: A Remote Sensing Perspective*, New Jersey: Prentice-Hall.
3. Lillesand, T. M. and Kiefer R. W., 2011: *Remote Sensing and Image Interpretation* – (6<sup>th</sup> Ed.), Wiley.

4. Joseph, G. 2005: *Introduction to Remote Sensing*, Universities Press (India) Pvt. Ltd, Hyderabad.
5. Rampal, K K, 1993: *Handbook of Aerial photography and Interpretation*, Concept Publication. Comp. New Delhi.



**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** *To provide indepth knowledge on structures and functions of forest ecosystems, regeneration processes and management of forest ecosystems.*

**Course outcomes**

1. This course is aimed to provide basic concepts and principles of forest ecosystem
2. Students will learn topics of Forest regeneration processes
3. Students will know forest management.
4. Students will understand forest productivity.
5. Concepts, dimensions and measures of forest diversity will be understood.

**Unit I: Introduction to Forest Ecosystem**

Forest and Forestry: Definition, branches of forestry and their relationships; types and structure of forest ecosystem; Bioclimate and micro climate effects on forest; Major forest types of the world; Forest types and forest cover of India with special reference to North East India.

**Unit III: Forest regeneration**

Forest regeneration; factors affecting forest regeneration; Natural, artificial and mixed regeneration; Natural regeneration - seed production, seed dispersal, germination and establishment; flowering, fruiting and seeding behavior; tropical trees and their characteristic features; phenology of trees; seed dormancy and germination.

**Unit III: Forest Productivity**

Productivity of forest ecosystems; Patterns of primary productivity in forest ecosystems; Litter production and decomposition of litter; Nutrient cycling and nutrient conservation strategies; Biomass of forest; methods of estimation of forest biomass.

**Unit IV: Forest Biodiversity**

Forest biodiversity: Concepts and dimensions of forest biodiversity; measures of forest diversity; functional attributes related to forest biodiversity; biodiversity in secondary forests; climate change and forest biodiversity.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – forest ecosystem-types, structure and function; micro climate effect on forests; forest types of India; regeneration of forest; phenology of trees; seed dormancy and germination; productivity in forest ecosystems; decomposition and litter production in forest; forest diversity-dimensions and measures; effect of climate change on forest biodiversity. (Compulsory – any four)

**Essential books:**

1. *Forest ecology*– Barnes, B V; Zak, D R; Denton, S R and Spurr, S R, 1998, (4th edition). John Wiley and Sons.
2. *Agroforestry in sustainable agricultural systems*– Buck, L.E. Lassoie, J.P. and Fernandez, E.C.M., 2002, CRC Press.
3. *A revised survey of the forest types of India* (Reprinted 2004) – Champion, H.G. and Seth, S.K., 1968, Natraj Publication, Dehradun.
4. *Forestry in India* – Diwedi, A P, 1993, Surya Publications, Dehradun.
5. *Plantation forestry in the tropics* – Evans, J. and Turnbull, J., 2004 (3rd Edition). Oxford University Press

**Additional Books:**

1. *The Indian Forest Act, (1927) along with Forest Conservation Act 1980*, Natraj Publishers, Dehradun.
2. *Survey of the diseases important native and exotic forest trees in India*– Bakshi, B.K., Ram Reddy, M.A., Puri, Y.N. and Singh, S. ,1972, FRI Publication, Dehradun.
3. *Forest entomology* – Jha, L.K. and Sen-Sarma, P.K., 1994, Ashish Publishing House, New Delhi.
4. *Joint forest management in India* – Ravindranath, N.H., 2004, Oxford University Press.
5. *Forest ecosystems: concepts and management* – Waring, R.H. and Schlesinger, W.H., 1985, Academic Press, New York.



**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objectives:** To provide basic knowledge on principles of environmental monitoring of air, water and soil pollutions, toxic and hazardous substances, and their impacts.

*Course outcomes*

1. Students will know principles and methods of air quality monitoring.
2. Water quality monitoring will be easy.
3. Assessment of soil quality will be understood.
4. Students will know topics of environmental toxicology.
5. The course allows students to understand the hazardous and toxic substances affecting the environment and their health impacts.

#### **UNIT I: Monitoring of Air Quality**

Monitoring of air pollution: introduction, concept and principle; sampling of air, ambient and stack emissions sampling; Analysis of air pollutants- SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>, TSPM & RSPM, Biomonitoring and Bioindicators of air pollution.

#### **UNIT II: Monitoring of Water Quality**

Monitoring of water pollution: introduction, concept and principle; sampling of water; aquatic biomonitors; biomonitoring of running water pollution; saprobic, diversity and biotic approaches; bioaccumulation of pesticides and heavy metals in aquatic ecosystems; pathogenic contamination of water and health hazards.

#### **UNIT III: Monitoring of Soil**

Monitoring of soil pollution: introduction, concept and principle; sampling of soil; assessment of soil quality with respect to soil profile, soil texture, bulk density, porosity, soil colour, soil pH, ion exchange capacity; heavy metals and trace metals in soil; bioindicators of soil pollution.

#### **UNIT IV: Environmental toxicology**

Introduction to environmental toxicology: acute toxicity, chronic toxicity and sub-lethal toxicity; multispecies toxicity tests; microorganisms in toxicity testing: microtox and other approaches; concepts of toxicogenomics; toxicity of engineered nanoparticles.

**Note:** Seminar and Group discussion may be incorporated during class hours. Home assignment-sampling and analysis of air pollutants, biomonitoring of air, biomonitoring of aquatic ecosystems, heavy metals in aquatic ecosystems and its health impacts, biomonitors of water pollution, physico-chemical parameters of soil, heavy metals in soil ecosystem, biomonitors of soil pollution, environmental toxicology, toxicity of nano particles, microbial toxicology. (*Compulsory – any four*)

#### **Essential Books:**

1. *Heavy metals in the Environment*. S.A. Abbasi, N. Abbasi, and R.Soni, 1998, Mittal Publications, New Delhi.
2. *Wastewater Microbiology* (3<sup>rd</sup> edition): G. Bitton, 2005, John Wiley and Sons.
3. *Ecotoxicology: A comprehensive treatment*. M.C. Newman and W.H. Clements, 2008, CRC Press.
4. *Monitoring ecological change*. I.F. Spellerberg, 1995, Cambridge University Press.
5. *Fundamentals of ecotoxicology*. M.C. Newman, 2001, Lewis Publishers.

#### **Reference Books:**

1. *Environmental monitoring*. G.B. Wiersma (Ed.), 2004, CRC Press.
2. *Ecotoxicology: ecological dimensions*. D.J. Baird, P.E. Douben, P. Greig-Smith and L. Maltby (Eds.), 1996, Chapman and Hall, Springer, Netherlands.
3. *Environmental chemistry*. A.K. De, 2006, New Age International Pvt. Ltd. Publishers, New Delhi.
4. *Conservation and management of aquatic resources*. A. Gautam (Ed.), 1998, Daya Publishing House, New Delhi.
5. *Fundamentals of Ecotoxicology*. M.C. Newman, 2001, Lewis Publisher, Boca Raton.



**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

Course outcomes

1. This course helps students to enhance capacity building in handling geoinformatics tools.
2. This course makes students to understand and deal with geospatial data and identify their utility.
3. Students will have knowledge on practical use of GIS tools
4. Use of geoinformatics in different fields will be understood.
5. Students will know use of GPS/ DGPS.

➤ **Practical on Remote Sensing**

1. Georeferencing of satellite images (1 exercise)
2. Stacking of images with various spectral bands (1 exercise)
3. Mosaicking and clipping by vector polygon boundary (1 exercise)
4. Image manipulation / enhancements and interpretation and feature identification (1 exercise)
5. Computation of image histogram and statistics (1 exercise)
6. Classification- Supervised and Unsupervised (2 exercises)

➤ **Practical on Aerial Photographs Interpretation**

1. Geometry of aerial photographs.
2. Photo interpretation and feature identification based on interpretation keys.
3. Determination of scale of aerial photograph.
4. Computation of photo coordinates.

➤ **Practical on Geographical Information System**

1. Scanning / digitization of maps of different themes.
2. Georeferencing of scanned maps with geographic coordinate system and earth model and its datum (1 exercise)
3. Projection system and Coordinate transformation of the georeferenced map and its layout. (1 exercise)
4. Creation and editing of vector data layers of points, lines and polygons including adding attributes and designing map layout of the theme(s). (1 exercise)
5. Preparation of thematic maps from points (Population distribution by pie-chart, sphere) and map layout of the theme. (2 exercises)
6. Digitization of drainages, basin delineation and drainage ordering and creation of map layout. (1 exercise)
7. Digitization of different types of roads and the railways and creation of map layout (1 exercise)
8. Polygon based thematic map (District level literacy/population density map of any state) (1 exercise)

➤ **Practical using Global Positioning System**

1. GPS/DGPS data collection of waypoints (Utility locations Bank, Hospitals, Shopping centres etc) and mapping (1 exercise)
2. GPS/DGPS data collection of routes and mapping thereon (1 exercise)
3. GPS / DGPS data collection of land use features and mapping (1 exercise)
4. Georeferencing of large scale scanned map (building plan / site plan etc.) (1 exercise)

**Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.

**Essential books:**

1. Date, C.J., 1995: *An Introduction to Data Base System*, 6th edition, Reading Massachusetts; Addison Wesley.
2. Fraser Taylor, D.R., (ed.), 1980 : *Progress in Contemporary Cartography*, John Wiley, Chichester U.K.

3. Fraser Taylor, D.R., (ed.), 1983 : *Graphic Communication and Design in Contemporary Cartography*, John Wiley & Sons Ltd. New York.
4. Jones, C., 1997 : *Geographic Information Systems and Computer Cartography*, Longman, London.
5. Kraak, M-J., and Ormeling, F., 2004: *Cartography: Visualization of Geospatial Data*, Pearson Education.
6. Misra, R.P., et al 2014: *Fundamentals of Cartography*, Concept Publishers, Delhi.



### MEV 306: Northeast India: Land, People and Culture (GE 1)

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To understand the biogeography, climate, agriculture, ethnicity, linguistics, economy, politics and cultural diversity of Northeast Region of India

#### Course outcomes

1. This course intends to make students to understand the biogeography, climate, agriculture, ethnicity, linguistics, economy and politics of Northeast Region of India.
2. Students will understand cultural diversity of Northeast Region of India.
3. The course will also make students know the speciality and uniqueness of the NE region.
4. Students will know industries and transportation of NE India
5. Students will understand and have knowledge on the different environmental related problems prevailed in the region.

#### Unit I: North East India: Introduction to Physical Basis

Location and significance of North East Region of India; Physiography, Climate, Soil and Vegetation of NE Region; Biodiversity of NE Region; factors affecting biogeography of NE Region.

#### Unit II: Population of North East India

Population characteristics: Peopling; Growth; Distribution and Density; Age and Sex composition; Rural–Urban composition and Religious composition; Ethnicity; Eco-Anthropology of the NE Region.

#### Unit III: Agriculture of North East India

Agricultural development and economy of North East India; Agro-climatic regions of NE Region; Agricultural practices and modernization of agriculture in NE Region; Major agricultural crops cultivated in NE Region.

#### Unit IV: Industries and Transportation of North East India

Industrial development and economy of North East India; distribution and production pattern of major Industries (Oil, Coal, Handloom and textile, Cottage industry, Agro-based industry, Food processing industry, Petrochemicals, Sugar, Paper and Cement industries, Tourism industry, Power industries), Transportation in NE Region: Roadways, Railways, Waterways, Airways, and Pipelines.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – biodiversity of northeast India; population characteristics, growth and distribution in northeast India; ethnicity of northeast India; major industries of northeast India (*Compulsory – any four*)

#### Essential Books:

1. Govt. of India: India-Reference Annual, 2001 Pub. Div., New Delhi.
2. Govt. of India: National Atlas of India NATMO Publication, Calcutta.
3. Govt. of India: The Gazetteer of India. Vol. I & III Publication Division.
4. Learmonth A.T.A et.al (etd.) *Man and land of South Asia*, Concept Education.
5. M. Shafi, 2000 – *Geography of South Asia*, McMillan & Co., Calcutta.
6. *Discovery of North East India - Geography, History, Culture, Religion, Politics, Sociology, Science, Education and Economy* (11 Volumes) Mittal Publications.
7. Dikshit, K. R., 2014, *North-East India: Land, People and Economy: Advances in Asian Human-Environmental Research*, Springer Science Business Median Dordrecht.



**UNIVERSITY OF SCIENCE AND TECHNOLOGY, MEGHALAYA**  
**SYLLABUS FOR M.Sc. ENVIRONMENTAL SCIENCE**  
**SEMESTER IV**

Paper Code	Paper Title	Nature of Paper	Credit	IA	ES	Marks
MEV 401	Environmental Geosciences and Meteorology	T	4	30	70	100
MEV 402 A	Wildlife Ecology: Conservation and Management	T	4	30	70	100
MEV 402 B	Hazards and Disaster Management: Preparedness and Mitigation	T	4	30	70	100
MEV 402 C	Geoinformatics: Principles and Techniques of GIS and GPS.	T	4	30	70	100
MEV 402 D	Forest Ecology and Management:	T	4	30	70	100
MEV 402 E	Environmental Monitoring and Management: Agroforestry and Forest Hydrology	T	4	30	70	100
MEV 403 A	Wildlife Ecology: Wildlife Health and Wealth	T	4	30	70	100
MEV 403 B	Hazards and Disaster Management: Issues and Policies	T	4	30	70	100
MEV 403 C	Geoinformatics: Applications in Major Areas	T	4	30	70	100
MEV 403 D	Forest Ecology and Management: Economics and Regulations	T	4	30	70	100
MEV 403 E	Environmental Monitoring and Management: Analytical Methods	T	4	30	70	100
MEV 404 A	Laboratory IV: Practical on Wildlife Ecology	P	4	30	70	100
MEV 404 B	Laboratory IV: Practical on Hazards and Disaster Management	P	4	30	70	100
MEV 404 C	Laboratory IV: Practical on Geoinformatics	P	4	30	70	100
MEV 404 D	Laboratory IV: Practical on Forest Ecology and Management	P	4	30	70	100
MEV 404 E	Laboratory IV: Practical on Environmental Monitoring and Management	P	4	30	70	100
MEV 405	Project Work	P	4	70	30	100
MEV 406	Disaster Management	T	4	30	70	100
<b>Total</b>			<b>24</b>	<b>220</b>	<b>380</b>	<b>600</b>

**T: Theory**

**P: Practical**

**IA: Internal Assessment**

**ES: End Semester**

**MEV 401: Environmental Geosciences and Meteorology**

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide information on earth's processes, geological hazards and meteorological processes.

*Course outcomes*

1. This course is designed to make students know about concepts of geomorphology

2. Students will learn concepts of geohydrology.
3. Students will understand causes and mechanisms of different geological hazards.
4. Students will know fundamentals of Meteorology.
5. Students will understand basic topics of climatology

### Unit I: General Geomorphology and Geohydrology

Origin and Evolution of earth; Plate tectonics, sea floor spreading, continental drift and mountain building; Transportation and deposition of earth's materials; Soil erosion; Physical and chemical aspects of glaciers, Himalayan glaciers; Glaciers as index of climate change; Geohydrology: concept, cycle, hydrologic budget, water abstraction, runoff and stream flow, ground water and aquifers, watershed management.

### Unit II: Geological activities and hazards

Concept of stress and strain; mechanism of folds and faults; structural elements- foliation, lineation, drag folds, cleavage and joints; Types of rocks and their formation; Formation and classification of mineral deposits; Environmental problems associated with extraction of minerals; Geological hazards: mechanism, causes, nature, frequency, effects, prediction, perception and adjustments to natural hazards (earthquake, flood, volcanism, landslides, fire, erosion and cyclone.)

### Unit III: Meteorology

Meteorology fundamentals; atmospheric stability; thermal structure of the atmosphere and its composition; earth and sun relations, solar constant, emission and absorption of terrestrial radiation, net radiation budget; insolation, factors affecting insolation; air pressure, wind, humidity, cloud formation and precipitation; water balance.

### Unit IV: Climatology

Meaning, scope and concept of climatology; Elements of climate, climate control parameters; spatial and temporal patterns of climate parameters; World Climate Types, Indian Monsoon; climate control factors of India with special reference to NE India; microclimate; weather forecasting and recent trends in climatology; climate change; climate and human environment.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – plate tectonics and sea floor spreading; Himalayan glaciers; types and formation of rocks; mechanisms of geological hazards; insolation and heat budget; atmospheric pressure; world climate types; Indian monsoon (*Compulsory – any four*)

### Essential Books:

1. *Atmosphere, Weather and Climate* – R.G. Barry and R. J. Chorley, 2003, Routledge.
2. *Hydrology: Principles, analysis and design* – H. M. Raghunath, 2006, New Age International (P) Limited.
3. *Geology of India* – D. N. Wadia, 1919, MacMillan Publishers.
5. *Applied Climatology* – J.E. Hobbs, 1980, Oxford University Press.
6. *Himalayan Snow and Glaciers*- J. Bahadur, 2004, Concept Publishing Company.
7. *Climatology* – D.S Lal, 2014, Sharda Pustak Bhawan, Allahabad.

## MEV 402 A: Wildlife Ecology: Conservation and Management

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide handsome concept and information on basic understanding of wildlife, its importance, threats, management and conservation strategies. The paper also provides a space to know about the wildlife of the India with special reference to NE India.

### Course outcomes

1. To provide information on the rich wildlife biodiversity in india with special reference to N.E. India.
2. It will give detailed information and knowledge about various migratory behaviors and routes of migration of Indian wildlife.
3. Knowledge on various census techniques of the wildlife in India.
4. Students will know in-situ and ex-situ conservation of wild life
5. Basic concept and information on wildlife threats, conservation and management strategies adopted locally, nationally and globally.

### **Unit I: Fundamentals of Wildlife Management**

Basic principles of wildlife management; threats and values of wildlife, problems in wildlife protection; flagship species and their conservation; wildlife distribution in diverse ecological habitats in India, endangered and threatened species of wildlife in India with special reference to northeast India.

### **Unit II: In-situ conservation of wildlife**

Principles and strategies of wildlife management in protected areas (sanctuaries, national parks, conservation reserve, community reserve, etc.); Biosphere Reserves; gene sanctuary; community conservation systems; wetlands for in-situ conservation.

### **Unit III: Ex-situ conservation of wildlife**

Role of zoos, parks, gardens, aquariums, seed banks, gene banks, tissue culture, cryopreservation, captive breeding in conservation of wildlife; genetics in wildlife conservation; ethics in wildlife conservation; concept of DNA bank; advantages and disadvantages of ex-situ conservation.

### **Unit IV: Major wildlife conservation projects in India**

Project Tiger; Project Elephant; Crocodile Breeding project; Indian Rhino Vision 2020; Sea Turtle project; Project Lion; Project Snow Leopard; Protecting Vultures, etc.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – threats and values of wildlife; endangered and threatened species of India; biosphere reserves; protected areas as in-situ conservation of wildlife; role of ex-situ conservation for wildlife; importance of gene bank and DNA bank for wildlife conservation; project tiger; project elephant; crocodile project; Indian rhino vision 2020. (*Compulsory – any four*)

### **Essential books:**

1. *A treatise on wildlife conservation in India* – C. Das, 2007, Eastern Book Corporation, New Delhi.
2. *Conserving wildlife* – S.K. Jacobson, 2002, Eastern Book Corporation, New Delhi.
3. *Endangered animals of India* – A.K. Mukherjee, 1982, Zoological Survey of India, Kolkata.
4. *Handbook of national parks, wildlife sanctuaries and biosphere reserves in India* – S.S. Negi, 2002, Eastern Book Corporation, New Delhi.
5. *Wildlife in India* – V.B. Saharia, 1990, Natraj Publishers, Dehradun

### **Additional Books:**

1. *The wildlife protection act, 1972 (as amended up to 2004)* – Anonymous (2004), Natraj publisher, Dehradun.
2. *Threatened animals of India* – B.K. Tikadar, 1983, Zoological Survey of India. Kolkata.
3. *Wildlife in the Himalayan foothills: conservation and management* – P.C. Tiwari and J. Bhagwati, 1997, Eastern Book Corporation, New Delhi.
4. *Wildlife tourism and conservation* – A. Mallya, 2006, Eastern Book Corporation, New Delhi.

## MEV 402 B: Hazards and Disaster Management: Preparedness and Mitigation

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objectives:** To provide indepth knowledge on various types natural and human induced disasters; and the techniques and tools for preparedness, mitigation and overall management of various disasters.

### Course outcomes

1. This course provides in-depth knowledge on various type natural and human induced disasters.
2. Students can understand different tools and techniques for disaster preparedness and mitigation.
3. Role of government and NGOs will be understood
4. Technologies for disaster management will be known
5. Information on various governmental and non-governmental organisations working on disaster management field.

### Unit I: Introduction to Disaster Preparedness

Definition and concept of disaster management: Prevention, Preparedness and Mitigation; Disaster Preparedness: Concept & Nature; Disaster Preparedness Plan; Disaster Preparedness for People and Infrastructure; Vulnerability-Women, Children and Old age people; Community based Disaster Preparedness Plan.

### Unit II: Role of Government and Non government agencies

Role of Information, Education, Communication and Training institutions; Role and Responsibilities of Central, State, District and local administration; Role and Responsibilities of Armed Forces, Police, Para Military Forces; Role and Responsibilities of International Agencies, NGO's, Community Based Organizations (CBO's).

### Unit III: Technologies for Disaster Management

Role of IT in Disaster Preparedness; Remote Sensing, GIS and GPS in disaster management; application of advance technologies for Emergency communication; Application and use of ICST for different disasters management.

### Unit IV: Disaster Mitigation

Disaster Mitigation: meaning and concept; Disaster Mitigation Strategies; Emerging Trends in Disaster Mitigation; Crisis Management; Mitigation management; Role of Team and Coordination.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment-Disaster Management-Prevention, Preparedness and Mitigation, Disaster Preparedness Plan, Vulnerability-Women, Children and Old age people, Role of Education, Information, Training, Remote sensing, GIS and GPS, disaster mitigation, crises management (*Compulsory any four*)

### Essential books:

1. *Natural Hazards* – Bryant Edwards, 2005, Cambridge University Press, U.K.
2. *Space Technology for Disaster management: A Remote Sensing & GIS Perspective* – Roy, P.S., 2000, Indian Institute of Remote Sensing (NRSA) Dehradun.
3. *Natural Disaster* – Sharma, R.K. & Sharma, G., 2005, APH Publishing Corporation, New Delhi.

### Additional Books:

1. *Vulnerable India* – Anu Kapur, 2010, Sage publications, New Delhi.
2. *Housing in Disaster prone areas, National Building Organization and U.N. Regional Centre*. G.C Mathur, 1986, ESCAP, New Delhi.
3. *Transforming adversity into opportunity: experiences from Gujarat earthquake reconstruction program World congress on Natural disaster mitigation proceedings*, 2004, P.K. Mishra, February.

## MEV 402 C: Geoinformatics: Principles and Techniques of GIS and GPS

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To appraise the benefits of geoinformatics in geographical studies and provide direction to take up research on thrust areas by understanding and using the science and technology of geoinformatics.

### Course outcomes

1. To teach the students the various principles of GIS and GPS technology.
2. Students will learn fundamentals of Geodesy.
3. Data management in Geoinformatics will be understood
4. Students can understand the benefits of geoinformatics tools in environmental studies.
5. Students are provided direction to take up research on thrust areas.

### Unit I: Fundamentals of Geodesy

Fundamentals of geodesy: Shape and size of the earth, Geoid, Ellipsoids and their flattening, Geodetic datum, Geodetic coordinate System, Map Projection System, Errors in GIS, Vector data editing tools and concept of tolerance- weeding and snapping, merging, combining, splitting and clipping; Errors in GIS,

### Unit II: Database Management in Geoinformatics

Concept of Database Management System (DBMS), Relational Database Management System (RDBMS), Geodatabase and data models in GIS. Attribute data processing and management; DEM data sources and the characteristics of data - SRTM, GTOPO, GLOBE, LiDAR, CARTOSAT DEM; GPS/DGPS data management and mapping- technical issues

### Unit III: Principles and Techniques of GIS - GPS Techniques

Topological relationships of vector data and network analysis, Spatial interpolation techniques - types, uses and problems; Uses of Digital elevation/terrain / surface model (DEM /DTM/ DSM) and Triangulated Irregular Networks (TIN) model; Concept, principles and applications of GPS/ DGPS and Errors involved in GPS signals.

### Unit IV: Spatial Modeling and Analysis

Concept of spatial modeling and analysis, Spatial autocorrelation; Geographically Weighted Regression; Spatial decision support by raster overlay analysis, Geoprocessing functions and tools- buffering, union and intersection; Web-GIS.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Home assignments - Drawing of Electromagnetic spectrum, List of Remote Sensing data products with specifications by satellite, Scale of aerial photograph, Image classification steps, Georeferencing and digitization flow charting, Data structures, Map Design and layout format, Thematic mapping steps (*compulsory - any four*).

### Essential Books:

1. Martin, D. 1995: *Geographic Information Systems Socioeconomic Applications*, Routledge
2. Heywood, Ian, Cornelius, S. 2011 : *An Introduction to GIS 4<sup>th</sup> Edition*, Pearson, New Delhi
3. Chang, Kang-tsung , 2008: *Introduction to Geographic Information System – (4<sup>th</sup> Ed.)*, Tata McGraw-Hill.
4. DeMers, M. N. 2000: *Fundamentals of Geographic Information Systems* : , John Willey, New York.

### Additional Books:

1. Longley, P. A M. Goodchild, M., D. J. Maguire, D. J. And Rhind, D. W. 2001: *Geographic Information Systems and Science* , John Willey, New York
2. Burrough, P. A. 1998: *Geographical Information for Land Resource Assessment* , Oxford.
3. Agarwal, N. K. 2004: *Essentials of GPS* , Spatial Networks Pvt. Ltd., Hyderabad.
4. Gopi, S. 2005: *Global Positioning System Principles and Applications*, Tata McGraw Hill, New Delhi

### MEV 402D: Forest Ecology and Management: Agroforestry and Forest Hydrology

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide indepth knowledge on agroforestry system, management of forest ecosystem and forest hydrology.

#### Course outcomes

1. Students will understand concepts of Agroforestry system
2. Students will know fundamentals of forest management
3. Topics of forest hydrology will be known by students.
4. Students will understand relationships between agroforestry and forest hydrology
5. Students will understand hydrological processes affected by forest lands.

#### Unit I: Introduction to Agroforestry system

Biophysical and social aspects of agroforestry systems; agroforestry and biodiversity conservation with special emphasis on homegardens; agroforestry and ecosystem services; shifting cultivation and management of fallows; ecoculture and wild biodiversity conservation.

#### Unit II: Fundamentals of Forest Management

Forest ecosystem management: Forest management in India; Joint Forest Management (JFM); Plantation and Social forestry; Application of GIS and RS in forestry; Deforestation and approaches to forestry conservation; Sustainable Forest Management; Non Timber Forest Products (NTFPs) and basic principles of silviculture; Forest trade; Forest diseases and control measures.

#### Unit III: Forest Hydrology I

Introduction to forest hydrology; Concepts of catchment; catchment hydrology; Water cycle: global water cycle, water cycle in forested area; Catchment morphology, principal characteristics and Drainage patterns and types; Role of vegetation (forests) in hydrology, evaporation and evapotranspiration; Forest features of hydrologic significance: soil organic matter, plant roots, plant and animal life and sheltering.

#### Unit IV: Forest Hydrology II

Hydrological processes affected by forest lands : storage and drainage, overland flow, erosion and sedimentation; Run-off formation: infiltration, water flow in soil, role of organic matter; Erosion and sediments: surface run-off, water erosion, principles of anti-erosion measures, principles of catchment organization; Water resources development; water availability.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – ecological and social aspects of agroforestry system; shifting cultivation in India; Joint Forest Management-policies, implementation and outcome; forest management practices in India; NTFPs; silviculture; forest hydrology; watershed management; evaporation and evapotranspiration; water cycle in forest area. (*Compulsory – any four*)

#### Essential books:

1. *Forest ecology*– Barnes, B V; Zak, D R; Denton, S R and Spurr, S R, 1998, (4th edition). John Wiley and Sons.



**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide indepth knowledge on principles of environmental monitoring of air, water, flora and fauna and developments in Environmental Management.

*Course outcomes*

1. Students will know water purification Processes in Natural Systems
2. Students will understand meteorology and Natural Purification Processes
3. Students will get knowledge on biological indicators in terrestrial and aquatic systems
4. Students will know effects of pollutants on flora and fauna in different ecosystems
5. Students will know recent developments

**Unit I: Water purification Processes in Natural Systems**

Physical, chemical and biochemical processes, Response of streams to biodegradable organic waste, Application of natural processes in engineered systems, Engineered systems for water purification, wastewater treatment and disposal.

**Unit II: Meteorology and Natural Purification Processes**

Elemental properties of atmosphere, Influence of meteorological phenomena on air quality, Effects of air pollution on meteorological conditions, Engineered systems and techniques for Air pollution control.

**UNIT III: Monitoring of Flora and Fauna**

Biological indicators in terrestrial and aquatic systems, Effect of pollutants on flora and fauna in terrestrial, marine and fresh water ecosystems.

**UNIT IV: Developments in Environmental Management**

Recent developments in environmental management: Organic farming and its ecological significance; solid and biomedical waste management; management of arsenic and fluoride in groundwater; constructed wetlands in wastewater treatment, Bioplastics; Biosensors in environmental monitoring.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – physico-chemical process of water purification, biochemical process of water purification, engineered system of water purification, wastewater treatment, impact of meteorological phenomena on air quality, effects of air pollution on atmospheric condition, control measures of air pollution, water pollutants and their impact on marine and freshwater biota, ecological significance of organic farming, biomedical waste treatment process, management of arsenic and fluoride in ground water, bioplastics, biosensors in environmental monitoring(*Compulsory – any four*).

**Essential Books:**

1. *Environmental Engineering*. H.S. Peavy, D. R. Rowe and G. Tchobanoglous, 1985, Mc Graw Hill Education (India) Pvt. Ltd
2. *Wastewater Microbiology* (3<sup>rd</sup> edition): G. Bitton, 2005, John Wiley and Sons.
3. *Ecotoxicology: A comprehensive treatment*. M.C. Newman and W.H. Clements, 2008, CRC Press.
4. *Monitoring ecological change*. I.F. Spellerberg, 1995, Cambridge University Press.

**Reference Books:**

1. *Environmental monitoring*. G.B. Wiersma (Ed.), 2004, CRC Press.
2. *Environmental chemistry*. A.K. De, 2006, New Age International Pvt. Ltd. Publishers, New Delhi.
3. *Conservation and management of aquatic resources*. A. Gautam (Ed.), 1998, Daya Publishing House, New Delhi.
4. *Biomedical Waste Management*. R. Radhakrishnan, 2002, Sumit Enterprises, New Delhi.





**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide indepth knowledge on wildlife behaviour, health issues, wildlife economy and trade, and laws related to wildlife in India.

*Course outcomes*

1. This course helps students to learn about wildlife behavior.
2. Offers information on various health issues faced by Indian wildlife.
3. Disease control mechanisms will be known
4. To understand, in details, wildlife economy and trade related and associated with wildlife in India.
5. To aware the students on various laws related to wildlife in India.

#### **Unit I: Wildlife Ethology:**

History and concept of ethology, Proximate and ultimate analysis of behaviour; innate and learned behaviour; stimuli, communication and signal; territoriality and home range.

#### **Unit II: Wildlife Disease and Health**

Introduction to disease and epizootiology; disease and disease transmission; major viral, bacterial, protozoan, fungal and parasitic diseases ; non-infectious diseases- nutritional diseases, poisoning, stress, shock, capture myopathy, physical trauma; assessment of health and nutritional status in animals; disease control mechanisms.

#### **Unit III: Wildlife Economy and Politics**

Contribution of wildlife to gross national productivity (GNP) and economic importance of wildlife; wildlife tourism; trade on wildlife and wildlife crime; economic and ecological issues; wildlife politics.

#### **Unit IV: Wildlife Law and Education**

Wildlife (Protection) Act, 1972 and latest amendment; wildlife conservation education and awareness, training and outreach programmes; Role of government and non-governmental organizations in wildlife conservation; advance technologies for wildlife management.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment – wildlife behavior ecology; home range and territoriality; infectious diseases in animals; non-infectious diseases in animals; economic importance of wildlife; illegal wildlife trade; Wildlife Protection Act, 1972 and latest amendment; role of NGOs in wildlife conservation. (*Compulsory – any four*)

#### **Essential books:**

1. *A treatise on wildlife conservation in India* – C. Das, 2007, Eastern Book Corporation, New Delhi.
2. *Conserving wildlife* – S.K. Jacobson, 2002, Eastern Book Corporation, New Delhi.
3. *Endangered animals of India* – A.K. Mukherjee, 1982, Zoological Survey of India, Kolkata.
4. *Handbook of national parks, wildlife sanctuaries and biosphere reserves in India* – S.S. Negi, 2002, Eastern Book Corporation, New Delhi.
5. *Wildlife in India* – V.B. Saharia, 1990, Natraj Publishers, Dehradun

#### **Additional Books:**

1. *The wildlife protection act, 1972 (as amended up to 2004)* – Anonymous (2004), Natraj publisher, Dehradun.
2. *Threatened animals of India* – B.K. Tikadar, 1983, Zoological Survey of India. Kolkata.
3. *Wildlife in the Himalayan foothills: conservation and management* – P.C. Tiwari and J. Bhagwati, 1997, Eastern Book Corporation, New Delhi.
4. *Wildlife tourism and conservation*– A. Mallya, 2006, Eastern Book Corporation, New Delhi.

## MEV 403 B: Hazards and Disaster Management: Issues and Policies

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

### Course outcomes:

1. Students will be taught various issues related to natural hazards
2. Students will learn man-made hazards and disaster in India.
3. Students will learn different policies framed for disaster management.
4. Students will learn various strategies adopted for disaster management.
5. Students will get knowledge of different disasters occurred locally and globally.

### Unit I: Rehabilitation, Reconstruction and Recovery

Recovery aspects- long term and short term; Physical and social infrastructure; Relocation and reconstruction of structural and non-structural components; Social and economic rehabilitation; Capacity building and skill enhancement for livelihood development; Training and awareness programmes; Medical aid therapy and counselling; Agricultural aids; Repair and retrofitting; Role of Micro finance in disaster management.

### Unit II: Policies for Disaster Management

Yokohama Declaration; International Decade for Natural Disaster Reduction (IDNDR); Hyogo framework; United Nations International Strategy for Disaster Reduction (UNISDR); Global Facility for Disaster Risk Reduction (GFDRR); Disaster prevention through Sustainable development; Community participation

### Unit III: Case studies of major Hazards and Disasters in India and the Globe (*in the last and present century*)

Earthquakes; Landslides; Tsunamis; Snow Falls; Floods; Droughts; Cyclones; Tsunamis; Nuclear, Biological; Industrial and Chemical disaster; major road Accidents.

### Unit IV: Causes, Consequences, Mitigation of Hazards and Disaster in North East India

Earthquake; Floods; Flash Floods; Landslides; Droughts; Accident related disasters.

**Note:** Seminar and Group discussion may be incorporated during class hour. Home assignment-Rehabilitation, recovery, reconstruction, Physical and social infrastructure, Training and awareness programmes, Medical aid therapy and counselling, Yokohama Declaration, IDNDR, UNISDR, Assam Earthquake-1950, Flood in Assam (*Compulsory any four*).

### Essential books:

1. *Disaster Management: A Disaster Manager's Handbook*, Carter, W.N., 1992, Asian Development Bank, Manila.
2. *Encyclopaedia on Disaster Management: Disaster Management Policy and Administration*, S.L. Goel, 2006, Deep & Deep Publications Pvt. Ltd. New Delhi.
3. *Disaster Management Recent Approaches*. Arvind Kumar, 2010, Anmol Publications Pvt. Ltd. New Delhi.
4. Kapur Anu and Neeti, Meeta, Deeptiman, Roshani and Debanjali, 2005, *Disasters in India Studies of Grim Reality*, Rawat Publications, New Delhi.

### Additional Books:

1. *Vulnerable India* – Anu Kapur, 2010, Sage publications, New Delhi.
2. *Housing in Disaster prone areas, National Building Organization and U.N. Regional Centre*. G.C Mathur, 1986, ESCAP, New Delhi.
3. *Transforming adversity into opportunity: experiences from Gujarat earthquake reconstruction program World congress on Natural disaster mitigation proceedings*, 2004, P.K. Mishra, February.
4. *Natural Hazards and Disasters Management-Vulnerability and Mitigation*, R.B. Singh, 2006, Rawat Pulb.

## MEV 403 C: Geoinformatics: Applications in Major Areas

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To appraise the benefits of geoinformatics in geographical studies and provide direction to take up research on thrust areas by understanding and using the science and technology of geoinformatics.

### Course outcomes:

1. This course will help students to gain knowledge on use of geoinformatics for natural resources monitoring and management
2. Students will be able to apply geoinformatics in hazards and disaster management
3. Students will know use of geoinformatics in planning and development
4. Application of geoinformatics in drainage basin
5. Application in hydrological analysis will be understood.

### Unit I: Geoinformatics for Natural Resources Monitoring and Management

Land use / Land cover (LU/LC) mapping: Introduction to Land use / Land cover: Definition and classification scheme (by USGS after Anderson and by NRSC at Level-1, Level-2 and Level-3), LU/LC interpretation keys for LANDSAT/IRS data, Resources mapping - water resources, soils, forests, minerals, agriculture etc.

### Unit II: Geoinformatics for Environmental Studies, Hazards and Disaster Management

Identification of flood prone area, landslide prone area, forest fire - data sources and dataset requirements, methodology charting and basic considerations, biodiversity, environmental pollution and climate change studies; Monitoring and warning systems of disastrous / hazardous events and mitigation plans.

### Unit III: Application of Geoinformatics in Planning and Development

Rural and urban infrastructure survey, mapping and planning - transportation, health, education and others; Urban sprawl and water logging mapping, Development strategy planning for flood and drought prone areas, hilly areas, Smart villages and smart cities.

### Unit IV: Geoinformatics for Drainage Basin and Hydrological Analysis

Drainage basin morphometry from maps and satellite data, basin hydrological studies, Geoinformatics based methodology for integrated approaches of basin development, Ground water potential studies; DEM generation and DEM based applications.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Home assignments - Land use system India, Drawing of flow / activity charts - preparation of land use / land cover map, flood hazard zoning, development strategy planning, integrated basin development, biodiversity mapping, disaster warning system, smart village planning, groundwater potential estimation (*Compulsory - any four*).

### Essential Books:

1. *Text book on Remote Sensing in Natural Resource Monitoring and Management* –Agarwal, C. S and Garg, P. K. 2000, Wheeler, New Delhi-1.
2. *Remote Sensing for the Beginner* – Guha, P.K. 2013, Affiliate East West Publishers, New Delhi.
3. *Remote sensing & Image interpretation* – Lillesand Thomas M, & Keifer, 1997, Wiley, New York
4. *Space Technology and*
5. *Geography* – Gautam, N. C., Raghavswamy, V. And Nagaraja, R. (Chief Editor) 1994, NRSC, Hyderabad

### Additional books:

1. *Remote Sensing of the Environment: An Earth Resource Perspective* – Jensen, J. R. 2011, Pearson Education., New Delhi.
2. *An Introduction to GIS* – Heywood, Ian, Cornelius, S. 2011, (4<sup>th</sup> ed), Pearson, New Delhi
3. *Remote Sensing in Land Evaluation* – Yadav, R. S. 1997, Rajesh Publication, New Delhi.
4. *Introduction to Remote Sensing* – Joseph, G. 2005, Universities Press (India) Pvt. Ltd, Hyderabad.
5. *Academic Journals and Periodicals*

## MEV 403 D: Forest Ecology and Management: Economics and Regulations

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To provide indepth knowledge on commercial utilization and economic benefits of forest resources and to make students aware of forest regulations in India.

### Course outcomes

1. Students will know objectives and relationship of Silviculture with other branches of forestry
2. Students will understand Forest Mensuration and Management
3. Topics related to forest economics will be understood.
4. Students will know different Forest Policies
5. Forest Laws in India will be known

### UnitI: Introduction to Silviculture

Forest Silviculture: introduction, objectives and relationship with other branches of forestry; classification of high forest system and coppice silvicultural system, advantages and disadvantages, felling pattern, regeneration methods and characteristics of new crops in each system; tending: weeding, thinning, pruning and pollarding.

### UnitII: Forest Mensuration and Management

Forest mensuration and management: definition and scope; methods for girth, diameter and height measurement; tree form and volume of log measurement; increment: types of increment, methods of increment measurement; growing stock; yield table and yield regulation; rotation period and types of rotation; periodic blocks and felling cycle; forest working plan, forest working scheme; forest conservation and management practices in North East India.

### UnitIII: Forest Economics

Forest resource utilization; timber and non-timber forest products; forest valuation: purposes and methods of valuation; agroforestry: types, crop combinations in different types, advantages and disadvantages; forest based industries in India; Forest ecosystem services.

### UnitIV: Forest Policy and Forest Laws in India

Indian Forest Act, 1927; Forest Conservation Act, 1980; Biological Diversity Act, 2002; Biodiversity Rules, 2004; India's Plant Variety Protection and Farmer's Right Act, 2002; Forest Rights Act, 2006; National Forest Policy, 1988; Compensatory Afforestation Fund Act, 2016; Wild life Protection Act, 1972.

**Note:** Seminar and Group Discussion may be incorporated during class hours. Home assignments - Silvicultural practices in India, methods of forest regeneration, forest mensuration, increment-types and methods of measurement, non-timber forest products, forest resource utilization in Northeast India, forest based industries in India, Indian Forest Act, 1927, Biological Diversity Act, 2002, Forest Rights Act, 2006, Compensatory Afforestation Fund Act, 2016 (*Compulsory - any four*).

### Essential Books:

1. *Forest Ecology* (4<sup>th</sup> Edition) – B.V. Barnes, D.R. Zak, S.R. Denton and S.R. Spurr, 1998, John Wiley and Sons
2. *Forestry: Principles and Applications* – A.J. Raj and S.B. Lal, 2012, Scientific Publishers, Dehradun, India
3. *Forest Mensuration and Biometry* (3<sup>rd</sup> Edition) – A.N. Chaturvedi and L S Khanna, 2000, Khanna Bandhu Publisher, Dehradun, India.
4. *Indian Forestry A Breakthrough Approach to Forest Service* – K. Manikandan and S. Prabhu, 2015, Jain Brothers, New Delhi, India.
5. *Agroforestry Indian Perspective* – L.K. Jha and P.K. Sen-Sharma, 2009, APH Publication, New Delhi, India.

### Additional Books:

1. *Forest entomology* – L.K. Jha and P.K. Sen-Sharma, 2009, 1994, Ashish Publishing House, New Delhi.
2. *Joint Forest Management in India* – N.H. Ravindranath, 2004, Oxford University Press.
3. *Forest Ecosystems: Concepts and Management* – R.H. Waring and W.H. Schlesinger, 1985, Academic Press, New York.

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objectives:** To provide knowledge on different analytical methods and instruments used in Environmental monitoring; working principles, applications and limitations of the methods/instruments.

*Course outcomes:*

1. Student will get knowledge on quantitative analysis
2. Qualitative analysis will be understood
3. Principles of wet-chemical and chromatographic methods of analysis will be known.
4. Principles, Instrumentation and Applications of Spectrophotometry will be understood by students.
5. Students will learn concepts and terminology of error estimation in environmental sampling and analysis.

### **UNIT I: Introduction to analytical methods**

Introduction to quantitative analysis and qualitative analysis, Introduction to wet chemical methods and instrumental methods, Radio analytical methods: Radiochemical techniques, Conductometry, Potentiometry, Voltammetry, Interaction of radiation with matter. Beer- Lambert's law, Light microscopy and Electron microscopy.

### **Unit II: Wet-chemical and chromatographic methods of analysis**

Titration and gravimetric methods of analysis, Solvent extraction, Chromatographic techniques (Paper chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography, Column chromatography).

### **UNIT III: Spectroscopic methods of analysis**

Principles, Instrumentation and Applications of Spectrophotometry (UV-Visible spectrophotometry, NDIR spectroscopy, flame photometry, Atomic Absorption spectrophotometry); X-ray diffraction; Inductively Coupled Plasma Spectroscopy.

### **Unit IV: Error Estimation in Environmental Sampling and Analysis**

Basic Concepts and Terminology, Sampling Error, Methods for Estimating Quality of Measurements, Targets for Acceptable Levels of Bias in Sampling and Analysis.

**Note:** Seminar and Group Discussion may be incorporated during class hours. Home assignments - Qualitative and quantitative analytical methods of environmental monitoring, Radiometric techniques for pollution analysis, Working principle and applications of EM, Working principles and applications of different types of chromatographic techniques-TLC, HPLC, GCL, Principles and applications of Spectrophotometry- UV visible spectrophotometry, Flame photometry and AAS, methods of estimating quality of measurement (error analysis)(*Compulsory - any four*).

### **Essential Books:**

1. *Introduction to Environmental Analysis*, Roger Reeve, 2002, John Wiley & Sons Ltd
2. *Instrumental Methods of Analysis*, H. Willard, L. Merritt, D.A. Dean and F.A. Settle, 1998, Wordsworth, New York.
3. *Instrumental Methods of Chemical Analysis*, W. Ewing Galen, 1995, McGraw Hill, New York.
4. *Fundamentals of Analytical Chemistry*, D.A. Skoog, D.M. West and F.J. Holler, 2001, Harcourt Asia Ltd., New Delhi.

### **Reference Books:**

1. *Environmental Monitoring*. G.B. Wiersma (Ed.), 2004, CRC Press.
2. *Quantitative Analysis*, A.I. Vogel, 1998, Prentice Hall Inc.
3. *APHA Standard Methods for Examination of Water and Wastewater Examination*(23<sup>rd</sup> Edition), 2017, American Water Works Association, Washington.



## MEV 404 A: Laboratory IV: Practical on Wildlife Ecology

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

### Course outcomes

1. This course will make students familiar with practical aspects of wildlife ecology.
2. This course will enhance student's ability to work in field and collection of field data.
3. Detailed information on how to process data and derive results will be known by students.
4. Students will learn different techniques of wildlife census
5. Students will know animal behavior, activity budgeting, nesting pattern of birds, etc.

### ➤ List of practicals on Wildlife Ecology

1. Measurement of species diversity: Shannon Winner index, evenness index, community dominance index, canopy area coverage, foliage height diversity.
2. Study of wildlife census techniques: Line transact, point transact, quadrat method, stratified, random sampling, Pellet group counting method, Pugmark census & analysis
3. Study of animal behaviour.
4. Time and activity budgeting, foraging efficiency
5. Survey of bird species.
6. Study of nesting pattern of birds: pattern, time and materials used in nest construction.
7. Identification of some animal species – invertebrate, vertebrates, higher vertebrates.
8. Identification of wildlife specimen/body components: skin, bone, horn, scat, pellet, feather, nest etc.
9. Visit to important wildlife habitat and prepare a report.

**Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.



## MEV 404 B: Laboratory IV: Practical on Hazards and Disaster Management

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

### Course outcomes

1. This course will make students familiar with practical analysis and techniques of hazard and disaster management.
2. Students will get knowledge on mapping of major crustal plates, earthquake zones
3. Mapping of flood and landslide hazard zones will be known
4. Understanding of risk mapping will be easy.
5. Students will know what to do in emergency situation through mock-drill.

### ➤ List of practicals on Hazards and Disaster Management

1. Mapping of Major Crustal Plates of the Earth
2. Diagrams showing relationship between earthquakes and plate margins
3. Mapping of Earthquake Zones of India according to risk levels
4. Mapping of Landslide Hazard Regions of India/ NE India
5. Mapping of Flood Hazard Zones of India/NE India using GIS
6. Prepare a brief report on Institutional survey on disaster preparedness and mitigation (Hospitals/Schools).
7. Methods of Risk Mapping.
8. Mock drill.

### ➤ Field Visit:

1. State Disaster Management Authority (SDMA) Assam.
2. Lokpriya Gopinath Bordoloi Regional Institute of Mental Health, Tezpur
3. Guwahati Psychiatric Hospital, Guwahati
4. Meghalaya Administrative Training Institute (MATI), Shillong.
5. Fire Safety Station, Dispur, Guwahati.

**Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

*Objective: To enhance capacity building in handling geoinformatics tools.*

*Course outcomes*

1. This course will enhance student's capacity in handling geo-informatics tools.
2. This will help in learning on how to collect data using GIS technology
3. This will provide knowledge on how to process data using GIS technology.
4. Students will learn use of geoinformatics tools in their project work.
5. Practicals using GPS will be known

➤ **Practicals on Remote Sensing**

1. Stacking of images (Image composition) with various spectral bands (1 exercise)
2. Mosaicking of images and clipping the same by vector polygon boundary and preparation of Land use land cover map using vector polygons based on visual interpretation (1 exercise)
3. Unsupervised classification and recoding of enhanced image and derivation of statistics (1 exercise)
4. Computation of NDVI from IRS-1C/1D/Resourcesat/ LANDSAT data (1 exercise)
5. Preparation of Land use / Land cover map of the same area for two different time periods and to perform change detection and accuracy assessment (1 exercise)

➤ **Practicals on Aerial Photograph Interpretation.**

1. Stereoscopic visualisation of Air photograph and drawing geographic features.
2. Photo interpretation and feature identification based on interpretation keys.
3. Determination of scale, parallax and displacements from aerial photograph
4. Computation of distance between the two known points on aerial photograph.

➤ **Practicals on Geographical Information System**

1. Digitization of contour features from a portion topographical map in projected system of coordinates and creation of TIN model with standard map layout. (1 exercise)
2. Creation of 2-D surface model from TIN model with standard map layout (1 exercise)
3. Generation slope from 2-D surface model. (1 exercise)
4. 3-D visualization of 2-D surface model with vertical enhancement (1 exercise)
5. Preparation of aspect map from slope and map layout of the theme. (1 exercise)
6. Drawing profiles from 2-D surface model (1 exercise)
7. Preparation of thematic map of Assam / Meghalaya or any N E state on 3 different themes (1 exercise)

➤ **Practicals on Global Positioning System**

1. GPS/DGPS data collection of few waypoints randomly from a variable terrain and preparation of a DEM and generation of contours (1 exercise)
2. GPS/DGPS data collection of a part of campus and mapping thereon (1 exercise)
3. GPS / DGPS data collection of land use features and mapping (1 exercise)
4. Preparation of large scale map from scanned map (building plan / site plan etc.) (1 exercise)

**Essential books:**

1. Jensen, J. R., 2011: *Introductory Digital Image Processing: A Remote Sensing Perspective*, New Jersey: Prentice-Hall.
2. Rampal, K K, 1993: *Handbook of Aerial photography and Interpretation*, Concept Publication Comp., New Delhi.
3. Gonzalez, R. C. and Woods, R. E., 2000: *Digital Image Processing*, Addison-Wesley, Singapore.
4. Lillesand, T. M. and Kiefer R. W, 2011: *Remote Sensing and Image Interpretation* – (6<sup>th</sup> Ed.), Wiley, New York
5. De Mers, M. N. 2000: *Fundamentals of Geographic Information Systems* : , John Willey, New York.
6. Longley, P. A M. Goodchild, M., D. J. Maguire, D. J. And Rhind, D. W. 2001: *Geographic Information Systems and Science* , John Willey, New York
7. Fraser Taylor, D.R., (ed.), 1980 : *Progress in Contemporary Cartography*, John Wiley, Chichester U.K.
8. Jones, C., 1997 : *Geographic Information Systems and Computer Cartography*, Longman, London.
10. Kraak, M. J., and Ormeling, F., 2004: *Cartography: Visualization of Geospatial Data*, Pearson Education.
11. Agarwal, N. K. 2004: *Essentials of GPS* , Spatial Networks Pvt. Ltd., Hyderabad.

**Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.

#### **MEV 404 D: Laboratory IV: Practicals on Forest Ecology and Management**

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** To make students familiar with practical aspects of forest ecology and develop skill for field based forest data collection.

#### **Course outcomes**

1. This course will make students familiar with practical aspects of forest ecology
2. The course will enhance student's ability to work in field
3. Collection of forest data will be understood
4. Students will be able to do practicals like measurement of girth increment of forest trees, preparation of herbarium, estimation of forest productivity etc.
5. Students will know time series analysis of rainfall data.

#### ➤ **List of practicals on Forest Ecology and Management**

1. Study of plant biodiversity in homegarden and agroforestry system.
2. Study of phenology and leafing pattern of selected tree species.
3. Measurement of girth increment of forest trees.
4. Study of clump characteristics of bamboo species.
5. Preparation of herbarium.
6. Estimation of forest productivity.
7. Estimation of biomass of sample plots.
8. Measurement of evaporation.
9. Time series analysis of rainfall data.
10. Measurement of infiltration by ring infiltrometer
11. Measurement of ground water level fluctuations.

**Note:** Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.

## MEV 404 E: Laboratory IV: Practicals on Environmental Monitoring and Management

**Total Credit : 04**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** *To develop analytical expertise by utilizing theoretical knowledge of monitoring on different parameters of environmental quality.*

### Course outcomes

1. This course will enhance student's capacity in handling different analytical instruments
2. This course will make students capable of particulate analysis of air samples.
3. Physico-chemical analysis of water samples will be known.
4. Students will be able to estimate basic soil physical properties.
5. Estimation of soil chemical properties will be known

### ➤ List of practicals on Environmental Monitoring and Management

1. Study of particulate air in different localities.
2. Physico-chemical study of different bodies with respect to- colour, odour, turbidity, pH, temperature, DO, etc.
3. Estimation of nitrate and phosphate in different water bodies.
4. Study of bacteriological parameters in different water bodies.
5. Determination of soil pH.
6. Determination of soil organic carbon content.
7. determination of soil porosity and bulk density.
8. Determination of soil moisture content.
9. Determination of noise level in different localities.

### Essential Books

1. *APHA Standard Methods for Examination of Water and Wastewater Examination* (23<sup>rd</sup> Edition), 2017, American Water Works Association, Washington.
2. *Practical Methods for Water and Air Pollution Monitoring* – S.K. Bhargava, 2008, New Age International (P) Limited.
3. *A Textbook of Experiment and Calculation in Engineering Chemistry* – S.S. Dara, 2003, S. Chand and Company Limited.
4. *Environmental Water and Soil Analysis* – P.K. Trivedi, 2014, Gurdeep Raj, Akshadeep Publishing House.

**Note:** *Each and every exercise / practical records including home assignment should contain the Date of Assignment and Date of Submission written on appropriate location of the exercise sheet /note book / record book, which is to be duly signed by concerned teacher on or before the date of submission. There should not be more than 7 days between these two dates for each exercise / home assignment to be completed on regular basis by the student maintaining a standard practical note book/ note sheet. Student can appear for the sessional or end semester examination on practical by submitting completed assigned exercises / home assignments only. The completed practical notebook / record book / sheets should be submitted 5 days before the commencement of the end semester practical examination.*

## MEV 405: Project work

**Total Credit : 04**

**Total Marks : 100** (70 marks for Internal Assessment + 30 marks for End Semester examination)

Course outcomes:

1. The course will help to think environmental aspects of any issue.
2. This course will allow students to identify and design a research problem related to wildlife ecology / Forestry
3. Topics related to Environmental monitoring can be identified
4. Topics related to Hazards and disaster management will be taken for study
5. It will help students to apply theoretical and practical knowledge to carry out a research work on local or regional topic with environmental significance.
6. This course will allow students to utilize various tools and techniques to analyse the research problem.
7. The course will impart training to students on how to present their research work and findings via presentation
8. Students will learn presentation through dissertation and research papers.

Students required carrying out a project work on any topic of their interest which can relate the theoretical, practical and applicability aspect of the subject matter in broader dimensions of environmental issues. The project work is to be related with the Elective Paper (A/B/C) they choose from 3<sup>rd</sup> semester onwards. Students need to submit the output of the project work in the form of a project report supported by presentation and viva-voce during the End Semester examination of 4<sup>th</sup> semester. The project report carries a total of 4 credits (equivalent to 100 marks) which includes Internal Assessment of 70% and End Semester evaluation of 30%.

The Internal Evaluation of 70 marks consists of one progress presentation of 30 marks and pre-submission presentation of 40 marks.

The End Semester Evaluation consists of 30 marks consisting of Project work = 10marks, Final presentation = 10marks and viva-voce = 10marks.

Evaluation process for Project Work

Evaluation stage	Internal Assessment	End Semester
Progress presentation	30	
Pre submission presentation	40	
Final report submission and presentation		30
<b>Total (100)</b>	<b>70</b>	<b>30</b>

The assessment of marks includes following parameters:

- Contents in the report.
- Fulfilment of objectives.
- Methodology and quality of work.
- Findings of the study.
- Regularity and sincerity in work.
- Submission and Presentation.

➤ Viva-voce.



## MEV 406: Disaster Management

**Total Credit : 04**

**Total Lecture : 60**

**Total Marks : 100** (30 marks for Internal Assessment + 70 marks for End Semester examination)

**Objective:** *To provide basic knowledge on various types natural and human induced disasters. To understand the techniques and tools for preparedness, mitigation and overall management of various disasters*

### UNIT I: Understanding Hazards and Disaster

Hazard and Disaster; Natural and Human-induced disasters – Introduction, Conceptual framework; difference between Hazard and Disaster, different stages involved in Disaster; Disaster phenomena and events (*Global, national and regional*).

### UNIT II: Environmental and Human Induced Disasters

Earthquake and associated impacts, structural damage and its prevention, dams and earthquakes; Tsunami: Mechanism and Control; Flood; causes, impacts and mitigation; Drought: causes, impacts, precautions and mitigation; Landslide and River bank Erosion: mechanism and control.

Occupational hazards; Industrial and chemical disasters; road/air/rail accidents; fire incidents; epidemics and disease outbreaks; alcoholism; suicides; crime; poverty; slum and terrorism.

### UNIT III: Disaster Management and Disaster Mitigation

Concept of disaster management; Hyogo framework, Community Based Disaster Management; Concept of mitigation and preparedness, Institutional framework for disaster preparedness and mitigation- Global and Indian scenario; Training and Human Resource Development Plan, Family disaster plan; GIS in Disaster Mitigation.

### UNITIV: Rehabilitation, Reconstruction and Recovery

Recovery aspects- long term and short term, Physical and social infrastructure: Relocation and reconstruction of structural and non-structural components, Social and economic rehabilitation: Capacity building and skill enhancement for livelihood development, training and awareness programmes, medical aid therapy and counselling, agricultural aids. Repair and retrofitting.

**Note:** Seminar and Group Discussion may be incorporated during class hour. Assignments – natural hazards: flood, earthquake, drought, landslide; occupational hazards, fire, alcoholism, crime; CBDM; family disaster plan; recovery aspects of disaster mitigation; social and economic rehabilitation; capacity building for disaster risk reduction . (*Compulsory - any four*).

### Essential books:

1. *Disaster Management: A Disaster Manager's Handbook*, Carter, W.N., 1992, Asian Development Bank, Manila.
2. *Encyclopaedia on Disaster Management: Disaster Management Policy and Administration*, S.L. Goel, 2006, Deep & Deep Publications Pvt. Ltd. New Delhi.
3. *Disaster Management Recent Approaches*. Arvind Kumar, 2010, Anmol Publications Pvt. Ltd. New Delhi.
4. Kapur Anu and Neeti, Meeta, Deeptiman, Roshani and Debanjali, 2005, *Disasters in India Studies of Grim Reality*, Rawat Publications, New Delhi.

### Additional Books:

1. *Vulnerable India* – Anu Kapur, 2010, Sage publications, New Delhi.
2. *Housing in Disaster prone areas, National Building Organization and U.N. Regional Centre*. G.C Mathur, 1986, ESCAP, New Delhi.
3. *Transforming adversity into opportunity: experiences from Gujarat earthquake reconstruction program World congress on Natural disaster mitigation proceedings*, 2004, P.K. Mishra, February.
4. *Natural Hazards and Disasters Management-Vulnerability and Mitigation*, R.B. Singh, 2006, Rawat Pulb.